Massachusetts Technical Reference Manual

for Estimating Savings from Energy Efficiency Measures

2024 Prospective Version

January 9, 2024

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Introduction

This *Massachusetts Technical Reference Manual for Estimating Savings from Energy Efficiency Measures* ("TRM") documents for regulatory agencies, customers, and other stakeholders how the energy efficiency Program Administrators ("PAs") consistently, reliably, and transparently calculate savings from the installation of efficient equipment, collectively called "measures." This reference manual provides methods, formulas, and default assumptions for estimating energy, peak demand, and other resource impacts from efficiency measures.

This document is available in an electronic database that allows interested parties to access reports and data in a consistent and easily accessible format. The electronic reports are accessible online via this link[1].

Within this document, efficiency measures are organized by the sector for which the measure is eligible and by the primary energy source associated with the measure. The three sectors are Residential, Income Eligible, and Commercial & Industrial ("C&I"). The primary energy sources addressed in this technical reference document are electricity and natural gas.

Each measure is presented in its own section as a "measure characterization." The measure characterizations provide mathematical equations for determining savings (algorithms), as well as default assumptions and sources, where applicable. In addition, any descriptions of calculation methods or baselines are provided as appropriate. The parameters for calculating savings are listed in the same order for each measure.

Algorithms are provided for estimating annual energy and peak demand impacts for primary and secondary energy sources if appropriate. In addition, algorithms or calculated results may be provided for other non-energy impacts (such as water savings or operation and maintenance cost savings). Data assumptions are based on Massachusetts PA data where available. Where Massachusetts-specific data is not available, assumptions may be based on: 1) manufacturer and industry data, 2) a combination of the best available data from jurisdictions in the same region, or 3) credible and realistic factors developed using engineering judgment.

This document will be reviewed and updated annually to reflect changes in technology, baselines, and evaluation results.

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[1] https://etrm.anbetrack.com/#/workarea/home?token=6d6c45766e692f527044

TRM Update Process

Overview

This section describes the process for updating this document. The update process is synchronized with the filing of Three-Year Plans and Plan-Year/Term Reports by the PAs with the Department of Public Utilities ("Department").

Updates can include:

- additions of new measures;
- updates to existing measures due to:
    o changes in baseline equipment or practices, affecting measure savings
    o changes in efficient equipment or practices, affecting measure savings
    o changes to deemed savings due the revised assumptions for algorithm parameter values (e.g., due to new market research or evaluation studies)
    o other similar types of changes;
- updates to impact factors (e.g., due to new impact evaluation studies);
- discontinuance of existing measures; and
- updates to the glossary and other background material included in this document.

Each report edition is associated with a specific program year, which corresponds to the calendar year. This document is updated over time as needed to plan for future program savings.

Key Stakeholders and Responsibilities

Key stakeholders and their responsibilities for the TRM updates are detailed in the following table.

Stakeholder	Responsibilities
Coordinating Committee	Administrative coordination of activities, including: Assure collaboration and consensus by the PAs regarding updates Assure updates are compiled from the PAs and incorporated Coordinate with related program activities (e.g., evaluation and program reporting processes)
Program Administrators	Provide one or two representatives to the Coordinating Committee. Both the planning and evaluation functions should be represented on the Committee. Identify needed updates Coordinate with other PAs on all updates File updates with the Department
Department of Energy Resources	Provide one representative to the Coordinating Committee Assure coordination with PA submissions of program plans and reported savings

Update Cycle

Per the Department, starting in 2022, new evaluation results will be applied on a prospective only basis instead of being applied both retrospectively and prospectively. The PAs will update gross savings assumptions and net and gross impact factors each year based on the latest evaluation studies and apply them on a prospective basis to calculate savings in subsequent years. At the beginning of each year, the latest TRM will be posted on Mass Save Data at this [link](#).[2]

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[2] https://www.masssavedata.com/Public/TechnicalReferenceLibrary

Measure Characterization Structure

This section describes the common entries or inputs that make up each measure characterization. A formatted template follows the descriptions of each section of the measure characterization. A single device or behavior is defined as a measure within each program and fuel.

The source of each assumption or default parameter value should be properly referenced.

The image below shows how a measure appears in this document and in the electronic report format. Each section of this measure report is described in more detail below.

Measure Summary

This section includes a high-level categorization of the energy efficiency measure:

Measure Code: A unique way to identify a measure where the first set of characters indicates the market, the second set of characters indicates the category, and the third set is an abbreviated code for the measure name.

Market: This is the sector for which the measure is applicable and can be Residential, Income Eligible or C&I.

Program Type, Category, and Sub-Category: A way of categorizing similar measures.

TRM Version and Version: Indicates that information is for the 2022-2024 TRM and allows for differentiation between versions for potential future updates.

Published On: Date that the measure was published.

01: Description

This section will include a plain text description of the energy efficiency measure, including the benefit(s) of its installation.

02: BCR Measure IDs

This section provides an overview of all individual measures to which the TRM entry applies, including:

BCR Measure Name: <Name used in PAs Benefit-Cost models >
Core Initiative: <Per PA definition, also referred to as Program Name>
BCR Measure ID: <Unique ID used in PAs Benefit-Cost models>

03: Algorithms for Calculating Primary Energy Impact

This section will describe the method for calculating electric savings and electric demand savings in appropriate units.

The savings algorithm will be provided in a form similar to the following:
$$\Delta kWh = \Delta kW \times Hours$$

Similarly, the method for calculating electric demand savings will be provided in a form similar to the following:
$$\Delta kW = (Watts_{BASE} - Watts_{EE})/1000$$

This section also describes any non-electric (gas, propane, oil) savings in appropriate units, i.e., MMBtu associated with the energy efficiency measure, including all assumptions and the method of calculation.

This section will summarize electric and non-electric savings in a table that contains the following information:

BCR Measure Name: <Name used in PAs Benefit-Cost models >
Core Initiative: <Per PA definition, also referred to as Program Name>
Savings: <Measure savings in units of kWh, kW, MMBtu, or other as applicable; this information may be contained in multiple fields>

04: Baseline Efficiency

This section will include a statement of the assumed equipment/operation efficiency in the absence of program intervention. Multiple baselines will be provided as needed, e.g., for different markets. Baselines may refer to reference tables or may be presented as a table for more complex measures.

05: High Efficiency

This section will describe the high efficiency case from which the energy and demand savings are determined. The high efficiency case may be based on specific details of the measure installation, minimum requirements for inclusion in the program, or an energy efficiency case based on historical participation. It may refer to tables within the measure characterization or in the appendices or efficiency standards set by organizations such as ENERGY STAR® and the Consortium for Energy Efficiency.

06: Measure Life

Measure Life includes equipment life, and the effects of measure persistence. Equipment life is the number of years that a measure is installed and will operate until failure. Measure persistence takes into account business turnover, early retirement of installed equipment, and other reasons measures might be removed or discontinued. As applicable, this section may include a table with the following information:

EUL: <Effective Useful Life>
OYF: <Out Year Factor>
RUL: <Remaining Useful Life>
AML: <Adjusted Measure Life>

07: Other Resource Impacts

If applicable, this section describes any water savings associated with the energy efficiency measure, including all assumptions.

08: Impact Factors for Calculating Adjusted Gross Savings

The section includes a table of impact factor values for calculating adjusted gross savings. These include in-service rates, realization rates, and coincidence factors. Further descriptions of the impact factors and the sources on which they are based are described below.

09: Impact Factors for Calculating Net Savings

This section includes a table of impact factors for calculating net savings. These includes free ridership, spillover, and/or net-to-gross ratio. Further descriptions of the impact factors and the sources on which they are based are described below.

Initiative/Program Names

The mapping of full core initiative names to abbreviated names is given below.

Sector	Full Core Initiative Name	Abbreviation
Residential	A1a - Residential New Homes & Renovations	RES_NH&R
	A2a - Residential Coordinated Delivery	RES_CD
	A2c - Residential Retail	RES_RETAIL

Sector	Full Core Initiative Name	Abbreviation
	A2d - Residential Behavior	RES_BEHVR
	A2e - Residential Active Demand Reduction	RES_ADR
Income Eligible	B1a - Income Eligible Coordinated Delivery	IE_CD
	B1b -Income Eligible Active Demand Reduction	IE_ADR
C&I	C1a - C&I New Buildings & Major Renovations	CI_NB&MR
	C2a - C&I Existing Building Retrofit	CI_RETRO
	C2b - C&I New & Replacement Equipment	CI_EQUIP
	C2c - C&I Active Demand Reduction	CI_ADR

Impact Factors for Calculating Adjusted Gross and Net Savings

PAs use the algorithms in the Measure Characterization sections to calculate the gross savings for energy efficiency measures. Impact factors are then applied to make various adjustments to the gross savings estimate to account for the performance of individual measures or energy efficiency programs as a whole in achieving energy reductions as assessed through evaluation studies. Impact factors address both the technical performance of energy efficiency measures and programs, accounting for the measured energy and demand reductions realized compared to the gross estimated reductions, as well as the programs' effect on the market for energy efficient products and services.

This section describes the types of impact factors used to make such adjustments, and how those impacts are applied to gross savings estimates. Definitions of the impact factors and other terms are also provided in Appendix D: Glossary.

Types of Impact Factors

The impact factors used to adjust savings fall into one of two categories:

Impact factors used to adjust gross savings:

- In-Service Rate ("ISR")
- Savings Persistence Factor ("SPF")
- Realization Rate ("RR")
- Summer and Winter Peak Demand Coincidence Factors ("CF")

Impact factors used to calculate net savings:

- Free-Ridership ("FR") and Spillover ("SO") Rates
- Net-to-Gross Ratios ("NTG")

The **in-service rate** is the actual portion of efficient units that are installed. For example, efficient lamps may have an in-service rate less than 1.00 since some lamps are purchased as replacement units and are not immediately installed. The ISR is 1.00 for most measures.

The **savings persistence factor** is the portion of first-year energy or demand savings expected to persist over the life of the energy efficiency measure. The SPF is developed by conducting surveys of installed equipment several years after installation to determine the actual operational capability of the equipment. The SPF is 1.00 for most measures.

In contrast to savings persistence, *measure persistence* takes into account business turnover, early retirement of installed equipment, and other reasons the installed equipment might be removed or discontinued. Measure persistence is generally incorporated as part of the measure life, and therefore is not included as a separate impact factor.

The **realization rate** is used to adjust the gross savings (as calculated by the savings algorithms) based on impact evaluation studies. The realization rate is equal to the ratio of measure savings developed from an impact evaluation to the estimated measure savings derived from the savings algorithms. The realization rate does not include the effects of any other impact factors. Depending on the impact evaluation study, there may be separate Realization Rates for electric energy (kWh), peak demand (kW), or non-electric energy (MMBtu).

A **coincidence factor** adjusts the connected load kW savings derived from the savings algorithm. A coincidence factor represents the fraction of the connected load reduction expected to occur at the same time as a particular system peak period. The coincidence factor includes both coincidence and diversity factors combined into one number, thus there is no need for a separate diversity factor in this TRM.

Coincidence Factors are provided for both the on-peak and seasonal peak periods as defined by the ISO New England for the Forward Capacity Market ("FCM") and are calculated consistently with the FCM methodology. Electric demand reduction during the ISO New England peak periods is defined as follows:

On-Peak Definition:
▪ Summer On-Peak: average demand reduction from 1:00-5:00 PM on non-holiday weekdays in June July, and August
▪ Winter On-Peak: average demand reduction from 5:00-7:00 PM on non-holiday weekdays in December and January

Seasonal Peak Definition:
▪ Summer Seasonal Peak: demand reduction when the real-time system hourly load is equal to or greater than 90% of the most recent "50/50" system peak forecast for June-August
▪ Winter Seasonal Peak: demand reduction when the real-time system hourly load is equal to or greater than 90% of the most recent "50/50" system peak load forecast for December-January

The values described as Coincidence Factors in the TRM are not always consistent with the strict definition of a Coincidence Factor (CF). It would be more accurate to define the Coincidence Factor as "the value that is multiplied by the Gross kW value to calculate the average kW reduction coincident with the peak periods." A coincidence factor of 1.00 may be used because the coincidence is already included in the estimate of Gross kW; this is often the case when the "Max kW Reduction" is not calculated and instead the "Gross kW" is estimated using the annual kWh reduction estimate and a loadshape model.

A **free-rider** is a customer who participates in an energy efficiency program (and gets an incentive) but who would have installed some or all of the same measure(s) on their own, with no change in timing of the installation, if the program had not been available. The **free-ridership rate** is the percentage of savings attributable to participants who would have installed the measures in the absence of program intervention.

The **spillover rate** is the percentage of savings attributable to a measure or program, but additional to the gross (tracked) savings of a program. Spillover includes the effects of 1) participants in the program

who install additional energy efficient measures outside of the program as a result of participating in the program, and 2) non-participants who install or influence the installation of energy efficient measures as a result of being aware of the program. These two components are the **participant spillover** (SO$_P$) and **non-participant spillover** (SO$_{NP}$).

The **net savings** value is the final value of savings that is attributable to a measure or program. Net savings differs from gross savings because it includes the effects of the free-ridership and/or spillover rates.

The **net-to-gross** ratio is the ratio of net savings to the gross savings adjusted by any impact factors (i.e., the "adjusted" gross savings). Depending on the evaluation study, the NTG ratio may be determined from the free-ridership and spillover rates, if available, or it may be a distinct value with no separate specification of FR and SO values.

Standard Net-to-Gross Formulas

The TRM measure entries provide algorithms for calculating the gross savings for those efficiency measures. The following standard formulas show how the impact factors are applied to calculate the adjusted gross savings, which in turn are used to calculate the net savings. These are the calculations used by the PAs to track and report gross and net savings. The gross savings reported by the PAs are the unadjusted gross savings without the application of any impact factors.

Calculation of Net Annual Electric Energy Savings

$$adj\_gross\_kWh = gross\_kWh \times RR_E \times SPF \times ISR$$
$$net\_kWh = adj\_gross\_kWh \times NTG$$

Calculation of Net Summer Electric Peak Demand Coincident kW Savings

$$adj\_gross\_kW_{SP} = gross\_kW \times RR_{SP} \times SPF \times ISR \times CF_{SP}$$
$$net\_kW_{SP} = adj\_gross\_kW_{SP} \times NTG$$

Calculation of Net Winter Electric Peak Demand Coincident kW Savings

$$adj\_gross\_kW_{WP} = gross\_kW \times RR_{WP} \times SPF \times ISR \times CF_{WP}$$
$$net\_kW_{WP} = adj\_gross\_kW_{WP} \times NTG$$

Calculation of Net Annual Natural Gas Energy Savings

$$adj\_gross\_MMBtu = gross\_MMBtu \times RR_{NE} \times SPF \times ISR$$
$$net\_MMbtu = adj\_gross\_MMBtu \times NTG$$

Depending on the evaluation study methodology:

- NTG is equal to (1 – FR + SO$_P$ + SO$_{NP}$), or
- NTG is a single value with no distinction of FR, SO$_P$, SO$_{NP}$, and/or other factors that cannot be reliably isolated.

Where:

Gross_kWh	=	Gross Annual kWh Savings
adj_gross_kWh	=	Adjusted Gross Annual kWh Savings
net_kWh	=	Net Annual kWh Savings
$Gross\_kW_{SP}$	=	Gross Connected kW Savings (summer peak)
$adj\_gross\_kW_{SP}$	=	Adjusted Gross Connected kW Savings (summer peak)
$Gross\_kW_{WP}$	=	Gross Connected kW Savings (winter peak)
$adj\_gross\_kW_{WP}$	=	Adjusted Gross Connected kW Savings (winter peak)
net_kW_{SP}	=	Adjusted Gross Connected kW Savings (summer peak)
net_kW_{WP}	=	Net Coincident kW Savings (winter peak)
Gross_MMBtu	=	Gross Annual MMBtu Savings
adj_gross_MMBtu	=	Adjusted Gross Annual MMBtu Savings
net_MMBtu	=	Net Annual MMBtu Savings
SPF	=	Savings Persistence Factor
ISR	=	In-Service Rate
CF_{SP}	=	Peak Coincidence Factor (summer peak)
CF_{WP}	=	Peak Coincidence Factor (winter peak)
RR_E	=	Realization Rate, electric(kWh)
RR_{NE}	=	Realization Rate, non-electric (MMBtu)
RR_{SP}	=	Realization Rate for summer peak kW
RR_{WP}	=	Realization Rate for winter peak kW
NTG	=	Net-to-Gross Ratio
FR	=	Free-Ridership Factor
SO_P	=	Participant Spillover Factor
SO_{NP}	=	Non-Participant Spillover Factor

Calculations of Coincident Peak Demand kW Using "Seasonal Peak" Coincidence Factors

The formulas above for peak demand kW savings use the "on-peak" Coincidence Factors: (CF_{SP}, CF_{WP}), which apply the "on-peak" coincidence methodology as allowed for submission to the FCM. The

alternative methodology is the "seasonal peak" methodology, which uses the identical formulas, but substituting the "seasonal peak" Coincidence Factors for the "on-peak" coincidence factors:

CF_{SSP}	=	Peak Coincidence Factor for Summer Seasonal Peak
CF_{WSP}	=	Peak Coincidence Factor for Winter Seasonal Peak

1 Residential Efficiency Measures

1.1 Appliance - Clothes Dryer

Measure Code	RES-A-CD
Market	Residential
Program Type	Retrofit
Category	Appliances

Measure Description:

Clothes Dryers exceeding minimum qualifying efficiency standards established as ENERGY STAR with drum moisture sensors and associated moisture sensing controls achieve greater energy savings over clothes dryers that do not have moisture sensors.

BCR Measure IDs:

Measure	Core Initiative	BCR Measure ID
Clothes Dryer (Energy Star)	Residential Retail (RES_RETAIL)	EA2c077

Algorithms for Calculating Primary Energy Impact:

Unit savings are deemed based on the following algorithms and assumptions:
Annual kWh Savings = Annual kWh usage baseline – Annual kWh usage Energy Star
Annual kWh usage baseline= (lbs/load) / Baseline CEF * loads/yr
Annual kWh usage ENERGY STAR= (lbs/load) / ENERGY STAR CEF * loads/yr
Where:
Baseline Combined Energy Factor (CEF) (lbs/kWh) = 3.11[1]
ENERGY STAR CEF = 3.93[2]
Lbs/load = 8.45[3]
Loads/Year = 283[4]

Demand savings are derived from the demand impact model which is developed as part of the Residential Baseline Study.[1]

Measure Name	ΔkWh	ΔkW
Dryer (Energy Star)	160	0.05

Baseline Efficiency:

The baseline efficiency case is a new electric resistance dryer that meets the federal standard as of January 1, 2015 which is an Energy Factor (EF) of 3.73 for a vented standard dryer.   Different testing

procedures were used in setting the federal standard (DOE Test Procedure Appendix D1) and the Energy Star standard (DOE Test Procedure Appendix D2). To enable comparison a baseline CEF of 3.11 is used. This was derived from ENERGY STAR Version 1.0 Estimated Baseline which multiplies the 2015 federal standard by the average change in electric dryers' assessed CEF between Appendix D1 and Appendix D2: 3.73-(3.73*0.166).

High Efficiency:

The high efficiency case is a new electric resistance dryer that meets the Energy Star standard as of January 1, 2015. The ENERGY STAR CEF (Combined Energy Factor) is 3.93.

Measure Life:

The measure life is 16 years.[5]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Dryer (Energy Star)	RES_RETAIL	All	16	n/a	n/a	16

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Dryer (Energy Star)	RES_RETAIL	All	0.99	1.00	n/a	1.00	1.00	0.42	0.56

In-Service Rates:
The in-service rate is 99% based on evaluation results.[6]

Realization Rates:
Realization rates are based on Massachusetts Common Assumptions.

Coincidence Factors:
Summer and winter coincidence factors are estimated using the demand allocation methodology described in the Demand Impact Model which is developed based on the Residential Baseline Study.[7]

Impact Factors for Calculating Net Savings:

Net-to-Gross values are based on evaluation results.[8]

2022

Measure Name	Core Initiative	PA	FR	SO$_P$	SO$_{NP}$	NTG
Dryer (Energy Star)	RES_RETAIL	All	0.47	0.00	0.00	0.53

2023

Measure Name	Core Initiative	PA	FR	SO$_P$	SO$_{NP}$	NTG
Dryer (Energy Star)	RES_RETAIL	All	0.48	0.00	0.00	0.52

2024

Measure Name	Core Initiative	PA	FR	SO$_P$	SO$_{NP}$	NTG
Dryer (Energy Star)	RES_RETAIL	All	0.48	0.00	0.00	0.52

Non-Energy Impacts:

There are no non-energy impacts identified for this measure.

Endnotes:

1 : DOE (2015). 10 CFR Part 431 March 27, 2015. Energy Conservation Program: Energy Conservation Standards for Residential Clothes Dryers. Table II.7. http://www.gpo.gov/fdsys/pkg/FR-2015-03-27/pdf/2015-07058.pdf

2 : DOE (2015). 10 CFR Part 431 March 27, 2015. Energy Conservation Program: Energy Conservation Standards for Residential Clothes Dryers. Table II.7. http://www.gpo.gov/fdsys/pkg/FR-2015-03-27/pdf/2015-07058.pdf

3 : DOE (2013). 10 CFR Parts 429 and 430 August 14, 2013. Energy Conservation Program: Test Procedures for Residential Clothes Dryers; Final Rule. Table 11.1. http://www.gpo.gov/fdsys/pkg/FR-2013-08-14/pdf/2013-18931.pdf

4 : DOE (2013). 10 CFR Parts 429 and 430 August 14, 2013. Energy Conservation Program: Test Procedures for Residential Clothes Dryers; Final Rule. Table 11.1. http://www.gpo.gov/fdsys/pkg/FR-2013-08-14/pdf/2013-18931.pdf

5 : Guidehouse (2021). Comprehensive TRM Review. 2021_Guidehouse_TRM_Final_Report

6 : NMR Group, Inc. (2021). Residential Products NTG Report. 2021_NMR_Res_Products_NTG_Report

7 : Guidehouse (2020). Residential Baseline Study Phase 4 2020_Guidehouse_Residential_Baseline_Phase_4

8 : NMR Group, Inc. (2021). Residential Products NTG Report. 2021_NMR_Res_Products_NTG_Report

1.2 Appliance - Dehumidifier

Measure Code	RES-PL-DH
Market	Residential
Program Type	Retrofit
Category	Appliances

Measure Description:

Rebate for the purchase of an Energy Star dehumidifier or early retirement of an existing dehumidifier.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Dehumidifier	Residential Retail (RES_RETAIL)	EA2c075
Dehumidifier Recycling	Residential Retail (RES_RETAIL)	EA2c076

Algorithms for Calculating Primary Energy Impact:

Unit savings are deemed based on the following algorithms and assumptions:

ΔkWh New = Dehumidification Load * ((1/EffBase)-(1/EffEE))
ΔkWh Recycling = Dehumidification Load * ((1/EffRetire)-(1/EffBase))

Where:
Dehumidification Load = Typical annual moisture removal, in Liters/year.   Average annual dehumidification load is 1,520 Liters/year.[1]
EffRETIRE = Average efficiency of model being recycled, in Liters/kWh (1.6 Liters/kWh)
EffBASE = Average efficiency of model meeting the federal standard, in Liters/kWh (2.8 Liters/kWh)
EffEE = Efficiency of ENERGY STAR® model, in Liters/kWh (3.3 Liters/kWh)

Dehumidifier Recycling savings is from an evaluation study.[2]

Demand savings are derived from the demand impact model which is developed as part of the Residential Baseline Study.[3]

Measure Name	ΔkWh	ΔkW
Dehumidifier	82.3	0.02
Dehumidifier Recycling	1,020	0.24

Baseline Efficiency:

The baseline efficiency for rebates on new equipment is a unit meeting the current federal standard (2.8 Liters/kWh).[4] The baseline efficiency for recycling is a unit that is approximately 8 years old, meeting the standard that was in place at the time (1.6 Liters/kWh).[5]

High Efficiency:

The high efficiency case for rebates on new equipment is an ENERGY STAR® unit (3.3 Liters/kWh).[6] The high efficiency case for recycling is a new unit that meets the current federal standard (2.8 Liters/kWh).

Measure Life:

The measure life is 17 years for the dehumidifier and 4 years for dehumidifier recycling. [7]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Dehumidifier	RES_RETAIL	All	17	n/a	n/a	17
Dehumidifier Recycling	RES_RETAIL	All	4	n/a	n/a	4

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Dehumidifier	RES_RETAIL	All	0.99	1.00	n/a	1.00	1.00	0.82	0.17
Dehumidifier Recycling	RES_RETAIL	All	1.00	1.00	n/a	1.00	1.00	0.82	0.17

In-Service Rates:
In-service rate for units incentivized through rebates is based on evaluation results.[8]   For recycling, in service rates are 100% because recycled units are collected.

Realization Rates:
Realization rates are set to 100% as unit savings are deemed.

Coincidence Factors:
Summer and winter coincidence factors are estimated using the demand allocation methodology described in the Demand Impact Model which is developed based on the Residential Baseline Study.[9]

Impact Factors for Calculating Net Savings:

Net-to-Gross values are based on evaluation results.[10] [11]

2022

Measure Name	Core Initiative	PA	FR	SO$_P$	SO$_{NP}$	NTG
Dehumidifier	RES_RETAIL	All	0.51	0.00	0.00	0.49

2023

Measure Name	Core Initiative	PA	FR	SO$_P$	SO$_{NP}$	NTG
Dehumidifier	RES_RETAIL	All	0.53	0.00	0.00	0.47

2024

Measure Name	Core Initiative	PA	FR	SO$_P$	SO$_{NP}$	NTG
Dehumidifier	RES_RETAIL	All	0.55	0.00	0.00	0.45

2022-2024

Measure Name	Core Initiative	PA	FR	SO$_P$	SO$_{NP}$	NTG
Dehumidifier Recycling	RES_RETAIL	All	0.59	0.00	0.00	0.41

<u>Non-Energy Impacts:</u>

There are no non-energy impacts identified for this measure.

<u>Endnotes:</u>

1 : Guidehouse (2021). Comprehensive TRM Review. 2021_Guidehouse_TRM_Final_Report
2 : Guidehouse (2021). Appliance Recycling Impact Study
2021_Guidehouse_Appliance_Recycling_2019_Impact_Report
3 : Guidehouse (2020). Residential Baseline Study Phase 4
2020_Guidehouse_Residential_Baseline_Phase_4
4 : 2020 Current Federal Standard: https://www.ecfr.gov/cgi-bin/text-idx?rgn=div8&node=10:3.0.1.4.18.3.9.2
5 : 2012 Federal Standard
6 : ENERGY STAR Dehumidifiers Version 5
7 : Guidehouse (2021). Comprehensive TRM Review. 2021_Guidehouse_TRM_Final_Report
8 : NMR Group Inc. (2021). Residential Products In Service Rates Memo. 2021_NMR_Products_ISR
9 : Guidehouse (2020). Residential Baseline Study Phase 4
2020_Guidehouse_Residential_Baseline_Phase_4
10 : NMR Group, Inc. (2021). Residential Products NTG Report.
2021_NMR_Res_Products_NTG_Report
11 : NMR Group, Inc. (2021). Appliance Recycling NTG Report.
2021_NMR_Appliance_Recycling_NTG_Report

1.3 Appliance - Early Retirement Clothes Washer

Measure Code	RES-A-ERCW
Market	Residential
Program Type	Retrofit
Category	Appliances

Measure Description:

The replacement and recycling of a working top-loading clothes washer with an agitator with an Energy Star rated washing machine.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Early Retirement CW Elec DHW & Elec Dryer - Retire	Residential Retail (RES_RETAIL)	EA2c301
Early Retirement CW Elec DHW & Elec Dryer - EE	Residential Retail (RES_RETAIL)	EA2c302
Early Retirement CW Gas DHW & Elec Dryer - Retire	Residential Retail (RES_RETAIL)	EA2c303
Early Retirement CW Gas DHW & Elec Dryer - EE	Residential Retail (RES_RETAIL)	EA2c304
Early Retirement CW Elec DHW & Gas Dryer - Retire	Residential Retail (RES_RETAIL)	EA2c305
Early Retirement CW Elec DHW & Gas Dryer - EE	Residential Retail (RES_RETAIL)	EA2c306
Early Retirement CW Oil DHW & Elec Dryer - Retire	Residential Retail (RES_RETAIL)	EA2c307
Early Retirement CW Oil DHW & Elec Dryer - EE	Residential Retail (RES_RETAIL)	EA2c308
Early Retirement CW Gas DHW & Gas Dryer - Retire	Residential Retail (RES_RETAIL)	EA2c309
Early Retirement CW Gas DHW & Gas Dryer - EE	Residential Retail (RES_RETAIL)	EA2c310

Measure Name	Core Initiative	BCR Measure ID
Early Retirement CW Propane DHW & Elec Dryer - Retire	Residential Retail (RES_RETAIL)	EA2c311
Early Retirement CW Propane DHW & Elec Dryer - EE	Residential Retail (RES_RETAIL)	EA2c312
Early Retirement CW (EE) Gas DHW & Elec Dryer	Residential Retail (RES_RETAIL)	GA2c050
Early Retirement CW (Retire) Gas DHW & Elec Dryer	Residential Retail (RES_RETAIL)	GA2c051
Early Retirement CW (EE) Gas DHW & Elec Dryer (Muni)	Residential Retail (RES_RETAIL)	GA2c052
Early Retirement CW (Retire) Gas DHW & Elec Dryer (Muni)	Residential Retail (RES_RETAIL)	GA2c053
Early Retirement CW (EE) Elec DHW & Gas Dryer	Residential Retail (RES_RETAIL)	GA2c054
Early Retirement CW (Retire) Elec DHW & Gas Dryer	Residential Retail (RES_RETAIL)	GA2c055
Early Retirement CW (EE) Elec DHW & Gas Dryer (Muni)	Residential Retail (RES_RETAIL)	GA2c056
Early Retirement CW (Retire) Elec DHW & Gas Dryer (Muni)	Residential Retail (RES_RETAIL)	GA2c057
Early Retirement CW (EE) Gas DHW & Gas Dryer	Residential Retail (RES_RETAIL)	GA2c058
Early Retirement CW (Retire) Gas DHW & Gas Dryer	Residential Retail (RES_RETAIL)	GA2c059

Algorithms for Calculating Primary Energy Impact:

Unit savings are deemed based on the following algorithms and assumptions:

ΔkWh = [(Capacity x 1/IMEFbase x Ncycles) * (%CWkwhbase + %DHWkwhbase + %Dryerkwhbase)] - [(Capacity x 1/IMEFeff x Ncycles) x (%CWkwheff + %DHWkwheff + %Dryerkwheff)]
ΔMMBTUs = [(Capacity x 1/MEFbase x Ncycles) x ((%DHWffbase x r_eff) + %Dryerffbase] - [(Capacity x 1/MEFeff x Ncycles) x (%DHWffeff x r_eff) + %Dryergaseff]xMMBTU_convert

Where:
Capacity = washer volume in ft3.

IMEF = Integrated Modified Energy Factor and is measured in ft3 /kWh/cycle

Ncycles = 283 loads per year[1]

%CWkwh = % of total kWh energy consumption for clothes washer operation (different for baseline and efficient unit). See table below

%DHWkwh = % of total kWh energy consumption used for water heating (different for baseline and efficient unit). See table below. If water is heated by gas or propane this is 0%

%DHWff = % of total kWh energy consumption for dryer operation (different for baseline and efficient unit). See table below. If the dryer is gas this is 0%

%Dryerkwh = % of total fossil fuel energy consumption used for water heating (different for baseline and efficient unit). See table below. If water is heated by electric this is 0%.

%Dryerff = % of total fossil fuel energy consumption for dryer operation (different for baseline and efficient unit). See table below. If the dryer is electric this is 0%.

r_eff = recovery energy factor used to account for the difference in recovery efficiencies of electric and gas/oil/propane hot water heaters. Electric water heaters are 100% efficient while other water heaters are 75% efficient. The ratio is 1.33 (100%/75%)

MMBTU_convert = Conversion factor from kWh to MMBTU is 0.003412

Efficiency Ratings and Percentage of Total Energy Consumption[2]

	% Energy used for:			IMEF	IWF	Volume
	Washer operation	Water heating	Drying	ft3/kWh /cycle	gallons/cycle /ft3	ft3
Existing-Top Loading CW	8%	34%	59%	0.84	9.92	3.1
New-Federal Standard Top Loading CW	3%	40%	56%	1.57	6.50	3.9
New-Energy Star Top Loading CW	4%	31%	65%	2.06	4.30	4.3

Savings from Early Retirement of Clothes Washers
Demand savings are derived from the demand impact model which is developed as part of the Residential Baseline Study.[3]

Measure Name	ΔkWh	ΔkW	ΔMMBtu
Early Retirement CW (Retire) Elec DHW & Elec Dryer	342	0.1	0
Early Retirement CW (EE) Elec DHW & Elec Dryer	112	0.03	0
Early Retirement CW (Retire) Gas DHW & Elec Dryer	272	0.08	0.32
Early Retirement CW (EE) Gas DHW & Elec Dryer	12	0	0.46
Early Retirement CW (Retire) Elec DHW & Gas Dryer	125	0.04	0.74
Early Retirement CW (EE) Elec DHW & Gas Dryer	101	0.03	0.04
Early Retirement CW (Retire) Gas DHW & Gas Dryer	56	0.02	0.32 / 0.74

Early Retirement CW (EE) Gas DHW & Gas Dryer	0.8	0	0.46 / 0.04
Early Retirement CW (Retire) Oil DHW & Elec Dryer	272	0.08	0.32
Early Retirement CW (EE) Oil DHW & Elec Dryer	12	0	0.46
Early Retirement CW (Retire) Propane DHW & Elec Dryer	272	0.08	0.32
Early Retirement CW (EE) Propane DHW & Elec Dryer	12	0	0.46

Baseline Efficiency:

It is assumed that the existing top loading clothes washer met the 2007 federal standard which was an MEF > 1.262 and WF < 9.53. This is equivalent to an IMEF of 0.84 and IWH of 9.92. A new standard efficiency clothes washer meets the federal standard for top loading washers effective 1/1/18 which requires an IMEF > 1.57 and an IWF < 6.5.

MEF is Modified Energy Factor and is measured in ft^3/kWh/cycle

WF is Water Factor and is measured in gallons/cycle/ft

IMEF is Integrated Modified Energy Factor and is measured in ft^3/kWh/cycle

IWF is Integrated Water Factor and is measured in gallons/cycle/ft3

High Efficiency:

The new high efficiency washer is an Energy Star (Version 8.0) rated washer top loading washer with a minimum IMEF > 2.06 and IWF < 4.3.[4]

Measure Life:

The effective useful life of the new clothes washer is assumed to be 12 years.[5] The remaining useful life of the existing clothes washer is assumed to be 1/3 of the effective useful life which is 4 years.

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Early Retirement CW (Retire)	RES_CD	All	4	n/a	n/a	4
Early Retirement CW (EE)	RES_CD	All	12	n/a	n/a	12

Other Resource Impacts:

Water savings are calculated using the following algorithm:

ΔWater (gallons) = (Capacity * (IWFbase - IWFeff)) * Ncycles

Water savings for the Retire portion is 1,568 gallons and 1,903 gallons for the EE portion. Total water savings are 3,471 gallons.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Early Retirement CW (Retire)	RES_CD	All	1.00	1.00	n/a	1.00	1.00	0.42	0.56
Early Retirement CW (EE)	RES_CD	All	1.00	1.00	n/a	1.00	1.00	0.42	0.56

In-Service Rates:
In-service rates are set to 100% based on the assumption that all purchased units are installed.

Realization Rates:
Realization rates are based on Massachusetts Common Assumptions.

Coincidence Factors:
Summer and winter coincidence factors are estimated using the demand allocation methodology described in the Demand Impact Model which is developed based on the Residential Baseline Study.[6]

Impact Factors for Calculating Net Savings:

Net-to-Gross values have not been studied. The default NTG is 1.00.

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Early Retirement CW (Retire)	RES_CD	All	0.00	0.00	0.00	1.00
Early Retirement CW (EE)	RES_CD	All	0.00	0.00	0.00	1.00

Non-Energy Impacts:

There are no NEIs associated with this measure.

Endnotes:

1 : DOE (2013). 10 CFR Parts 429 and 430 Energy Conservation Program: Test Procedures for Residential Clothes Dryers; Final Rule. DOE_2013_Test_Procedures_for_Residential_Clothes_Dryers
2 : DOE (2012). Residential Clothes Washers Direct Final Rule Technical Support Document; Chapter 7. DOE_2012_Technical_Support_Document_Clothes_Washers
3 : Guidehouse (2020). Residential Baseline Study Phase 4
2020_Guidehouse_Residential_Baseline_Phase_4

4 : New Energy Star standard for top loading washers as of 2/15/2018
5 : Environmental Protection Agency (2018). Savings Calculator for ENERGY STAR Qualified Appliances. https://www.energystar.gov/sites/default/files/asset/document/appliance_calculator.xlsx
Energy_Star_2018_Consumer_Appliance_Calc
6 : Guidehouse (2020). Residential Baseline Study Phase 4
2020_Guidehouse_Residential_Baseline_Phase_4

1.4 Appliance - Heat Pump Clothes Dryer

Measure Code	RES-A-HPCD
Market	Residential
Program Type	Retrofit
Category	Appliances

Measure Description:

Heat pump dryers take in ambient air, heat it, and then recirculate it in the dryer to maintain the temperature without using much energy. Rather than releasing moist air through a dryer vent to the exterior of the home as a conventional dryer does, a heat pump dryer passes humid air in the dryer drum through a condenser to remove the moisture without losing too much heat.

BCR Measure IDs:

Measure	Core Initiative	BCR Measure ID
Heat Pump Dryer - Standard	Residential Retail (RES_RETAIL)	EA2c391
Heat Pump Dryer - Compact	Residential Retail (RES_RETAIL)	EA2c390

Algorithms for Calculating Primary Energy Impact:

Unit savings are deemed based on the following algorithms and assumptions:
Annual kWh Savings = Annual kWh usage baseline – Annual kWh usage Energy Star
Annual kWh usage = (lbs/load) / CEF * loads/yr
Where:
Baseline Combined Energy Factor (CEF) (lbs/kWh) = 3.11 for standard dryers, 2.73 for compact dyers[1]
ENERGY STAR CEF = 6.5 for standard dryers, 6.2 for compact dryers[2]
Lbs/load = 8.45 for standard size and 3.0 for compact size[3]
Loads/Year = 236[4]
Baseline Standard Size blended usage = 468 kWh, 5.1 therms, 0.02 propane MMBTUs
Energy Star Most Efficient Standard Size usage = 307 kWh
Baseline Compact Size blended usage = 189 kWh, 1.8 therms, 0.01 propane MMBTUs
Energy Star Most Efficient Compact Size usage = 114 kWh
Demand savings are derived from the demand impact model which is developed as part of the Residential Baseline Study.[1]

Measure Name	ΔkWh	ΔkW	ΔTherms	ΔMMBTU (propane)
Energy Star Most Efficient Standard Size	161	0.05	5.1	0.02

Energy Star Most Efficient Compact Size	75	0.02	1.8	0.01

Baseline Efficiency:

The baseline efficiency case is a blended baseline, between electric, gas, and propane dryers (73% electric, 26% natural gas, 1% propane, based on MA prevalence). The electric baseline is a new electric resistance dryer that meets the federal standard as of January 1, 2015, which is an Energy Factor (EF) of 3.73 for a vented standard dryer and 3.27 for compact (240V) dryer.[5]

Different testing procedures were used in setting the federal standard (DOE Test Procedure Appendix D1) and the Energy Star standard (DOE Test Procedure Appendix D2). To enable comparison a baseline Combined Energy Factor (CEF) of 3.11 is used for the standard dryers and 2.73 for the compact dryer. This was derived from ENERGY STAR Version 1.0 Estimated Baseline which multiplies the 2015 federal standard by the average change in electric dryers' assessed CEF between Appendix D1 and Appendix D2: 3.73- (3.73*0.166) and 3.27- (3.27*01.66). The gas baseline is a gas dryer that meets the federal standard as of January 1, 2015, which is a CEF of 3.48. The propane baseline is a propane dryer which has the same efficiency as the gas dryer.

High Efficiency:

The Energy Star Most Efficient Heat Pump Dryer has a CEF of 6.5 for the standard size and 6.2 for the compact size

Measure Life:

The measure life is 16 years.[6]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Heat Pump Clothes Dryer	RES_RETAIL	All	16	n/a	n/a	16

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Heat Pump Clothes Dryer	RES_RETAIL	All	0.99	1.00	n/a	1.00	1.00	0.42	0.56

In-Service Rates:
The in-service rate is 100%

Realization Rates:

Realization rates are set to 100%

Coincidence Factors:

Summer and winter coincidence factors are estimated using the demand allocation methodology described in the Demand Impact Model which is developed based on the Residential Baseline Study.[7]

Impact Factors for Calculating Net Savings:

Measure Name	Core Initiative	PA	FR	SO$_P$	SO$_{NP}$	NTG
Heat Pump Clothes Dryer	RES_RETAIL	All	0.0	0.00	0.00	1.00

Non-Energy Impacts:

There are no non-energy impacts identified for this measure.

Endnotes:

1 : https://www.govinfo.gov/content/pkg/CFR-2012-title10-vol3/pdf/CFR-2012-title10-vol3-sec430-32.pdf

2 : Average CEF of available ENERGY STAR Most Efficient Clothes Dryers with Heat Pump technology. EPA ENERGY STAR. May 2023. https://www.energystar.gov/productfinder/product/certified-clothes-dryers/.

3 : Energy Efficiency and Renewable Energy Office (2021). 2021-10-22 Energy Conservation Program: Test Procedure for Clothes Dryers; Final rule. https://www.regulations.gov/document/EERE-2014-BT-TP-0034-0039

4 : Energy Efficiency and Renewable Energy Office (2021). 2021-10-22 Energy Conservation Program: Test Procedure for Clothes Dryers; Final rule. https://www.regulations.gov/document/EERE-2014-BT-TP-0034-0039

5 : https://www.govinfo.gov/content/pkg/CFR-2012-title10-vol3/pdf/CFR-2012-title10-vol3-sec430-32.pdf

6 : Guidehouse (2021). Comprehensive TRM Review. 2021_Guidehouse_TRM_Final_Report

7 : Guidehouse (2020). Residential Baseline Study Phase 4
2020_Guidehouse_Residential_Baseline_Phase_4

1.5 Appliance - Refrigerator/Freezer Recycling

Measure Code	RES-A-RFR
Market	Residential
Program Type	Retrofit
Category	Appliances

Measure Description:

The retirement of old, inefficient refrigerators and freezers.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Freezer Recycling	Residential Retail (RES_RETAIL)	EA2c052
Refrigerator Recycling (Combined)	Residential Retail (RES_RETAIL)	EA2c066

Algorithms for Calculating Primary Energy Impact:

Unit savings are deemed and are obtained from the referenced study.[1]   Demand savings are derived from the demand impact model which is developed as part of the Residential Baseline Study.[2]

Measure Name	ΔkWh	ΔkW
Freezer Recycling	753	0.13
Refrigerator Recycling	1005	0.17

Baseline Efficiency:

The baseline efficiency case is an old, inefficient working refrigerator or freezer.

High Efficiency:

The high efficiency case assumes no replacement of the recycled unit.

Measure Life:

The measure life is 4 years.

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML

Freezer Recycling	RES_RETAIL	All	4	n/a	n/a	4
Refrigerator Recycling	RES_RETAIL	All	4	n/a	n/a	4

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR$_E$	RR$_{NE}$	RR$_{SP}$	RR$_{WP}$	CF$_{SP}$	CF$_{WP}$
Freezer Recycling	RES_RETAIL	All	1.00	0.83	0.83	0.83	0.83	0.85	0.65
Refrigerator Recycling	RES_RETAIL	All	1.00	0.88	0.88	0.88	0.88	0.85	0.65

In-Service Rates:
All installations have 100% in service rate.

Realization Rates:
Realization rates represent the Part Use Factor, and account for units not being plugged in for the entire year.[3]

Coincidence Factors:
Summer and winter coincidence factors are estimated using the demand allocation methodology described in the Demand Impact Model which is developed based on the Residential Baseline Study.[4]

Impact Factors for Calculating Net Savings:

Net-to-gross factors are based on study results.[5]

Measure Name	Core Initiative	PA	FR	SO$_P$	SO$_{NP}$	NTG
Freezer Recycling	RES_RETAIL	All	0.50	0.00	0.00	0.50
Refrigerator Recycling	RES_RETAIL	All	0.54	0.00	0.00	0.46

Non-Energy Impacts:

There are no non-energy impacts identified with this measure.

Endnotes:

1 : Guidehouse (2021). Appliance Recycling Impact Study.
2021_Guidehouse_Appliance_Recycling_2019_Impact_Report

2 : Guidehouse (2020). Residential Baseline Study Phase 4
2020_Guidehouse_Residential_Baseline_Phase_4
3 : Guidehouse (2021). Appliance Recycling Impact Study
2021_Guidehouse_Appliance_Recycling_2019_Impact_Report
4 : Guidehouse (2020). Residential Baseline Study Phase 4
2020_Guidehouse_Residential_Baseline_Phase_4
5 : NMR Group, Inc. (2021). Appliance Recycling NTG Report.
2021_NMR_Appliance_Recycling_NTG_Report

1.6 Appliance - Room Air Cleaner

Measure Code	RES-PL-RAC
Market	Residential
Program Type	Time of Sale
Category	Appliances

Measure Description:

Rebates provided for the purchase of an ENERGY STAR® qualified room air cleaner. ENERGY STAR® air cleaners are 40% more energy-efficient than standard models.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Room Air Cleaner	Residential Retail (RES_RETAIL)	EA2c072

Algorithms for Calculating Primary Energy Impact:

Unit savings are deemed based on averaged inputs.[1] The weight is based on 2019 - Aug 2020 National Grid rebated units.

CADR Range	CADR Value in Calculator	Baseline Consumption (kWh)	High Efficiency Consumption (kWh)	Energy Savings (kWh)	Weight
51-100	75	441	148	293	11%
101-150	125	733	245	488	33%
151-200	175	1025	342	683	15%
201-250	225	1317	440	877	22%
Over 250	300	1755	586	1169	19%

kW savings is based on a 24 hour operation.

Measure Name	kWh	kW
Room Air Cleaner	713	0.08

Baseline Efficiency:

The baseline efficiency case is a unit with 1.0 CADR/Watt$_{dust}$.[2]

High Efficiency:

The current EnergyStar specification requires a minimum of 2.0 CADR/Watt$_{dust}$. However, the ENERGY STAR average CADR/Watt (Dust) of models available in their US market database (approximately 170 models) is approximately 3.5 CADR/Watt$_{dust}$. Therefore it is assumed that the high efficiency unit has a 3.0 CADR/Watt$_{dust}$

Measure Life:

The measure life is 9 years.[3]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Room Air Cleaner	RES_RETAIL	All	9	n/a	n/a	9

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR$_E$	RR$_{NE}$	RR$_{SP}$	RR$_{WP}$	CF$_{SP}$	CF$_{WP}$
Room Air Cleaner	RES_RETAIL	All	0.97	1.00	n/a	1.00	1.00	1.00	1.00

In-Service Rates:
In-service rates is based on evaluation results.[4]

Realization Rates:
Realization rates are set to 100% since unit savings are deemed.

Coincidence Factors:
Summer and winter coincidence factors are calculated assuming that the unit runs continuously, 8760 hours/year.

Impact Factors for Calculating Net Savings:

Net to gross factors are based on evaluation results and are weighted based on 2020 sales (53% in-store and 47% online).[5]

2022

Measure Name	Core Initiative	PA	FR	SO$_P$	SO$_{NP}$	NTG

| Room Air Cleaner | RES_RETAIL | All | 0.34 | 0.00 | 0.00 | 0.66 |

2023

Measure Name	Core Initiative	PA	FR	SO$_P$	SO$_{NP}$	NTG
Room Air Cleaner	RES_RETAIL	All	0.36	0.00	0.00	0.64

2024

Measure Name	Core Initiative	PA	FR	SO$_P$	SO$_{NP}$	NTG
Room Air Cleaner	RES_RETAIL	All	0.37	0.00	0.00	0.63

Non-Energy Impacts:

There are no non-energy impacts identified for this measure.

Endnotes:

1 : Guidehouse (2021). Comprehensive TRM Review. 2021_Guidehouse_TRM_Final_Report
2 : Guidehouse (2021). Comprehensive TRM Review. 2021_Guidehouse_TRM_Final_Report
3 : Environmental Protection Agency (2018). Savings Calculator for Energy Star Qualified Appliances. Energy_Star_2018_Consumer_Appliance_Calc
4 : NMR Group Inc. (2021). Residential Products In Service Rates Memo. 2021_NMR_Products_ISR
5 : NMR Group, Inc. (2021). Residential Products NTG Report. 2021_NMR_Res_Products_NTG_Report

1.7 Appliance - Ultra Low GWP Refrigerator

Market	Residential
Measure Code	RES-CM-REF
Program Type	Lost Opportunity
Category	Appliances

Measure Description:

Rebates for purchase of Energy Star Most Efficiency qualified refrigerators using a natural refrigerant.

BCR Measure IDs:

Measure	Core Initiative	BCR Measure ID
Ultra Low GWP Refrigerator	Residential Retail (RES_RETAIL)	EA2c342

Algorithms for Calculating Primary Energy Impact:

Unit savings are calculated using the following algorithms and assumptions:
$\Delta kWh = kWh_{base} - kWh_{HE}$

Where:
kWh_{base} = Average usage of a new refrigerator meeting federal standards, by model type
kWh_{HE} = Average usage of a new natural refrigerant refrigerator meeting ENERGY STAR® Most Efficient Standards, by model type
Demand savings are derived from the demand impact model which is developed as part of the Residential Baseline Study.[1]

Measure	ΔkWh^2	ΔkW
Ultra Low GWP Refrigerator	101	0.02

Baseline Efficiency:

The baseline efficiency case is a residential refrigerator that meets the federal minimum standard for energy efficiency and uses a conventional refrigerant.

High Efficiency:

The high efficiency case is an ENERGY STAR most efficient qualified residential refrigerator that uses a natural refrigerant.

Measure Life:

The measure life is 12 years.[3]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Ultra Low GWP Refrigerator	RES_RETAIL	All	12	n/a	n/a	12

Other Resource Impacts:

There are GHG savings related to refrigerant disposal associated with this measure.[4]

Measure Name	Annual GHG savings (MT CO2e/unit)
Ultra Low GWP Refrigerator	0.001

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Ultra Low GWP Refrigerator	RES_RETAIL	All	1.00	1.00	1.00	1.00	1.00	0.85	0.65

In-Service Rates:

The in-service rate is assumed to be 100% absent evaluation.

Realization Rates:

The in-service rate is assumed to be 100% absent evaluation.

Coincidence Factors:

Summer and winter coincidence factors are estimated using the demand allocation methodology described in the Demand Impact Model which is developed based on the Residential Baseline Study.[5]

Impact Factors for Calculating Net Savings:

Assumed 10% free-ridership.

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Ultra Low GWP Refrigerator	RES_RETAIL	All	0.10	0.00	0.00	0.90

Non-Energy Impacts:

There are no non-energy impacts for this measure.

Endnotes:

1 : Guidehouse (2020). Residential Baseline Study Phase 4
2020_Guidehouse_Residential_Baseline_Phase_4
2 : Apex Analytics (2021). Refrigerator Savings Modeling
2021_APEX_Analytics_Refrigerators_Savings_Modeling
3 : Energy Star (2018). Consumer Appliance Calculator Energy_Star_2018_Consumer_Appliance_Calc
4 : 2021_NationalGrid_Ultra_Low_GWP_Resi_Refrig_GHG
5 : Guidehouse (2020). Residential Baseline Study Phase 4
2020_Guidehouse_Residential_Baseline_Phase_4

1.8 Behavior - Home Energy Report

Measure Code	RES-O-HER
Market	Residential
Program Type	Behavior
Category	Other

Measure Description:

The Behavior/Feedback programs send energy use reports to participating electric and natural gas customers in order to change customers' energy-use behavior.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Home Energy Reports	Residential Behavior (RES_BEHVR)	EA2d001
Home Energy Reports	Residential Behavior (RES_BEHVR)	GA2d001

Algorithms for Calculating Primary Energy Impact:

National Grid, Unitil, CLC and Berkshire unit savings are custom and based on calculations from vendor results.

$\Delta kWh = (kWh_{BASE}) (\%SAVE)$

$\Delta MMBtu = (MMBtu_{BASE}) (\%SAVE)$

Where:

Unit = One participant household.

$kWh/MMBTU_{BASE}$ = Baseline energy consumption kWh/MMBTu.

%SAVE = Energy savings percent per program participant.

The Eversource savings for the Delivered Energy Insights will use savings of 0.428 mmbtu per gas customer and 45.55 kWh per electric customer based on study results.[1]

Baseline Efficiency:

The baseline efficiency case is a customer who does not receive a Home Energy Report.

High Efficiency:

The high efficiency case is a customer who receives a Home Energy Report.

Measure Life:

The measure life is 1 year.

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	Fuel Type	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Home Energy Reports Persistence	RES_BEHVR	Eversource	Elec	1.00	1.00	n/a	1.00	1.00	0.19	0.35
Home Energy Reports	RES_BEHVR	National Grid	Elec	1.00	0.95	n/a	0.95	0.95	0.19	0.35
Home Energy Reports	RES_BEHVR	CLC	Elec	1.00	1.04	n/a	1.00	1.00	0.19	0.35
Home Energy Reports	RES_BEHVR	Unitil	Elec	1.00	1.00	n/a	1.00	1.00	0.19	0.35
Home Energy Reports	RES_BEHVR	National Grid	Gas	1.00	n/a	0.98	n/a	n/a	n/a	n/a
Home Energy Reports Persistence	RES_BEHVR	Eversource	Gas	1.00	n/a	1.00	n/a	n/a	n/a	n/a
Home Energy Reports	RES_BEHVR	Berkshire	Gas	1.00	n/a	1.00	n/a	n/a	n/a	n/a
Home Energy Reports	RES_BEHVR	Unitil	Gas	1.00	n/a	1.00	n/a	n/a	n/a	n/a

In-Service Rates:

In-services rates are 100% since the program tracks all participating customers.

Realization Rates:

Eversource HER program persistence savings assume a 100% realization rate based on a 2021 evaluation.[1]   All other PA realization rates are based on 2015 evaluation results.[2]

Coincidence Factors:

Summer and winter coincidence factors are estimated using the demand allocation methodology described in the Demand Impact Model which is developed based on the Residential Baseline Study.[3]

Impact Factors for Calculating Net Savings:

The PAs assume 100% net-to-gross.

Non-Energy Impacts:

There are no non-energy impacts identified for this measure.

Endnotes:

1 : Guidehouse (2021) Re: 2020 Persistence Savings from the Home Energy Reports Program

2 : Navigant Consulting and Illume Advising (2015). Behavior Program Evaluation Opower Results. Navigant_Illume_2014_Behavior_Program_Impact_Evaluation

3 : Guidehouse (2020). Residential Baseline Study Phase 4

2020_Guidehouse_Residential_Baseline_Phase_4

1.9 Building Shell - Air Sealing

Measure Code	RES-BS-AS
Market	Residential
Program Type	Retrofit
Category	Building Shell

Measure Description:

Air sealing will decrease the infiltration of outside air through cracks and leaks in the building.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Air Sealing, Electric (Single Family)	Residential Coordinated Delivery (RES_CD)	EA2a028
Air Sealing, Gas (Single Family)	Residential Coordinated Delivery (RES_CD)	EA2a029
Air Sealing, Oil (Single Family)	Residential Coordinated Delivery (RES_CD)	EA2a030
Air Sealing, Other (Single Family)	Residential Coordinated Delivery (RES_CD)	EA2a031
Moderate Income Qualified - Air Sealing, Electric (Single Family)	Residential Coordinated Delivery (RES_CD)	EA2a301
Moderate Income Qualified - Air Sealing, Gas (Single Family)	Residential Coordinated Delivery (RES_CD)	EA2a302
Moderate Income Qualified - Air Sealing, Oil (Single Family)	Residential Coordinated Delivery (RES_CD)	EA2a303
Moderate Income Qualified - Air Sealing, Other (Single Family)	Residential Coordinated Delivery (RES_CD)	EA2a304
Air Sealing, Electric (Attached Low Rise)	Residential Coordinated Delivery (RES_CD)	EA2a105
Air Sealing, Gas (Attached Low Rise)	Residential Coordinated Delivery (RES_CD)	EA2a293
Air Sealing, Oil (Attached Low Rise)	Residential Coordinated Delivery	EA2a106

Measure Name	Core Initiative	BCR Measure ID
	(RES_CD)	
Air Sealing, Other (Attached Low Rise)	Residential Coordinated Delivery (RES_CD)	EA2a107
Moderate Income Qualified - Air Sealing, Electric (Attached Low Rise)	Residential Coordinated Delivery (RES_CD)	EA2a309
Moderate Income Qualified - Air Sealing, Gas (Attached Low Rise)	Residential Coordinated Delivery (RES_CD)	EA2a310
Moderate Income Qualified - Air Sealing, Oil (Attached Low Rise)	Residential Coordinated Delivery (RES_CD)	EA2a311
Moderate Income Qualified - Air Sealing, Other (Attached Low Rise)	Residential Coordinated Delivery (RES_CD)	EA2a312
Air Sealing, Electric (High Rise)	Residential Coordinated Delivery (RES_CD)	EA2a193
Air Sealing, Oil (High Rise)	Residential Coordinated Delivery (RES_CD)	EA2a194
Air Sealing, Other (High Rise)	Residential Coordinated Delivery (RES_CD)	EA2a195
Air Sealing, Gas (Single Family)	Residential Coordinated Delivery (RES_CD)	GA2a001
Air Sealing, Gas (Attached Low Rise)	Residential Coordinated Delivery (RES_CD)	GA2a046
Moderate Income Qualified - Air Sealing, Gas (Single Family)	Residential Coordinated Delivery (RES_CD)	GA2a132
Moderate Income Qualified - Air Sealing, Gas (Attached Low Rise)	Residential Coordinated Delivery (RES_CD)	GA2a059
Air Sealing, Gas (High Rise)	Residential Coordinated Delivery (RES_CD)	GA2a079

Algorithms for Calculating Primary Energy Impact:

Single Family and Low Rise Attached:

The Program Administrators currently use vendor calculated energy savings for these measures in the Residential Home Energy Services electric program. These savings values are calculated using vendor

proprietary software where the user inputs a minimum set of technical data about the house and the software calculates building heating and cooling loads and other key parameters. The proprietary building model is based on thermal transfer, building gains, and a variable-based heating/cooling degree day/hour climate model. This provides an initial estimate of energy use that may be compared with actual billing data to adjust as needed for existing conditions. Then, specific recommendations for improvements are added and savings are calculated using measure-specific heat transfer algorithms.

Rather than using a fixed degree day approach, the building model estimates both heating degree days and cooling degree hours based on the actual characteristics and location of the house to determine the heating and cooling balance point temperatures. Savings from shell measures use standard U-value, area, and degree day algorithms. Infiltration savings use site-specific seasonal N-factors to convert measured leakage to seasonal energy impacts. HVAC savings are estimated based on changes in system and/or distribution efficiency improvements, using ASHRAE 152 as their basis. Lighting, appliance, and water heating savings are based on standard algorithms, taking into account operating conditions and pre- and post-retrofit energy consumption. Interactivity between architectural and mechanical measures is always included, to avoid overestimating savings due to incorrectly "adding" individual measure results.

The PAs calculate demand (kW) savings by applying a kW/kWh factor to the vendor-estimated electric energy savings. The kW/kWh factor for Air Sealing (Electric) is 0.00073.[1]

High Rise:

Unit savings are calculated using the following algorithms and assumptions:
MMBtu = (Vol x ΔACH x 0.018 x HDD60 x 24) / (1,000,000 * ηheating)
kWh = MMBtu * 293.1
kW = kWh x kW/kWh

Where:
Vol = [ft3]   This is the air volume of the treated space, calculated from the dimensions of the space, which could include the number of floors, the floor area per floor, and the floor-toceiling height, or the dwelling floor area and number of dwellings. The treated space can be the entire building including the common areas, or just the individual dwelling units. (Auditor Input)
ΔACH = [ºF-day]   Infiltration reduction in Air Changes per Hour, natural infiltration basis. This will typically be a default value, but the source of the assumption should be transparent and traceable, or it could come from a blower door test. (Stipulated Value[2] or Blower Door Test)
HDD60 = Heating degree-days, base 60 from TMYx weather data. See table below.
ηheating = [AFUE, COP, thermal efficiency(%)]   Efficiency of the heating system, as determined on site (Auditor Input)
24 = Conversion factor: 24 hours per day
0.018 = [Btu/ft3- ºF]   Air heat capacity: The specific heat of air (0.24 Btu/ºF.lb) times the density of air (0.075 lb/ft3)
1,000,000 = Conversion factor: 1,000,000 Btu per MMBtu
293.1 = Conversion factor: 293.1 kWh / MMBtu
kW/kWh = Average kW reduction per kWh reduction: 0.00073 kW/kWh[3]

Hours:

Heating hours are characterized by the heating degree days for the facility. The heating degree days and cooling degree hours are looked up based on the nearest weather station to the customer, as selected by the program vendor.

TMYx - City/Station	HDD	CDH
Barnstable Muni Boa	4,241	2,159
Beverly Muni	4,736	3,799
Boston Logan Int'l Arpt	4,156	5,937
Chicopee Falls Westo	5,078	6,642
Lawrence Muni	4,607	5,009
Marthas Vineyard	4,335	2,234
Nantucket Memorial AP	3,900	448
New Bedford Rgnl	4,319	5,082
North Adams	5,420	3,507
Norwood Memorial	4,509	7,230
Otis ANGBb	4,440	2,420
Plymouth Municipal	4,589	4,189
Provincetown (AWOS)	4,103	1,785
Westfield Barnes Muni AP	4,916	4,796
Worchester Regional Arpt	5,082	3,207

These values have been derived from TMYx data downloaded from the Massachusetts Typical Weather - Research and Dataset Development Evaluation.[4] The HDD values were calculated by taking the minimum and maximum temperatures for each day, and calculating a daily average.

Baseline Efficiency:

The baseline efficiency case is the existing building before the air sealing measure is implemented. For High Rise, the baseline building is characterized by the existing air changes per hour (ACHPRE) for multi-family facilities, which is measured prior to the implementation of the air sealing measure. This will typically be a default value of a baseline/pre-retrofit ACH =0.5.

High Efficiency:

The high efficiency case is the existing building after the air sealing measure is implemented. For High Rise, the high efficiency building is characterized by the new air changes per hour (ACHPOST) for multi-family facilities, which is measured after the air sealing measure is implemented. This will typically be a default value of a post-retrofit ACH =0.4.

Measure Life:

 The measure life is 15 years.[5]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Air Sealing	RES_CD	All	15	n/a	n/a	15

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Moderate Income Qualified use the same impact factors.

Measure Name	Core Initiative	PA	ISR	RR$_E$	RR$_{NE}$	RR$_{SP}$	RR$_{WP}$	CF$_{SP}$	CF$_{WP}$
Air Sealing, Electric (Single Family)	RES_CD	NGRID	1.00	0.56	n/a	0.56	0.56	0.00	0.43
Air Sealing, Gas (Single Family)	RES_CD	NGRID	1.00	n/a	0.75	n/a	n/a	n/a	n/a
Air Sealing, Oil (Single Family)	RES_CD	NGRID	1.00	n/a	0.77	n/a	n/a	n/a	n/a
Air Sealing, Other (Single Family)	RES_CD	NGRID	1.00	n/a	1.00	n/a	n/a	n/a	n/a
Air Sealing, Electric (Attached Low Rise)	RES_CD	NGRID	1.00	0.56	n/a	0.56	0.56	0.00	0.43
Air Sealing, Gas (Attached Low Rise)	RES_CD	NGRID	1.00	n/a	0.75	n/a	n/a	n/a	n/a
Air Sealing, Oil (Attached Low Rise)	RES_CD	NGRID	1.00	n/a	0.77	n/a	n/a	n/a	n/a
Air Sealing, Other (Attached Low Rise)	RES_CD	NGRID	1.00	n/a	1.00	n/a	n/a	n/a	n/a
Air Sealing, Electric (Single Family)	RES_CD	Eversource	1.00	0.56	n/a	0.56	0.56	0.00	0.43

Measure Name	Core Initiative	PA	ISR	RR$_E$	RR$_{NE}$	RR$_{SP}$	RR$_{WP}$	CF$_{SP}$	CF$_{WP}$
Air Sealing, Gas (Single Family)	RES_CD	Eversource	1.00	n/a	0.75	n/a	n/a	n/a	n/a
Air Sealing, Oil (Single Family)	RES_CD	Eversource	1.00	n/a	0.77	n/a	n/a	n/a	n/a
Air Sealing, Other (Single Family)	RES_CD	Eversource	1.00	n/a	1.00	n/a	n/a	n/a	n/a
Air Sealing, Electric (Attached Low Rise)	RES_CD	Eversource	1.00	0.56	n/a	0.56	0.56	0.00	0.43
Air Sealing, Gas (Attached Low Rise)	RES_CD	Eversource	1.00	n/a	0.75	n/a	n/a	n/a	n/a
Air Sealing, Oil (Attached Low Rise)	RES_CD	Eversource	1.00	n/a	0.77	n/a	n/a	n/a	n/a
Air Sealing, Other (Attached Low Rise)	RES_CD	Eversource	1.00	n/a	1.00	n/a	n/a	n/a	n/a
Air Sealing, Electric (Single Family)	RES_CD	Unitil	1.00	0.54	n/a	0.54	0.54	0.00	0.43
Air Sealing, Gas (Single Family)	RES_CD	Unitil	1.00	n/a	0.68	n/a	n/a	n/a	n/a
Air Sealing, Oil (Single Family)	RES_CD	Unitil	1.00	n/a	0.79	n/a	n/a	n/a	n/a
Air Sealing, Other (Single Family)	RES_CD	Unitil	1.00	n/a	0.89	n/a	n/a	n/a	n/a
Air Sealing, Electric (Attached Low Rise)	RES_CD	Unitil	1.00	0.54	n/a	0.54	0.54	0.00	0.43
Air Sealing, Gas (Attached Low Rise)	RES_CD	Unitil	1.00	n/a	0.68	n/a	n/a	n/a	n/a
Air Sealing, Oil (Attached Low Rise)	RES_CD	Unitil	1.00	n/a	0.79	n/a	n/a	n/a	n/a
Air Sealing, Other (Attached Low Rise)	RES_CD	Unitil	1.00	n/a	0.89	n/a	n/a	n/a	n/a
Air Sealing, Electric (Single Family)	RES_CD	CLC	1.00	0.54	n/a	0.54	0.54	0.00	0.43
Air Sealing, Gas (Single Family)	RES_CD	CLC	1.00	n/a	0.68	n/a	n/a	n/a	n/a
Air Sealing, Oil (Single Family)	RES_CD	CLC	1.00	n/a	0.79	n/a	n/a	n/a	n/a
Air Sealing, Other (Single	RES_CD	CLC	1.00	n/a	0.89	n/a	n/a	n/a	n/a

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Family)									
Air Sealing, Electric (Attached Low Rise)	RES_CD	CLC	1.00	0.54	n/a	0.54	0.54	0.00	0.43
Air Sealing, Gas (Attached Low Rise)	RES_CD	CLC	1.00	n/a	0.68	n/a	n/a	n/a	n/a
Air Sealing, Oil (Attached Low Rise)	RES_CD	CLC	1.00	n/a	0.79	n/a	n/a	n/a	n/a
Air Sealing, Other (Attached Low Rise)	RES_CD	CLC	1.00	n/a	0.89	n/a	n/a	n/a	n/a
Air Sealing, Gas (Single Family)	RES_CD	Berkshire	1.00	n/a	0.83	n/a	n/a	n/a	n/a
Air Sealing, Gas (Attached Low Rise)	RES_CD	Berkshire	1.00	n/a	0.83	n/a	n/a	n/a	n/a
Air Sealing, Gas (Single Family)	RES_CD	Columbia	1.00	n/a	0.68	n/a	n/a	n/a	n/a
Air Sealing, Gas (Attached Low Rise)	RES_CD	Columbia	1.00	n/a	0.68	n/a	n/a	n/a	n/a
Air Sealing, Gas (Single Family)	RES_CD	Liberty	1.00	n/a	0.68	n/a	n/a	n/a	n/a
Air Sealing, Gas (Attached Low Rise)	RES_CD	Liberty	1.00	n/a	0.68	n/a	n/a	n/a	n/a
Air Sealing, Electric (High Rise)	RES_CD	All	1.00	0.86	n/a	0.86	0.86	0.00	0.43
Air Sealing, Oil (High Rise)	RES_CD	All	1.00	1.00	0.86	n/a	n/a	n/a	n/a
Air Sealing, Other (High Rise)	RES_CD	All	1.00	1.00	0.86	n/a	n/a	n/a	n/a
Air Sealing, Gas (High Rise)	RES_CD	All	1.00	1.00	0.86	n/a	n/a	n/a	n/a

In-Service Rates:

All installations have 100% in service rate since all PA programs include verification of equipment installations.

Realization Rates:

Realization rates are for Single Family and Attached Low Rise based on HES evaluation results[6] while High Rise is based on Multifamily evaluation results.[7]

Coincidence Factors:

Summer and winter coincidence factors are estimated using the demand allocation methodology described in the Demand Impact Model which is developed based on the Residential Baseline Study.[8]

Impact Factors for Calculating Net Savings:

Net-to-gross factors are based on evaluation results.[9] Moderate Income Qualified use the same NTG values.

Measure Name	Core Initiative	PA	FR	SO$_P$	SO$_{NP}$	NTG
Air Sealing, Electric (Single Family)	RES_CD	All	0.12	0.12	0.04	1.04
Air Sealing, Gas (Single Family)	RES_CD	All	0.19	0.12	0.04	0.97
Air Sealing, Oil (Single Family)	RES_CD	All	0.12	0.12	0.04	1.04
Air Sealing, Other (Single Family)	RES_CD	All	0.12	0.12	0.04	1.04
Air Sealing, Electric (Attached Low Rise)	RES_CD	All	0.12	0.12	0.04	1.04
Air Sealing, Gas (Attached Low Rise)	RES_CD	All	0.19	0.12	0.04	0.97
Air Sealing, Oil (Attached Low Rise)	RES_CD	All	0.12	0.12	0.04	1.04
Air Sealing, Other (Attached Low Rise)	RES_CD	All	0.12	0.12	0.04	1.04
Air Sealing, Electric (High Rise)	RES_CD	All	0.14	0.0	0.0	0.86
Air Sealing, Oil (High Rise)	RES_CD	All	0.14	0.0	0.0	0.86
Air Sealing, Other (High Rise)	RES_CD	All	0.14	0.0	0.0	0.86
Air Sealing, Gas (High Rise)	RES_CD	All	0.14	0.0	0.0	0.86

Non-Energy Impacts:

NEI values are rolled up, component values can be found in Appendix B.

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per KWh	Annual $ per Therm	One-time $ per Therm
Air Sealing (High Rise)	RES_CD	All	$19.35	$0.00	$0.00	$0.00	$0.00	$0.00
Air Sealing (Single	RES_CD	All	$19.28	$0.00	$0.00	$0.00	$0.00	$0.00

Family)								
Air Sealing (Low Rise Attached)	RES_CD	All	$19.28	$0.00	$0.00	$0.00	$0.00	$0.00

Endnotes:

1 : Guidehouse (2020). Residential Baseline Study Phase 4
2020_Guidehouse_Residential_Baseline_Phase_4
2 : The Cadmus Group (2012). MARR Multifamily Impacts Analysis Report.
CADMUS_2012_Multifamily_Impacts_Analysis_Report
3 : Guidehouse (2020). Residential Baseline Study Phase 4
2020_Guidehouse_Residential_Baseline_Phase_4
4 : DNV (2023). Massachusetts Typical Weather – Research and Dataset Development Study.
2023_DNV_MA_TMYx-Final_Report
5 : GDS_2007_Measure_Life_Report_Residential_and_CI_Lighting_and_HVAC_Measures
GDS_2007_Measure_Life_Report_Residential_and_CI_Lighting_and_HVAC_Measures
6 : Navigant Consulting (2018). HES Impact Evaluation 2018_Navigant_HES_Impact_Evaluation
7 : Navigant Consulting (2018). Multi-Family Program Impact and Net-to-Gross Evaluation
2018_Navigant_Multifamily_Program_Impact_Evaluation
8 : Guidehouse (2020). Residential Baseline Study Phase 4
2020_Guidehouse_Residential_Baseline_Phase_4
9 : Guidehouse (2021). Residential Programs Net-to-Gross Research of RCD and Select Products
Measures: Results Workbook 2021_Guidehouse_MA_Res_NTG_Final_Results_Workbook

1.10 Building Shell - Air Sealing - Simplified Savings Tool

Measure Code	RES-BS-ASSST
Market	Residential
Program Type	Retrofit
Category	Building Shell

Measure Description:

Air sealing will decrease the infiltration of outside air through cracks and leaks in the building.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Simplified Savings - Air Sealing, Electric (Single Family)	Residential Coordinated Delivery (RES_CD)	EA2a323
Simplified Savings - Air Sealing, Gas (Single Family)	Residential Coordinated Delivery (RES_CD)	EA2a324 GA2a136
Simplified Savings - Air Sealing, Oil (Single Family)	Residential Coordinated Delivery (RES_CD)	EA2a325
Simplified Savings - Air Sealing, Other (Single Family)	Residential Coordinated Delivery (RES_CD)	EA2a326
Moderate Income Qualified - Simplified Savings - Air Sealing, Electric (Single Family)	Residential Coordinated Delivery (RES_CD)	EA2a331
Moderate Income Qualified - Simplified Savings - Air Sealing, Gas (Single Family)	Residential Coordinated Delivery (RES_CD)	EA2a332 GA2a138
Moderate Income Qualified - Simplified Savings - Air Sealing, Oil (Single Family)	Residential Coordinated Delivery (RES_CD)	EA2a333
Moderate Income Qualified - Simplified Savings - Air Sealing, Other (Single Family)	Residential Coordinated Delivery (RES_CD)	EA2a334

Algorithms for Calculating Primary Energy Impact:

Savings are calculated using the Simplified Weatherization Savings Tool[1]. The tool uses a linear regression or sum of a set of linear regression equations based on normalized 2021 RCD tracking data

(including lead vendor modeled weatherizations savings, participant building characteristics, and project characteristics) to estimate annual savings. Air sealing savings estimates use a single linear regression equation to predict savings. The predictive variables used in all of the linear regressions are year home was built, square footage of instulation/hours of air sealing, and floor area of the home. This methodology was used for all fuel types.

Baseline Efficiency:

The baseline efficiency case is the existing building before the air sealing measure is implemented. This measure is for single family conditioned or semi-conditioned install locations not receiving traditional RCD insulation and air sealing. This measure is not subject to fixed RCD weatherization measure pricing. This measure must use calculated savings from the simplified savings tool. This measures is not for unconditioned spaces, renovations, additions or other new construction.

High Efficiency:

The high efficiency case is the existing building after the air sealing measure is implemented.

Measure Life:

The measure life is 15 years.[2]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Air Sealing	RES_CD	All	15	n/a	n/a	15

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Air Sealing, Electric (Single Family)	RES_CD	All	1.00	1.00	1.00	1.00	1.00	0.37	0.22
Air Sealing, Gas (Single Family)	RES_CD	All	1.00	1.00	1.00	1.00	1.00	0.37	0.22
Air Sealing, Oil (Single Family)	RES_CD	All	1.00	1.00	1.00	1.00	1.00	0.37	0.22
Air Sealing, Propane (Single Family)	RES_CD	All	1.00	n/a	1.00	1.00	1.00	0.37	0.22

In-Service Rates:

All installations have 100% in service rate since all PA programs include verification of equipment installations.

Realization Rates:

The simplified weatherization savings tool incorporated realization rates and correction factors into the regression model, so realization rates should not be applied again. The realization rates that were factored into the tool come from the HES evaluation[3].

Coincidence Factors:

Summer and winter coincidence factors are estimated using the demand allocation methodology described in the Demand Impact Model which is developed based on the Residential Baseline Study.[4]

Impact Factors for Calculating Net Savings:

Net-to-gross factors are based on evaluation results.[9]

Measure Name	Core Initiative	PA	FR	SO$_P$	SO$_{NP}$	NTG
Air Sealing, Electric (Single Family)	RES_CD	All	0.12	0.12	0.04	1.04
Air Sealing, Gas (Single Family)	RES_CD	All	0.19	0.12	0.04	0.97
Air Sealing, Oil (Single Family)	RES_CD	All	0.12	0.12	0.04	1.04
Air Sealing, Propane (Single Family)	RES_CD	All	0.12	0.12	0.04	1.04

Non-Energy Impacts:

NEI values are rolled up, component values can be found in Appendix B.

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per KWh	Annual $ per Therm	One-time $ per Therm
Air Sealing (Single Family)	RES_CD	All	$19.28	$0.00	$0.00	$0.00	$0.00	$0.00

Endnotes:

1 : 2022_Cadeo_MA22R50-B-SWSA Simplified Wx Savings Workbook

2 : GDS_2007_Measure_Life_Report_Residential_and_CI_Lighting_and_HVAC_Measures
GDS_2007_Measure_Life_Report_Residential_and_CI_Lighting_and_HVAC_Measures

3 : Navigant Consulting (2018). HES Impact Evaluation 2018_Navigant_HES_Impact_Evaluation

4 : Guidehouse (2020). Residential Baseline Study Phase 4
2020_Guidehouse_Residential_Baseline_Phase_4

5 : Guidehouse (2021). Residential Programs Net-to-Gross Research of RCD and Select Products
Measures: Results Workbook 2021_Guidehouse_MA_Res_NTG_Final_Results_Workbook

1.11 Building Shell - Air Sealing Self Install

Measure Code	RES-BS-ASSI
Market	Residential
Program Type	Consumer Products
Category	Building Shell

Measure Description:

Weatherstripping and window insulation kit

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Air Sealing Self Install	Residential Retail (RES_RETAIL)	EA2c377
Air Sealing Self Install	Residential Retail (RES_RETAIL)	GA2c089

Algorithms for Calculating Primary Energy Impact:

Unit savings are deemed based on the following algorithms and assumptions:

Estimated to be 1% of total home air sealing savings based on latest single family weatherization impact evaluation.[1]

Air Sealing, Electric	274	kWh	x 1%	2.74
Air Sealing, Gas	3.2	MMBtu	x 1%	0.032
Air Sealing, Oil	3.2	MMBtu	x 1%	0.032
Air Sealing, Other	3.2	MMBtu	x 1%	0.032

Electric, Oil and Other savings are weighted based on household heating fuel type from 2020 ACS data.

Measure	Fuel Type	Savings	Savings	Savings
Air Sealing Self Install	Electric	0.99 kWh	0.018 Oil MMBTUs	0.003 Other MMBTUs
Air Sealing Self Install	Gas	0.032 MMBTUs	n/a	n/a

Baseline Efficiency:

The baseline efficiency case is unsealed windows and doors.

High Efficiency:

The high efficiency case is the installation of weatherstripping around windows and doors or the installation of the window insulation kit.

Measure Life:

The measure life is assumed to be 1 year.

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Air Sealing Self Install	RES_RETAIL	All	1	n/a	n/a	1

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Air Sealing Self Install	RES_RETAIL	All	0.50	1.00	1.00	1.00	1.00	0.00	0.43

In-Service Rates:

A 50% installation rate is assumed.

Realization Rates:

Realization rates are assumed to be 100% since savings are deemed.

Coincidence Factors:

Summer and winter coincidence factors are estimated using the demand allocation methodology described in the Demand Impact Model which is developed based on the Residential Baseline Study.[2]

Impact Factors for Calculating Net Savings:

NTG factors are assumed.

Measure Name	Core Initiative	PA	FR	SO$_P$	SO$_{NP}$	NTG
Air Sealing Self Install	RES_RETAIL	All	0.50	0.00	0.00	0.50

Non-Energy Impacts:

There are no non-energy impacts identified for this measure.

Endnotes:

1 : Navigant Consulting (2018). HES Impact Evaluation. 2018_Navigant_HES_Impact_Evaluation
2 : Guidehouse (2020). Residential Baseline Study Phase 4
2020_Guidehouse_Residential_Baseline_Phase_4

1.12 Building Shell - Insulation

Measure Code	RES-BS-I
Market	Residential
Program Type	Retrofit
Category	Building Shell

Measure Description:

Shell insulation installed through the Residential Coordinated Delivery program.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Insulation, Electric (Single Family)	Residential Coordinated Delivery (RES_CD)	EA2a032
Insulation, Gas (Single Family)	Residential Coordinated Delivery (RES_CD)	EA2a033
Insulation, Oil (Single Family)	Residential Coordinated Delivery (RES_CD)	EA2a034
Insulation, Other (Single Family)	Residential Coordinated Delivery (RES_CD)	EA2a035
Moderate Income Qualified - Insulation, Electric (Single Family)	Residential Coordinated Delivery (RES_CD)	EA2a305
Moderate Income Qualified - Insulation, Gas (Single Family)	Residential Coordinated Delivery (RES_CD)	EA2a306
Moderate Income Qualified - Insulation, Oil (Single Family)	Residential Coordinated Delivery (RES_CD)	EA2a307
Moderate Income Qualified - Insulation, Other (Single Family)	Residential Coordinated Delivery (RES_CD)	EA2a308
Insulation, Electric (Attached Low Rise)	Residential Coordinated Delivery (RES_CD)	EA2a108
Insulation, Cooling for Electrically-Heated Unit (Attached Low Rise)	Residential Coordinated Delivery (RES_CD)	EA2a109

Measure Name	Core Initiative	BCR Measure ID
Insulation, Gas (Attached Low Rise)	Residential Coordinated Delivery (RES_CD)	EA2a294
Insulation, Oil (Attached Low Rise)	Residential Coordinated Delivery (RES_CD)	EA2a110
Insulation, Other (Attached Low Rise)	Residential Coordinated Delivery (RES_CD)	EA2a111
Moderate Income Qualified - Insulation, Electric (Attached Low Rise)	Residential Coordinated Delivery (RES_CD)	EA2a313
Moderate Income Qualified - Insulation, Cooling for Electrically-Heated Unit (Attached Low Rise)	Residential Coordinated Delivery (RES_CD)	EA2a314
Moderate Income Qualified - Insulation, Gas (Attached Low Rise)	Residential Coordinated Delivery (RES_CD)	EA2a315
Moderate Income Qualified - Insulation, Oil (Attached Low Rise)	Residential Coordinated Delivery (RES_CD)	EA2a316
Moderate Income Qualified - Insulation, Other (Attached Low Rise)	Residential Coordinated Delivery (RES_CD)	EA2a317
Insulation, Electric (High Rise)	Residential Coordinated Delivery (RES_CD)	EA2a196
Insulation, Cooling for Electrically-Heated Unit (High Rise)	Residential Coordinated Delivery (RES_CD)	EA2a197
Insulation, Oil (High Rise)	Residential Coordinated Delivery (RES_CD)	EA2a198
Insulation, Other (High Rise)	Residential Coordinated Delivery (RES_CD)	EA2a199
Insulation, Gas (Single Family)	Residential Coordinated Delivery (RES_CD)	GA2a002
Moderate Income Qualified - Insulation, Gas (Single Family)	Residential Coordinated Delivery (RES_CD)	GA2a133
Insulation, Gas (Attached Low Rise)	Residential Coordinated Delivery (RES_CD)	GA2a047
Moderate Income Qualified - Insulation, Gas	Residential Coordinated Delivery	GA2a060

Measure Name	Core Initiative	BCR Measure ID
(Attached Low Rise)	(RES_CD)	
Insulation, Gas (High Rise)	Residential Coordinated Delivery (RES_CD)	GA2a080

Algorithms for Calculating Primary Energy Impact:

Single Family and Attached Low Rise:

The Program Administrators currently use vendor calculated energy savings for these measures in the Residential Coordinated Delivery program. These savings values are calculated using vendor proprietary software where the user inputs a minimum set of technical data about the house and the software calculates building heating and cooling loads and other key parameters. The proprietary building model is based on thermal transfer, building gains, and a variable-based heating/cooling degree day/hour climate model. This provides an initial estimate of energy use that may be compared with actual billing data to adjust as needed for existing conditions. Then, specific recommendations for improvements are added and savings are calculated using measure-specific heat transfer algorithms.

Rather than using a fixed degree day approach, the building model estimates both heating degree days and cooling degree hours based on the actual characteristics and location of the house to determine the heating and cooling balance point temperatures. Savings from shell measures use standard U-value, area, and degree day algorithms. Infiltration savings use site-specific seasonal N-factors to convert measured leakage to seasonal energy impacts.   HVAC savings are estimated based on changes in system and/or distribution efficiency improvements, using ASHRAE 152 as their basis. Lighting, appliance, and water heating savings are based on standard algorithms, taking into account operating conditions and pre- and post-retrofit energy consumption. Interactivity between architectural and mechanical measures is always included, to avoid overestimating savings due to incorrectly "adding" individual measure results. The PAs calculate demand (kW) savings by applying a kW/kWh factor to the vendor-estimated electric energy savings. The kW/kWh factors are provided in the table below.

kW Factors for Vendor Measures[1] :

Measure	kW/kWh Factor
Insulation (Electric)	0.00073
Insulation (Gas, Oil, Other FF)	0.00076
Insulation, Central AC in Electrically-Heated Unit	0.00059

High Rise:

$$MMBtu = ((1/R_{exist} - 1/R_{new}) * HDD * 24 * Area) / (1000000 * \eta_{heat})$$

$$kWh = MMBtu * 293.1$$

$$kW = kWh * kW/kWh_{heat}$$

Where:

R_{exist} = Existing effective R-value (R-ExistingInsulation + R-Assembly),ft2-°F/Btuh

R_{new} = New total effective R-value (R-ProposedMeasure + R-ExistingInsulation+ R-Assembly), ft2-°F/Btuh

Area = Square footage of insulated area

η_{heat} = Efficiency of the heating system (AFUE or COP), site specific

293.1 = Conversion constant (1MMBtu = 293.1 kWh)

24 = Conversion for hours per day

HDD = Heating Degree Days; dependent on location, see table below

1,000,000 = Conversion from Btu to MMBtu

kW/kWh_{heat} = Average annual kW reduction per kWh reduction: 0.00073 kW/kWh

If Facility has central cooling then also calculate air conditioning savings:

$$kWh_{cool} = ((1/R_{exist} - 1/R_{new}) * CDH * DUA * Area) / (1000\ Btu/kBtu * \eta cool)$$

$$kW = kWh * kW/kWh_{cool}$$

Where:

R_{exist} = Existing effective R-value (R-ExistingInsulation + R-Assembly),ft2-°F/Btuh

R_{new} = New total effective R-value (R-ProposedMeasure + R-ExistingInsulation+ R-Assembly), ft2-°F/Btuh

DUA = Discretionary Use Adjustment to account for the fact that people do not always operate their air conditioning system when the outside temperature is greater than 75°F = 0.75^2

Area = Square footage of insulated area

$\eta cool$ = Efficiency of air conditioning equipment (SEER), site specific

CDH = Cooling Degree Hours; dependent on location, see table below

kW/kWh_{cool} = Average annual kW reduction per kWh reduction: 0.00073 kW/kWh

Hours:

Heating hours are characterized by the heating degree days for the facility. The heating degree days and cooling degree hours are looked up based on the nearest weather station to the customer, as selected by the program vendor.

TMYx - City/Station	HDD	CDH
Barnstable Muni Boa	4,241	2,159
Beverly Muni	4,736	3,799
Boston Logan Int'l Arpt	4,156	5,937

Chicopee Falls Westo	5,078	6,642
Lawrence Muni	4,607	5,009
Marthas Vineyard	4,335	2,234
Nantucket Memorial AP	3,900	448
New Bedford Rgnl	4,319	5,082
North Adams	5,420	3,507
Norwood Memorial	4,509	7,230
Otis ANGBb	4,440	2,420
Plymouth Municipal	4,589	4,189
Provincetown (AWOS)	4,103	1,785
Westfield Barnes Muni AP	4,916	4,796
Worchester Regional Arpt	5,082	3,207

These values have been derived from TMYx data downloaded from the Massachusetts Typical Weather - Research and Dataset Development Evaluation.[3] The HDD values were calculated by taking the minimum and maximum temperatures for each day, and calculating a daily average.

Baseline Efficiency:

The baseline efficiency case is the existing conditions of the participating household.

For high rise the baseline efficiency case is characterized by the total R-value of the existing attic, basement or sidewall (Rexist). This is calculated as the R-value of the existing insulation, estimated by the program contractor, plus the R-value of the ceiling, floor, or wall (R-Assembly for all projects : RCEILING = 3.36; RFLOOR = 6.16; RWALL = 6.65).[4]

High Efficiency:

The high efficiency case is characterized by the total R-value of the installation of additional attic, basement or sidewall insulation. This is calculated as the sum of the existing R-value (Rexisit) plus the R-value of the added insulation.

Measure Life:

The measure life is 25 years.[5]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Insulation	RES_CD	All	25	n/a	n/a	25

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Moderate Income Qualified use the same impact factors

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Insulation, Electric (Single Family)	RES_CD	National Grid	1.00	0.56	1.00	0.56	0.56	0.00	0.43
Insulation, Gas (Single Family)	RES_CD	National Grid	1.00	1.00	0.75	1.00	1.00	0.24	0.25
Insulation, Oil (Single Family)	RES_CD	National Grid	1.00	1.00	0.77	1.00	1.00	0.24	0.25
Insulation, Other (Single Family)	RES_CD	National Grid	1.00	1.00	1.00	1.00	1.00	0.24	0.25
Insulation, Electric (Attached Low Rise)	RES_CD	National Grid	1.00	0.56	1.00	0.56	0.56	0.00	0.43
Insulation, Central AC in Electrically-Heated Unit (Attached Low Rise)	RES_CD	National Grid	1.00	0.56	1.00	0.56	0.56	0.35	0.00
Insulation, Gas (Attached Low Rise)	RES_CD	National Grid	1.00	1.00	0.75	1.00	1.00	0.34	0.21
Insulation, Oil (Attached Low Rise)	RES_CD	National Grid	1.00	1.00	0.77	1.00	1.00	0.24	0.25
Insulation, Other (Attached Low Rise)	RES_CD	National Grid	1.00	1.00	1.00	1.00	1.00	0.24	0.25
Insulation, Electric (Single Family)	RES_CD	Eversource	1.00	0.56	1.00	0.56	0.56	0.00	0.43
Insulation, Gas (Single Family)	RES_CD	Eversource	1.00	1.00	0.75	1.00	1.00	0.24	0.25
Insulation, Oil (Single Family)	RES_CD	Eversource	1.00	1.00	0.77	1.00	1.00	0.24	0.25
Insulation, Other (Single Family)	RES_CD	Eversource	1.00	1.00	1.00	1.00	1.00	0.24	0.25
Insulation, Electric (Attached Low Rise)	RES_CD	Eversource	1.00	0.56	1.00	0.56	0.56	0.00	0.43
Insulation, Central AC in Electrically-Heated Unit	RES_CD	Eversource	1.00	0.56	1.00	0.56	0.56	0.50	0.00

Measure Name	Core Initiative	PA	ISR	RR$_E$	RR$_{NE}$	RR$_{SP}$	RR$_{WP}$	CF$_{SP}$	CF$_{WP}$
(Attached Low Rise)									
Insulation, Gas (Attached Low Rise)	RES_CD	Eversource	1.00	1.00	0.75	1.00	1.00	0.24	0.25
Insulation, Oil (Attached Low Rise)	RES_CD	Eversource	1.00	1.00	0.77	1.00	1.00	0.24	0.25
Insulation, Other (Attached Low Rise)	RES_CD	Eversource	1.00	1.00	1.00	1.00	1.00	0.24	0.25
Insulation, Electric (Single Family)	RES_CD	Unitil	1.00	0.54	1.00	0.54	0.54	0.00	0.43
Insulation, Gas (Single Family)	RES_CD	Unitil	1.00	1.00	0.68	1.00	1.00	0.24	0.25
Insulation, Oil (Single Family)	RES_CD	Unitil	1.00	1.00	0.79	1.00	1.00	0.24	0.25
Insulation, Other (Single Family)	RES_CD	Unitil	1.00	1.00	0.89	1.00	1.00	0.24	0.25
Insulation, Electric (Attached Low Rise)	RES_CD	Unitil	1.00	0.54	1.00	0.54	0.54	0.00	0.43
Insulation, Central AC in Electrically-Heated Unit (Attached Low Rise)	RES_CD	Unitil	1.00	0.54	1.00	0.54	0.54	0.50	0.00
Insulation, Gas (Attached Low Rise)	RES_CD	Unitil	1.00	1.00	0.68	1.00	1.00	0.24	0.25
Insulation, Oil (Attached Low Rise)	RES_CD	Unitil	1.00	1.00	0.79	1.00	1.00	0.24	0.25
Insulation, Other (Attached Low Rise)	RES_CD	Unitil	1.00	1.00	0.89	1.00	1.00	0.24	0.25
Insulation, Electric (Single Family)	RES_CD	CLC	1.00	0.54	1.00	0.54	0.54	0.00	0.43
Insulation, Gas (Single Family)	RES_CD	CLC	1.00	1.00	0.68	1.00	1.00	0.24	0.25
Insulation, Oil (Single Family)	RES_CD	CLC	1.00	1.00	0.79	1.00	1.00	0.24	0.25
Insulation, Other (Single Family)	RES_CD	CLC	1.00	1.00	0.89	1.00	1.00	0.24	0.25
Insulation, Electric (Attached Low Rise)	RES_CD	CLC	1.00	0.56	1.00	0.56	0.56	0.00	0.43
Insulation, Central AC in	RES_CD	CLC	1.00	0.54	1.00	0.54	0.54	0.50	0.00

Measure Name	Core Initiative	PA	ISR	RR$_E$	RR$_{NE}$	RR$_{SP}$	RR$_{WP}$	CF$_{SP}$	CF$_{WP}$
Electrically-Heated Unit (Attached Low Rise)									
Insulation, Gas (Attached Low Rise)	RES_CD	CLC	1.00	1.00	0.68	1.00	1.00	0.24	0.25
Insulation, Oil (Attached Low Rise)	RES_CD	CLC	1.00	1.00	0.79	1.00	1.00	0.24	0.25
Insulation, Other (Attached Low Rise)	RES_CD	CLC	1.00	1.00	0.89	1.00	1.00	0.24	0.25
Insulation, Gas (Single Family)	RES_CD	Berkshire	1.00	1.00	0.83	1.00	1.00	0.24	0.25
Insulation, Gas (Attached Low Rise)	RES_CD	Berkshire	1.00	1.00	0.83	1.00	1.00	0.24	0.25
Insulation, Gas (Single Family)	RES_CD	Columbia	1.00	1.00	0.68	1.00	1.00	0.24	0.25
Insulation, Gas (Attached Low Rise)	RES_CD	Columbia	1.00	1.00	0.68	1.00	1.00	0.24	0.25
Insulation, Gas (Single Family)	RES_CD	Liberty	1.00	1.00	0.68	1.00	1.00	0.24	0.25
Insulation, Gas (Attached Low Rise)	RES_CD	Liberty	1.00	1.00	0.68	1.00	1.00	0.24	0.25
Insulation, Electric (High Rise)	RES_CD	All	1.00	0.86	n/a	0.86	0.86	0.00	0.43
Insulation, Central AC in Electrically-Heated Unit (High Rise)	RES_CD	All	1.00	0.86	n/a	0.86	0.86	0.50	0.00
Insulation, Gas (High Rise)	RES_CD	All	1.00	n/a	0.86	n/a	n/a	n/a	n/a
Insulation, Oil (High Rise)	RES_CD	All	1.00	n/a	0.86	n/a	n/a	n/a	n/a
Insulation, Other (High Rise)	RES_CD	All	1.00	n/a	0.86	n/a	n/a	n/a	n/a

In-Service Rates:

All installations have 100% in service rate since all PA programs include verification of installations.

Realization Rates:

Realization rates are based on evaluation results.[6] [7]

Coincidence Factor:

Summer and winter coincidence factors are estimated using the demand allocation methodology described in the Demand Impact Model which is developed based on the Residential Baseline Study.[8]

Impact Factors for Calculating Net Savings:

Net-to-Gross values are based on evaluation results.[9]

Measure Name	Core Initiative	PA	FR	SO$_P$	SO$_{NP}$	NTG
Insulation, Electric (Single Family)	RES_CD	All	0.12	0.12	0.04	1.04
Insulation, Gas (Single Family)	RES_CD	All	0.19	0.12	0.04	0.97
Insulation, Oil (Single Family)	RES_CD	All	0.12	0.12	0.04	1.04
Insulation, Other (Single Family)	RES_CD	All	0.12	0.12	0.04	1.04
Insulation, Electric (Attached Low Rise)	RES_CD	All	0.12	0.12	0.04	1.04
Insulation, Central AC in Electrically-Heated Unit (Attached Low Rise)	RES_CD	All	0.12	0.12	0.04	1.04
Insulation, Gas (Attached Low Rise)	RES_CD	All	0.19	0.12	0.04	0.97
Insulation, Oil (Attached Low Rise)	RES_CD	All	0.12	0.12	0.04	1.04
Insulation, Other (Attached Low Rise)	RES_CD	All	0.12	0.12	0.04	1.04
Insulation (High Rise)	RES_CD	All	0.14	0.00	0.00	0.86

Non-Energy Impacts:

NEI values are rolled up, component values can be found in Appendix B.

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per KWh	Annual $ per Therm	One-time $ per Therm
Insulation (Single Family)	RES_CD	All	$47.31	$0.00	$0.00	$0.00	$0.00	$0.00
Insulation (Attached Low Rise)	RES_CD	All	$47.31	$0.00	$0.00	$0.00	$0.00	$0.00
Insulation (High Rise)	RES_CD	All	$47.31	$0.00	$0.00	$0.00	$0.00	$0.00

Endnotes:

1 : Guidehouse (2020). Residential Baseline Study Phase 4
2020_Guidehouse_Residential_Baseline_Phase_4
2 : The Cadmus Group (2012). Massachusetts 2011 Residential Retrofit Multifamily Program Impact Analysis. CADMUS_2012_Multifamily_Impacts_Analysis_Report
3 : DNV (2023). Massachusetts Typical Weather – Research and Dataset Development Study. 2023_DNV_MA_TMYx-Final_Report
4 : Assumptions from National Grid program vendor.
5 : GDS Associates (2007). Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures.
GDS_2007_Measure_Life_Report_Residential_and_CI_Lighting_and_HVAC_Measures
6 : Single Family and Attached Low Rise: Navigant Consulting (2018). Home Energy Services (HES) Impact Evaluation. 2018_Navigant_HES_Impact_Evaluation
7 : Navigant Consulting (2018). Multi-Family Program Impact and Net-to-Gross Evaluation. 2018_Navigant_Multifamily_Program_Impact_Evaluation
8 : Guidehouse (2020). Residential Baseline Study Phase 4
2020_Guidehouse_Residential_Baseline_Phase_4
9 : Guidehouse (2021). Residential Programs Net-to-Gross Research of RCD and Select Products Measures: Results Workbook 2021_Guidehouse_MA_Res_NTG_Final_Results_Workbook

1.13 Building Shell - Insulation Simplified Savings Tool

Measure Code	RES-BS-ISST
Market	Residential
Program Type	Retrofit
Category	Building Shell

Measure Description:

Shell insulation installed through the Residential Coordinated Delivery program.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Simplified Savings - Insulation, Electric (Single Family)	Residential Coordinated Delivery (RES_CD)	EA2a327
Simplified Savings - Insulation, Gas (Single Family)	Residential Coordinated Delivery (RES_CD)	EA2a328 GA2a137
Simplified Savings - Insulation, Oil (Single Family)	Residential Coordinated Delivery (RES_CD)	EA2a329
Simplified Savings - Insulation, Other (Single Family)	Residential Coordinated Delivery (RES_CD)	EA2a330
Moderate Income Qualified - Simplified Savings - Insulation, Electric (Single Family)	Residential Coordinated Delivery (RES_CD)	EA2a335
Moderate Income Qualified - Simplified Savings - Insulation, Gas (Single Family)	Residential Coordinated Delivery (RES_CD)	EA2a336 GA2a139
Moderate Income Qualified - Simplified Savings - Insulation, Oil (Single Family)	Residential Coordinated Delivery (RES_CD)	EA2a337
Moderate Income Qualified - Simplified Savings - Insulation, Other (Single Family)	Residential Coordinated Delivery (RES_CD)	EA2a338

Algorithms for Calculating Primary Energy Impact:

Savings are calculated using the Simplified Weatherization Savings Tool[1] . The tool uses a linear regression or sum of a set of linear regression equations based on normalized 2021 RCD tracking data (including lead vendor modeled weatherizations savings, participant building characteristics, and project characteristics) to estimate annual savings. Wall insulation savings estimates use a single linear

regression equation to predict savings. Attic and floor savings estiamtes are the result of a sum of linear regression results for smaller measure categories for better accuary:

Attic savings = attic wall savings + attic slope savings + attic floor savings + attic door savings

Floor savings = basement savings + crawlspace savings + garage ceiling savings + overhang savings + rim joist savings + exterior door savings

The predictive variables used in all of the linear regressions are year home was built, square footage of instulation/hours of air sealing, and floor area of the home. This methodology was used for all fuel types.

Baseline Efficiency:

The baseline efficiency case is the existing conditions of the participating household. This measure is for single family conditioned or semi-conditioned install locations not receiving traditional RCD installation and air sealing. This measure is not subject to fixed RCD weatherization measure pricing. This measure must use calculated savings from the simplified savings tool. This measure is not for unconditioned spaces, renovations, additions, or other new construction.

High Efficiency:

The high efficiency case is the existing building after the insulation is installed.

Measure Life:

The measure life is 25 years.[2]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Insulation	RES_CD	All	25	n/a	n/a	25

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Moderate Income Qualified use the same impact factors

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Insulation, Electric (Single Family)	RES_CD	National Grid	1.00	1.00	1.00	1.00	1.00	0.37	0.22
Insulation, Gas (Single Family)	RES_CD	National Grid	1.00	1.00	1.00	1.00	1.00	0.37	0.22

| Insulation, Oil (Single Family) | RES_CD | National Grid | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 0.37 | 0.22 |
| Insulation, Propane (Single Family) | RES_CD | National Grid | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 0.37 | 0.22 |

In-Service Rates:

All installations have 100% in service rate since all PA programs include verification of installations.

Realization Rates:

The simplified weatherization savings tool incorporated realization rates and correction factors into the regression model, so realization rates should not be applied again. The realization rates that were factored into the tool come from the HES evaluation. 4

Coincidence Factor:

Summer and winter coincidence factors are estimated using the demand allocation methodology described in the Demand Impact Model which is developed based on the Residential Baseline Study.[5]

Impact Factors for Calculating Net Savings:

Net-to-Gross values are based on evaluation results.[6]

Measure Name	Core Initiative	PA	FR	SO$_P$	SO$_{NP}$	NTG
Insulation, Electric (Single Family)	RES_CD	All	0.12	0.12	0.04	1.04
Insulation, Gas (Single Family)	RES_CD	All	0.19	0.12	0.04	0.97
Insulation, Oil (Single Family)	RES_CD	All	0.12	0.12	0.04	1.04
Insulation, Propane (Single Family)	RES_CD	All	0.12	0.12	0.04	1.04

Non-Energy Impacts:

NEI values are rolled up, component values can be found in Appendix B.

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per	Annual $ per kWh	One-time $ per KWh	Annual $ per Therm	One-time $ per Therm

			Unit					
Insulation (Single Family)	RES_CD	All	$47.31	$0.00	$0.00	$0.00	$0.00	$0.00

Endnotes:

1 : 2022_Cadeo_MA22R50-B-SWSA Simplified Wx Savings Workbook

2 : GDS Associates (2007). Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures.
GDS_2007_Measure_Life_Report_Residential_and_CI_Lighting_and_HVAC_Measures

3 : Single Family and Attached Low Rise: Navigant Consulting (2018). Home Energy Services (HES) Impact Evaluation. 2018_Navigant_HES_Impact_Evaluation

4 : Navigant Consulting (2018). Multi-Family Program Impact and Net-to-Gross Evaluation.
2018_Navigant_Multifamily_Program_Impact_Evaluation

5 : Guidehouse (2020). Residential Baseline Study Phase 4
2020_Guidehouse_Residential_Baseline_Phase_4

6 : Guidehouse (2021). Residential Programs Net-to-Gross Research of RCD and Select Products Measures: Results Workbook 2021_Guidehouse_MA_Res_NTG_Final_Results_Workbook

1.14 Building Shell - Window

Measure Code	RES-BS-WIN
Market	Residential
Program Type	Early Replacement
Category	Building Shell

Measure Description:

Early replacement of a single pane window either with or without a storm with a triple pane window.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Window - Electric Resistance	Residential Retail (RES_RETAIL)	EA2c344
Window - Heat Pump	Residential Retail (RES_RETAIL)	EA2c345
Window - Gas	Residential Retail (RES_RETAIL)	GA2c078
Window - Oil	Residential Retail (RES_RETAIL)	EA2c346
Window - Propane	Residential Retail (RES_RETAIL)	EA2c347

Algorithms for Calculating Primary Energy Impact:

Savings are calculated using the installed area of the replacement window and usage factors develop using RESFEN[1] to model different window types and heating fuels. The results of this analysis are shown in the 'Annual Energy Usage' table below, which provides the annual usage based by window type. Since this is an early replacement measure it is assumed that for one-third of the measure life the savings are calculated as the difference between the existing conditions and a triple pane window and for the remaining two-thirds of the measure life the savings are calculated as the difference between an ENERGY STAR double pane and ENERGY STAR triple pane window. The savings are deemed by heating fuel type per window based on the following table.

Heating Fuel Type	Gross Annual kWh Saved	Maximum Load Reduction (kW)	Savings (MMBtu / Year)
Window - Electric Resistance Heating	131	0.13	-
Window - Heat Pump*	69	0.05	-

| Window - Gas Heating | 7 | 0.01 | 0.6 |
| Window - Oil/Propane Heating | 7 | 0.01 | 0.6 |

* Heat pump savings are assumed to be half of the electric resistance savings.

The early replacement remaining life heating savings were calculated as consumption of the existing window minus consumption of the Energy Star triple pane window where the final savings apply a 30.9% weight to the single pane 'tight' window and a 60.1% weight to the single pane with storm window (based on National Grid home energy assessment data). The savings are calculated as follows:
Single Pane 'tight' electric resistance heating savings are calculated using the following: $(AEHb-AEHes3)*SqFt = 215$ kWh
Single Pane with storm electric resistance heating savings are calculated using the following: $(AEHb2-AEHes3)*SqFt = 83.7$ kWh
Single Pane 'tight' fossil fuel heating savings are calculated using the following: $(AGUb-AGUes3)*SqFt = 1.08$ MMBtu
Single Pane with storm fossil fuel heating savings are calculated using the following: $(AGUb2-AGUes3)*SqFt = 0.42$ MMBtu
where:
$AEHb=22.02$ (see Annual Energy Usage table)
$AEHb2=10.79$ (see Annual Energy Usage table)
$AEHes3=3.64$ (see Annual Energy Usage table)
$AGUb=0.111$ (see Annual Energy Usage table)
$AGUb2=0.054$ (see Annual Energy Usage table)
$AGUes3=0.018$ (see Annual Energy Usage table)
SqFt= Assumed 11.7 square feet of area per window based on an average window size of 31.5"x53.5"

The heating savings after the remaining life were calculated as consumption of the Energy Star double pane window (standard device) minus consumption of the Energy Star triple pane window. The savings are calculated as follows:
Energy Star double pane electric resistance heating savings are calculated using the following: $(AEHes2-AEHes3)*SqFt = 23.7$ kWh
Energy Star double pane fossil fuel heating savings are calculated using the following: $(AGUes2-AGUes3)*SqFt = 0.12$ MMBtu
where:
$AEHes2=5.66$ (see Annual Energy Usage table)
$AEHes3=3.64$ (see Annual Energy Usage table)
$AGUes2=0.028$ (see Annual Energy Usage table)
$AGUes3=0.018$ (see Annual Energy Usage table)
SqFt= Assumed 11.7 square feet of area per window based on an average window size of 31.5"x53.5"

The cooling savings are weighted assuming that 34% of homes have central cooling and 53% of homes have window ACs.[2] The window AC savings are assumed to be 28.3% of the central cooling savings[3] calculated as follows:

Cooling early replacement savings are calculated using the following: (AECb2-AECes3)*SqFt = 14.27 kWh

Cooling savings after the remaining life are calculated using the following: (AECes2-AECes3)*SqFt = 1.64 kWh

AECb2=2.57 (see Annual Energy Usage table)

AECes2=1.49 (see Annual Energy Usage table)

AECes3=1.35 (see Annual Energy Usage table)

SqFt= Assumed 11.7 square feet of area per window based on an average window size of 31.5"x53.5"

Annual Energy Usage

Window /Sliding Glass Door Type	Annual Electric Heating Usage AEH (kWh/ft[5])	Annual Electric Cooling Usage AEC (kWh/ft[6])	Annual Fossil Fuel Usage AGU (MMBtu/ft[7])
Single Pane ("tight")	22.02	2.57	0.11
Double Pane (or single with storm)	10.79	2.57	0.05
ENERGY STAR - Double Pane	5.66	1.49	0.03
ENERGY STAR - Triple Pane	3.64	1.35	0.02

Baseline Efficiency:

The baseline efficiency case is a single pane window with or without a storm.

High Efficiency:

The high efficiency case is an ENERGY STAR® qualified triple pane window.

Measure Life:

The measure life is 25 years.[4]   Dual baseline savings were calculated and assumed that the remaining life of the existing windows would be 1/3rd of the 25 year measure life or 8 years. Savings after the remaining life of the existing windows are assumed to be 2/3rd of the 25 year measure life or 17 years. The adjusted measure life (AML) was calculated by dividing calculated lifetime savings by annual savings.

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Window - Electric Resistance Heating	RES_RETAIL	All	25	n/a	8	17
Window - Heat Pump	RES_RETAIL	All	25	n/a	8	16

Window - Gas Heating	RES_RETAIL	All	25	n/a	8	17
Window - Oil/Propane Heating	RES_RETAIL	All	25	n/a	8	17

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Window - Electric Resistance Heating	RES_RETAIL	All	1.00	1.00	n/a	1.00	1.00	0.06	0.13
Window - Heat Pump	RES_RETAIL	All	1.00	1.00	n/a	1.00	1.00	0.24	0.25
Window - Gas Heating	RES_RETAIL	All	1.00	1.00	n/a	1.00	1.00	0.50	0.04
Window - Oil/Propane Heating	RES_RETAIL	All	1.00	1.00	n/a	1.00	1.00	0.50	0.04

In-Service Rates:

The in-service rate is assumed to be 100%.

Realization Rates:

Realization rates are based on Massachusetts Common Assumptions.

Coincidence Factors:

Summer and winter coincidence factors are estimated using demand allocation methodology described in the Demand Impact Model.[5]

Impact Factors for Calculating Net Savings:

Assumed 4% free-ridership based on the low market share of triple pane windows.

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Window	RES_RETAIL	All	0.04	0.00	0.00	0.96

Non-Energy Impacts:

NEI values are rolled up, component values can be found in Appendix B.[6]

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $	Annual $ per	One-time $ per	Annual $ per	One-time $

			per Unit	kWh	KWh	Therm	per Therm
Window	RES_RETAIL	All	$6.72	$0.00	$0.00	$0.00	$0.00	$0.00

Endnotes:

1 : Lawrence Berkeley National Laboratory, RESFEN 5.0 computer software, May 12, 2005. http://windows.lbl.gov/software.

2 : Guidehouse (2020). Residential Baseline Study Phase 4.
2020_Guidehouse_Residential_Baseline_Phase_4

3 : Nexant Market Research Inc. (2007). Market Assessment for ENERGY STAR Room Air Conditioners in Connecticut.

4 : GDS Associates (2007). Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures.
GDS_2007_Measure_Life_Report_Residential_and_CI_Lighting_and_HVAC_Measures

5 : Guidehouse (2020). Residential Baseline Study Phase 4
2020_Guidehouse_Residential_Baseline_Phase_4

6 : NMR Group, Inc., Tetra Tech (2011). Massachusetts Special and Cross-Sector Studies Area, Residential and Low-Income Non-Energy Impacts (NEI) Evaluation.
Tetra_Tech_and_NMR_2011_MA_Res_and_LI_NEI_Evaluation

1.15 Cooking - Induction Stove

Measure Code	RES-FS-ISP
Market	Residential
Program Type	Lost Opportunity
Category	Food Service Equipment, Food Service and Cooking Equipment

Measure Description:

Rebate provided for the purchase of a propane induction stove.

BCR Measure IDs:

Measure	**Core Initiative**	**BCR Measure ID**
Induction Stove replacing Propane	Residential Retail (RES_RETAIL)	EA2c352
Induction Stove - FS - Natural Gas	Residential Retail (RES_RETAIL)	GA2c091

Algorithms for Calculating Primary Energy Impact:

Unit kWh savings are deemed.[1] Demand savings are derived from the demand impact model which is developed as part of the Residential Baseline Study.[2]

Measure Name	**Core Initiative**	**ΔkWh**	**ΔkW**
Induction Stove	RES_RETAIL	-258	-0.06

Baseline Efficiency:

The baseline efficiency case for the induction stove is a propane or natural gas range.

High Efficiency:

The high efficiency case is an electric induction stove.

Measure Life:

The measure life is shown below.[3]

Measure Name	**Core Initiative**	**PA**	**EUL**	**OYF**	**RUL**	**AML**
Induction Stove	RES_RETAIL	All	16	n/a	n/a	16

Other Resource Impacts:

Measure Name	Core Initiative	PA	MMBTUs[4]
Induction Stove	RES_RETAIL	All	2.10

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Induction Stove	RES_RETAIL	All	1.00	1.00	1.00	1.00	1.00	0.31	0.84

In-Service Rates:

The in-service rate is assumed to be 100% absent evaluation.

Realization Rates:

The realization rate is assumed to be 100% absent evaluation.

Coincidence Factors:

Summer and winter coincidence factors are estimated using the demand allocation methodology described in the Demand Impact Model which is developed based on the Residential Baseline Study.[5]

Impact Factors for Calculating Net Savings:

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Induction Stove	RES_RETAIL	All	0.00	0.00	0.00	1.00

Non-Energy Impacts:

For details on the NEIs being applied to these measures, please refer to the following study: [6] The same NEI values are used for both replacing propane and natural gas with induction stovetops.

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per kWh	Annual $ per Therm	One-time $ per Therm
Induction Stove	Residential Retail (RES_RETAIL)	All	$194.49	$-57.78	0	0	0	0

Endnotes:

1 : Frontier Energy (2019). Residential Cooktop Performance and Energy Comparison Study.
2019_Frontier_Energy_Residential_Cooktop_Performance_and_Energy_Comparison_Study
2 : Guidehouse (2020). Residential Baseline Study Phase 4
2020_Guidehouse_Residential_Baseline_Phase_4
3 : Frontier Energy (2019). Residential Cooktop Performance and Energy Comparison Study.
2019_Frontier_Energy_Residential_Cooktop_Performance_and_Energy_Comparison_Study
4 : Frontier Energy (2019). Residential Cooktop Performance and Energy Comparison Study.
2019_Frontier_Energy_Residential_Cooktop_Performance_and_Energy_Comparison_Study
5 : Guidehouse (2020). Residential Baseline Study Phase 4
2020_Guidehouse_Residential_Baseline_Phase_4
6 : NMR (2022) : Gas-to-induction stovetop NEI study 2022_NMR_MA22X03-E-GSCNEI_Gas-to-Induction Stovetop NEIs Study_ Final Report_1

1.16 Custom - Residential Multi-Family

Measure Code	RES-CM-CMRCD
Market	Residential
Program Type	Retrofit
Category	Custom

Measure Description:

Vendors install a variety of electric and gas measures. The measures covered in this entry are associated with commercial gas and electric meters. Measures include HVAC, process, and domestic hot water equipment measures.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Custom - HVAC	Residential Coordinated Delivery (RES_CD)	EA2a272
Custom - Water Heating	Residential Coordinated Delivery (RES_CD)	EA2a273
Custom - Process	Residential Coordinated Delivery (RES_CD)	EA2a251
Custom - CHP	Residential Coordinated Delivery (RES_CD)	EA2a252
Custom - Other	Residential Coordinated Delivery (RES_CD)	EA2a253
Custom - Heating	Residential Coordinated Delivery (RES_CD)	GA2a094
Custom - Process	Residential Coordinated Delivery (RES_CD)	GA2a095
Custom - Water Heating	Residential Coordinated Delivery (RES_CD)	GA2a096

Algorithms for Calculating Primary Energy Impact:

Gross energy and demand savings estimates for custom RCD projects are calculated by approved vendors with project-specific details. Energy and demand savings calculations are based on projected or measured changes in equipment efficiencies and operating characteristics and are determined on a case-by-case basis.

Baseline Efficiency:

For retrofit projects, the baseline efficiency case is the same as the existing, or pre-retrofit, case for the facility.

High Efficiency:

The high efficiency scenario is specific to the facility and may include one or more energy efficiency measures.

Measure Life:

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Custom - HVAC	RES_CD	Statewide	custom	n/a	n/a	custom
Custom - Water Heating	RES_CD	Statewide	custom	n/a	n/a	custom
Custom - Process	RES_CD	Statewide	custom	n/a	n/a	custom
Custom - CHP	RES_CD	Statewide	custom	n/a	n/a	custom
Custom - Other	RES_CD	Statewide	custom	n/a	n/a	custom
Heating, Gas - Custom (High Rise)	RES_CD	Statewide	custom	n/a	n/a	custom
Process, Gas - Custom (High Rise)	RES_CD	Statewide	custom	n/a	n/a	custom
Water Heating, Gas - Custom (High Rise)	RES_CD	Statewide	custom	n/a	n/a	custom

Other Resource Impacts:

Other resource impacts are determined on a case by case basis.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Custom - HVAC	RES_CD	All	1.00	0.86	0.86	0.86	0.86	0.00	0.00
Custom - Water Heating	RES_CD	All	1.00	0.86	0.86	0.86	0.86	0.00	0.00
Custom - Process	RES_CD	All	1.00	0.86	0.86	0.86	0.86	0.00	0.00
Custom - CHP	RES_CD	All	1.00	1.10	1.22	1.44	1.01	0.00	0.43
Custom - Other	RES_CD	All	1.00	0.86	0.86	0.86	0.86	0.00	0.00
Heating, Gas - Custom (High Rise)	RES_CD	All	1.00	0.86	0.86	0.86	0.86	n/a	n/a
Process, Gas - Custom (High Rise)	RES_CD	All	1.00	0.86	0.86	0.86	0.86	n/a	n/a

Water Heating, Gas - Custom (High Rise)	RES_CD	All	1.00	0.86	0.86	0.86	0.86	n/a	n/a

In-Service Rates:

All installations have 100% in-service rates since all PA programs include verification of equipment installations.

Realization Rates:

Realization rates are based on an evaluation study.[1]

Coincidence Factors:

Summer and winter coincidence factors are estimated using the demand allocation methodology described in the Demand Impact Model which is developed based on the Residential Baseline Study.[2]

Impact Factors for Calculating Net Savings:

Net-to-gross factors are based on evaluation results.[3]

Measure Name	Core Initiative	PA	FR	SO$_P$	SO$_{NP}$	NTG
All Measures - Custom	RES_CD	Statewide	0.14	0.0	0.0	0.86

Non-Energy Impacts:

NEI values are rolled up, component values can be found in Appendix B.[4]

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per kWh	Annual $ per Therm	One-time $ per Therm
HVAC- Custom	RES_CD	All			$0.149			
Water Heating - Custom	RES_CD	All			$0.065			
Process - Custom	RES_CD	All			$0.098			
CHP	RES_CD	All			$0.098			
Other - Custom	RES_CD	All			$0.098			
Heating, Gas - Custom (High Rise)	RES_CD	All					($0.037)	
Process, Gas - Custom (High Rise)	RES_CD	All					($0.045)	
Water Heating, Gas -	RES_CD	All					$0.349	

Custom (High Rise)								

Endnotes:

1 : Navigant Consulting (2018). Multi-Family Program Impact and Net-to-Gross Evaluation.
2018_Navigant_Multifamily_Program_Impact_Evaluation
2 : Guidehouse (2020). Residential Baseline Study Phase 4
2020_Guidehouse_Residential_Baseline_Phase_4
3 : Guidehouse (2021). Residential Programs Net-to-Gross Research of RCD and Select Products.
2021_Guidehouse_MA_Res_NTG_Final_Report
4 : NMR Group, Inc. (2021). C&I O&M and Non-O&M Non-Energy Impacts Study 2021_NMR_CIOM and NonOM NEI Study

1.17 Demand - Active Demand Reduction

Measure Code	RES-DR-ADR
Market	Residential
Program Type	Active Demand Response
Category	Custom

Measure Description:

The core model for the Residential Direct Load Control offering is focused on reducing demand during summer peak load. The design is a bring-your-own-device model, starting first with communicating thermostats controlling central air conditioning units and cooling loads. Additional eligible connected devices may include water heaters, pool pumps, and other devices. Program Administrators, through the demand response management platform, send a signal to the device during an event that causes the controller to reduce the demand of the connected device. Events are called in the summer (June - September) during afternoon and evening hours. Customers can opt-out of events; however, they may be removed from the program if they regularly do not participate. Program Administrators will seek to enroll both customers with devices already installed and customers installing devices through the energy efficiency delivery pathways during the 2022-2024 plan period.

Under the Residential Storage Performance offering, customers are incentivized to decrease demand through the discharge of energy from storage in response to a signal or communication from the Program Administrators during daily peak hours in the summer and some targeted hours in winter months.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Direct Load Control	Residential Active Demand Reduction (RES_ADR)	EA2e001
Battery Storage Daily Dispatch, discharge (savings) Summer	Residential Active Demand Reduction (RES_ADR)	EA2e003
Battery Storage Daily Dispatch, charge (consumption) Summer	Residential Active Demand Reduction (RES_ADR)	EA2e011
CVEO Moderate - Battery Storage Daily Dispatch, discharge (savings) Summer	Residential Active Demand Reduction (RES_ADR)	CVEO5
CVEO Moderate - Battery Storage Daily Dispatch, charge (consumption) Summer	Residential Active Demand Reduction (RES_ADR)	CVEO6

Measure Name	Core Initiative	BCR Measure ID
CVEO Affordable - Battery Storage Daily Dispatch, discharge (savings) Summer	Residential Active Demand Reduction (RES_ADR)	CVEO19
CVEO Affordable - Battery Storage Daily Dispatch, charge (consumption) Summer	Residential Active Demand Reduction (RES_ADR)	CVEO20
CVEO Battery Storage Daily Dispatch, discharge (savings) Summer	Income Eligible Active Demand Reduction (IE_ADR)	CVEO13
CVEO Battery Storage Daily Dispatch, charge (consumption) Summer	Income Eligible Active Demand Reduction (IE_ADR)	CVEO14

Algorithms for Calculating Primary Energy Impact:

For Direct Load Control, Initial savings are based on vendor estimates, which are then adjusted by hourly load adjustment factors described below in the Impact Factors for Calculating Adjusted Gross Savings section. [1]

For Summer Storage Daily Dispatch, unit savings are calculated by the vendor based on discharge data during a DR event.[2] The CVEO measures including the income eligible measures use the same savings methodology as the standard offerings and are unique offering for CLC.

Summer kW savings supplied by vendors is the average of the top hour of each day in July and August on which events were called.

Baseline Efficiency:

For Direct Load Control, evaluators determined baseline conditions using an experimental design methodology (randomly assigned treatment and control groups), or a within-subject methodology or savings adjustment factor for demand reduction events where experimental design was not possible.[2]

For Storage Daily Dispatch, demand and energy impacts of the energy storage are measured assuming the whole-home and solar PV data as the baseline.[3]

High Efficiency:

N/A, Active Demand Reduction does not directly increase efficiency. Direct load control does reduce energy consumption by curtailing use, but does not increase efficiency per se. Storage increases energy consumption due to round trip efficiency losses.

Measure Life:

Because Active Demand Reduction is based on Program Administrators calling demand reduction events each year, the measure life is one year.

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
All Active Demand Reduction measures	RES_ADR	All	1	n/a	n/a	1

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

To date only the Direct Load Control (DLC) and Storage Daily Dispatch offers have been evaluated. For other offers, realization rates and coincidence factors are assumed to be 1.0 until evaluation results are available.

For the DLC offer, realization rates are set to 100% because hourly load adjustment factors, based on evaluation results, are used instead. Evaluators determined hourly load adjustment factors to adjust vendor-reported demand reduction based on evaluated results. The hourly load adjustment factor is 0.72 during the pre-cooling period and 0.68 during the recovery period. During the event, the hourly load adjustment factor is a function of temperature, equal to -3.06 + (0.05 x Average Temperature °F).   This calculation applies under the following conditions: when the ISO-NE or PJM baseline is used, the event duration is three hours, the assumed air conditioning nameplate capacity continues to be 3.5 kW, and the average outdoor temperature is 75 degrees F or higher.[4] Benefits are calculated based on adjusted demand reduction during the peak hour of each of the 62 days in July and August. This generates an average curtailment amount and a limited scaling factor that are used to calculate demand reduction benefits.

For Storage Daily Dispatch, realization rates are set to 100% since deemed savings are based on evaluation results.[5]

Measure Name	Core Initiative	PA	ISR	RR$_E$	RR$_{NE}$	RR$_{SP}$	RR$_{WP}$	CF$_{SP}$	CF$_{WP}$
Direct Load Control	RES_ADR	All	1.00	1.00	1.00	1.00	1.00	1.00	0.00
Storage Daily Dispatch, discharge (savings) Summer	RES_ADR	All	1.00	1.00	1.00	1.00	1.00	1.00	0.00
Storage Daily Dispatch, charge (consumption) Summer	RES_ADR	All	1.00	1.00	1.00	1.00	1.00	0.00	0.00

Impact Factors for Calculating Net Savings:

Net-to-gross ratios are assumed to be 1.0 for the demand response program offerings.

Measure Name	Core Initiative	PA	FR	SO$_P$	SO$_{NP}$	NTG
All Active Demand Reduction measures	RES_ADR	All	0.00	0.00	0.00	1.00

Non-Energy Impacts:

There are no non-energy impacts identified for this measure.

Endnotes:

1 : Guidehouse (2020). 2019 Residential Energy Storage Demand Response Demonstration Evaluation: Summer Season 2020_Guidehouse_Residential_Energy_Storage_Demand_Response_Summer
2 : Guidehouse (2020). 2019 Residential Wi-Fi Thermostat Direct Load Control Offering Evaluation 2019_Guidehouse_Residential_Wi-Fi_Thermostat_DLC
3 : Guidehouse (2020). 2019 Residential Energy Storage Demand Response Demonstration Evaluation: Summer Season 2020_Guidehouse_Residential_Energy_Storage_Demand_Response_Summer
4 : Guidehouse (2020). 2019 Residential Wi-Fi Thermostat Direct Load Control Offering Evaluation 2019_Guidehouse_Residential_Wi-Fi_Thermostat_DLC
5 : Guidehouse (2020). 2019 Residential Energy Storage Demand Response Demonstration Evaluation: Summer Season 2020_Guidehouse_Residential_Energy_Storage_Demand_Response_Summer

1.18 HVAC - Air Source Central Heat Pump

Measure Code	RES-HVAC-ASHP
Market	Residential
Program Type	Early Retirement, Replace on Burnout, Retrofit
Category	Heating Ventilation and Air Conditioning

Measure Description:

The installation of high efficiency air source, central heat pump systems.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Central Heat Pump, No Integrated Controls	Residential Retail (RES_RETAIL)	EA2c003

Algorithms for Calculating Primary Energy Impact:

Unit savings are based on a per ton using the following algorithms and assumptions and reflect a blend of replace on failure and early retirement for the Central Heat Pump, No Integrated Controls measure:

$\Delta kWh/ ton = \Delta kWh_{cool} /ton+ \Delta kWh_{heat} / ton = [12kBtu/hr/Ton \times (1/SEER_{BASE} - 1/SEER_{EE}) \times HOURS_C]$
$+ [12kBtu/hr/Ton \times (1/HSPF_{BASE} - 1/HSPF_{EE}) \times HOURS_H]$
$\Delta kW / ton = max (\Delta kW_{cool}, \Delta kW_{heat})$
$\Delta kW_{cool} / ton = \Delta kWh_{cool} \times$ Annual Maximum Demand Factor (cool)
$\Delta kW_{heat} / ton= \Delta kWh_{heat} \times$ Annual Maximum Demand Factor (heat)

Where:
Unit = Savings per outdoor unit
Tons = Capacity of HP equipment
$SEER_{BASE}$ = Seasonal Energy Efficiency Ratio of baseline HP equipment
$SEER_{EE}$ = Seasonal Energy Efficiency Ratio of new efficient HP equipment.
$HSPF_{BASE}$ = Heating Seasonal Performance Factor of baseline HP equipment
$HSPF_{EE}$ = Heating Seasonal Performance Factor of new efficient HP equipment.
$Hours_C$ = Equivalent Full Load Hours (EFLH) for cooling
$Hours_H$ = EFLH for heating

For replace on failure, unit savings are counted as the efficiency savings for the high efficiency heat pump unit compared to a code-compliant heat pump unit for the full life of the new high efficiency heat pump unit.

For early retirement of an existing heat pump unit, unit savings are counted in two parts: (1) early retirement savings for a code-compliant heat pump unit compared to the existing heat pump unit over the remaining life of the existing heat pump unit, and (2) efficiency savings for the high efficiency heat pump unit compared to a code-compliant heat pump unit for the full life of the new high efficiency heat pump unit.

The savings for this measure are blended 69.5% Replace on Failure and 31.5% Early Retirement.

Savings for Residential Air-Source Heat Pumps [1]

Measure Name	Energy Type	Average SEER[2]	Average HSPF[3]	Tons	Hours[2]	ΔkWh/ Ton	Annual Max Demand Factor[3]	ΔkW/ton
Central Heat Pump, No Integrated Controls	Electric	17.6	9.81	3.03	419 (cool) 1,200 (heat)	506	0.00117 (winter)	0.59

Baseline Efficiency:

Central Heat Pump, No Integrated Controls

For replace on failure, the baseline is a code-compliant SEER 14, HSPF 8.2 heat pump unit,.

For early retirement, over the remaining life of the existing heat pump unit, the baseline is an existing inefficient SEER 10, HSPF 7 heat pump unit. For early retirement, over the life of the new heat pump, the baseline is a code-compliant SEER 14, HSPF 8.2 heat pump unit.

Moderate Income Qualified - Central Heat Pump, No Integrated Controls

The baseline is an existing central heat pump; SEER 10 and HSPF 7.

High Efficiency:

Central Heat Pump, No Integrated Controls

For replace on failure, the high efficiency case is a SEER 17.6, HSPF 9.8 heat pump unit, based on the efficiency levels of units rebated in the previous calendar year.

For early retirement, over the remaining life of the existing heat pump unit, the high efficiency case is a code-compliant SEER 14, HSPF 8.2 heat pump unit. For early retirement, over the life of the new heat pump, the high efficiency case is a SEER 17.6, HSPF 9.8 heat pump unit.

Moderate Income Qualified - Central Heat Pump, No Integrated Controls

The high efficiency case is a SEER 17.6, HSPF 9.8 heat pump unit.

Measure Life:

The measure life is based on evaluation results and a blend of replace on failure and early retirement.[4] The remaining life for the existing unit is 6 years, and the measure life of new equipment is 18 years. The blended measure life is 15 years.

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Central Heat Pump, No Integrated Controls	RES_RETAIL	All	18	n/a	6	15

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Central Heat Pump, No Integrated Controls	RES_RETAIL	All	1.00	1.00	1.00	1.00	1.00	0.38	0.05

In-Service Rates

All installations have 100% in service rate since all PAs programs include verification of equipment installations.

Realization Rates

Realization rates are set to 100% since deemed savings are based on evaluation results.

Coincidence Factors

Summer and winter coincidence factors are estimated using the demand allocation methodology described in the Demand Impact Model which is developed based on the Residential Baseline Study.[5]

Impact Factors for Calculating Net Savings:

Net-to-gross factors are based on evaluation results.

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Central Heat Pump, No Integrated Controls[6]	RES_RETAIL	All	0.34	0.12	0.10	0.88

Non-Energy Impacts:

The PAs do not claim any NEIs for this measure. The NEIs are claimed as part of the fuel displacement to heat pump measures.

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per kWh	Annual $ per Therm	One-time $ per Therm
Central Heat Pump, No Integrated Controls	RES_RETAIL	All	$0.00	$0.00	$0.00	$0.00	n/a	n/a

Endnotes:

1 : Percentages of replace on failure and early retirement are from NMR Group (2018), Massachusetts Residential HVAC NTG and Market Effects Study (TXC34); and subsequently adjusted by 10% per agreement with EEAC consultants. The calculation of these percentages and unit savings can be found here. Savings are based on a per ton. MA_PAs_2022-2024 Planning Electric H&C Savings Workbook_2021-06-17

2 : Navigant Consulting (2018). RES 1 Baseline Load Shape Study (cooling hours). 2018_Navigant_Baseline_Loadshape_Comprehensive_Report

3 : Guidehouse (2020). Residential Baseline Study Phase 4 2020_Guidehouse_Residential_Baseline_Phase_4

4 : MA PAs (2021). 2022-2024 plan Electric HVAC Calculations Workbook. Measure life reflects a blend of replace on failure and early replacement. MA_PAs_2022-2024 Planning Electric H&C Savings Workbook_2021-06-17

5 : Guidehouse (2020). Residential Baseline Study Phase 4 2020_Guidehouse_Residential_Baseline_Phase_4

6 : MA PAs (2021). 2022-2024 Electric HVAC Calculations Workbook. NTG factors reflect a blend of replace on failure NTG factors obtained from NMR Group (2018), Massachusetts Residential HVAC NTG and Market Effects Study and early retirement and NTG factors obtained from Navigant (2018) Heating and Cooling Early Retirement Net-to-Gross. The calculation of the blended NTG factors can be found in MA PAs (2021). 2022-2024 plan Electric HVAC Calculations Workbook. 2021_Guidehouse_MA_Res_NTG_Final_Report

7 : MA PAs (2021). 2022-2024 planning Electric HVAC Calculations Workbook. MA_PAs_2022-2024 Planning Electric H&C Savings Workbook_2021-06-17

1.19 HVAC - Boiler Reset Control

Measure Code	RES-HVAC-BSC
Market	Residential
Program Type	Retrofit
Category	Heating Ventilation and Air Conditioning

Measure Description:

Boiler Reset Controls are devices that automatically control boiler water temperature based on outdoor or return water temperature using a software program.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Room Response Boiler Reset Control, Propane	Residential Retail (RES_RETAIL)	EA2c288
Boiler Reset Control, Gas - Midstream	Residential Retail (RES_RETAIL)	EA2c276
Boiler Reset Control, Oil - Midstream	Residential Retail (RES_RETAIL)	EA2c277
Boiler Reset Control, Other - Midstream	Residential Retail (RES_RETAIL)	EA2c278
Boiler Reset Control, Gas (Single Family)	Residential Coordinated Delivery (RES_CD)	GA2a039
Boiler Reset Control, Gas	Residential Retail (RES_RETAIL)	GA2c021
Room Response Boiler Reset Control	Residential Retail (RES_RETAIL)	GA1c035
Boiler Reset Control, Gas - Midstream	Residential Retail (RES_RETAIL)	GA2c048

Algorithms for Calculating Primary Energy Impact:

For standard boiler reset controls unit savings are deemed based on study results for all boiler reset controls.[1] A Boiler Reset Control is a devise that automatically **controls** the **boiler** water temperature according to a software program based on outdoor temperature. The water can be run a little cooler during fall and spring, and a little hotter during the coldest parts of the winter. For Room Response boiler controls measures, savings are based on a 2.5 % savings estimate using the source: [2] A room response control reduces boiler energy usage by adjusting the boiler outlet water temperature based on the building's response time to achieve room setpoint temperatures. When the building calls for heat, a control automatically adjusts condensing boiler sending water temperatures to a minimum level while

still providing sufficient heat to meet building load based on real time heating load from recent boiler cycles, increasing the efficiency of the boiler without requiring an outdoor air temperature sensor.

Measure Name	ΔMMBtu
Boiler Reset Control, Gas - Midstream	5.1
Boiler Reset Control, Oil - Midstream	5.2
Boiler Reset Control, Other - Midstream	5.1
Boiler Reset Control, Gas (Single Family)	5.1
Boiler Reset Control, Gas	5.1
Room Response Boiler Reset Control, Propane	2.2
Room Response Boiler Reset Control	2.2

Baseline Efficiency:

The baseline efficiency case is a boiler without reset controls for all boiler reset controls. The baseline efficiency case for room response boiler reset control is a standard boiler reset control.

High Efficiency:

The high efficiency case is a boiler with reset controls for all boiler reset control measures. For the room response boiler reset control measure the high efficiency case is a room response boiler reset control connected to a condensing boiler.

Measure Life:

The measure life is 15 years.[3]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Boiler Reset Control, Gas - Midstream	RES_RETAIL	All	15	n/a	n/a	15
Boiler Reset Control, Oil - Midstream	RES_RETAIL	All	15	n/a	n/a	15
Boiler Reset Control, Other - Midstream	RES_RETAIL	All	15	n/a	n/a	15
Boiler Reset Control, Gas (Single Family)	RES_CD	All	15	n/a	n/a	15

Boiler Reset Control, Gas	RES_RETAIL	All	15	n/a	n/a	15
Room Response Boiler Reset Control, Propane	RES_RETAIL	All	15	n/a	n/a	15
Room Response Boiler Reset Control	RES_RETAIL	All	15	n/a	n/a	15

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Boiler Reset Control, Gas - Midstream	RES_RETAIL	All	1.00	n/a	1.00	n/a	n/a	n/a	n/a
Boiler Reset Control, Oil - Midstream	RES_RETAIL	All	1.00	n/a	1.00	n/a	n/a	n/a	n/a
Boiler Reset Control, Other - Midstream	RES_RETAIL	All	1.00	n/a	1.00	n/a	n/a	n/a	n/a
Boiler Reset Control, Gas (Single Family)	RES_CD	All	1.00	n/a	1.00	n/a	n/a	n/a	n/a
Boiler Reset Control, Gas	RES_RETAIL	All	1.00	n/a	1.00	n/a	n/a	n/a	n/a
Room Response Boiler Reset Control, Propane	RES_RETAIL	All	1.00	n/a	1.00	n/a	n/a	n/a	n/a
Room Response Boiler Reset Control	RES_RETAIL	All	1.00	n/a	1.00	n/a	n/a	n/a	n/a

In-Service Rates:
All installations have 100% in service rate since programs include verification of equipment installations.

Realization Rates:
All PAs use 100% energy realization rate. The summer and winter peak realization rates are not applicable for this measure since there are no electric savings claimed.

Coincidence Factors:
Not applicable for this measure since no electric savings are claimed.

Impact Factors for Calculating Net Savings:

Measure Name[3]	Core Initiative	PA	FR	SO$_P$	SO$_{NP}$	NTG
Boiler Reset Control, Gas - Midstream	RES_RETAIL	All	0.36	0.12	0.00	0.76
Boiler Reset Control, Oil - Midstream	RES_RETAIL	All	0.33	0.12	0.01	0.80
Boiler Reset Control, Other - Midstream	RES_RETAIL	All	0.33	0.12	0.01	0.80
Boiler Reset Control, Gas (Single Family)	RES_CD	All	0.36	0.12	0.00	0.76
Boiler Reset Control, Gas	RES_RETAIL	All	0.36	0.12	0.00	0.76
Room Response Boiler Reset Control, Propane	RES_RETAIL	All	0.33	0.12	0.01	0.80
Room Response Boiler Reset Control	RES_RETAIL	All	0.36	0.12	0.00	0.76

Non-Energy Impacts:

There are no non-energy impacts identified for this measure.

Endnotes:

1 : Navigant Consulting (2018). Home Energy Services (HES) Impact Evaluation.
2018_Navigant_HES_Impact_Evaluation
2 : This source recommends a 2.5% savings that is comparing a standard boiler reset control to the more advanced room to room controls. Mass Save Residential Technology Energy Savings Submittal March 2019
3 : NTG values were derived from the following study using the fuel specific NTG values (1 for gas and 1 for other fuels): 2021_Guidehouse_MA_Res_NTG_Final_Report

1.20 HVAC - CVEO Battery Storage Dispatch

Measure Code	RES-HVAC-CVEO-BAT
Market	Residential
Program Type	Active Demand Response
Category	Other

BCR Measure IDs:

Measure	Core Initiative	BCR Measure ID
CVEO Battery Storage Daily Dispatch, discharge (savings) Summer	Residential Active Demand Reduction (RES_ADR)	CVEO5
CVEO Battery Storage Daily Dispatch, charge (consumption) Summer	Residential Active Demand Reduction (RES_ADR)	CVEO6
CVEO Battery Storage Targeted Dispatch, discharge (savings) Winter	Residential Active Demand Reduction (RES_ADR)	CVEO7
CVEO Battery Storage Targeted Dispatch, charge (consumption) Winter	Residential Active Demand Reduction (RES_ADR)	CVEO8

Under the Residential Storage Performance offering, customers are incentivized to decrease demand through the discharge of energy from storage in response to a signal.

The measures in the CVEO initiative planned by CLC are consistent with the Statewide Residential Active Demand Core Initiative.   CLC has not yet evaluated Battery Storage and plans to in the near future.

Algorithms for Calculating Primary Energy Impact:

For Summer Storage Daily Dispatch, unit savings are deemed based on study results.[1]

For Winter Storage Daily Dispatch, unit savings are deemed based on study results.[2]

PA	kW Savings per Battery*
National Grid - Summer	5.5
National Grid - Winter	6.9
Unitil - Summer	1.3
Unitil - Winter	8.3

* Savings per battery represent the average demand savings (which is equivalent to the battery discharge) during events for batteries that successfully participated.

Baseline Efficiency:

For Storage Daily Dispatch, demand and energy impacts of the energy storage are measures assuming the whole-home and solar PV data as the baseline.[3] [4]

High Efficiency:

N/A, Active Demand Reduction does not directly increase efficiency. Storage increases energy consumption due to round trip efficiency losses.

Measure Life:

Because Active Demand Reduction is based on Program Administrators calling demand reduction events each year, the measure life is one year.

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
CVEO Battery Storage	RES_ADR	CLC	1	n/a	n/a	1

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

For Storage Daily Dispatch, realization rates are set to 100% since deemed savings are based on evaluation results.[5] [6]

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Storage Daily Dispatch, discharge (savings) Summer	RES_ADR	CLC	1.00	1.00	1.00	1.00	1.00	1.00	0.00
Storage Daily Dispatch, discharge (consumption) Summer	RES_ADR	CLC	1.00	1.00	1.00	1.00	1.00	1.00	0.00
Storage Daily Dispatch, discharge (savings) Winter	RES_ADR	CLC	1.00	1.00	1.00	1.00	1.00	0.00	1.00

Storage Daily Dispatch, discharge (consumption) Winter	RES_ADR	CLC	1.00	1.00	1.00	1.00	1.00	0.00	1.00

Impact Factors for Calculating Net Savings:

Active Demand Reduction offerings are new and have not yet been evaluated. Net-to-gross ratios are assumed to be 1.0 until the statewide program is evaluated.

Measure Name	Core Initiative	PA	FR	SO$_P$	SO$_{NP}$	NTG
CVEO Battery Storage	RES_ADR	CLC	0.00	0.00	0.00	1.00

Non-Energy Impacts:

There are no non-energy impacts identified for this measure.

Endnotes:

1 : 2020_Guidehouse_Residential_Energy_Storage_Demand_Response_Summer
2 : 2020_Guidehouse_Residential_Energy_Storage_Demand_Response_Winter_Season
3 : 2020_Guidehouse_Residential_Energy_Storage_Demand_Response_Summer
4 : 2020_Guidehouse_Residential_Energy_Storage_Demand_Response_Winter_Season
5 : 2020_Guidehouse_Residential_Energy_Storage_Demand_Response_Summer
6 : 2020_Guidehouse_Residential_Energy_Storage_Demand_Response_Winter_Season

1.21 HVAC - CVEO Solar PV

Measure Code	RES-HVAC-CVEO-SOLPV
Market	Residential
Program Type	Early Retirement
Category	Heating Ventilation and Air Conditioning

BCR Measure IDs:

Measure	Core Initiative	BCR Measure ID
CVEO Solar PV	Residential Coordinated Delivery (RES_CD)	CVEO4

Algorithms for Calculating Primary Energy Impact:

The annual energy (in kWh and kW) produced by the installed solar PV system, accounting for location, system size, system orientation, and capacity factor.

The kWh for a particular system can be estimated using the National Renewable Energy Laboratory ("NREL") PVWatts Calculator, available at: https://pvwatts.nrel.gov/

Baseline Efficiency:

No Solar PV

High Efficiency:

Installation of Solar

Measure Life:

The measure life for a new solar PV system is assumed to be 25 years, consistent with net metering credit availability in Massachusetts. See: https://www.mass.gov/guides/net-metering-guide.

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
CVEO Solar PV	Res_CD	CLC	25	n/a	n/a	25

Other Resource Impacts:

There are no other resource impacts for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR$_E$	RR$_{NE}$	RR$_{SP}$	RR$_{WP}$	CF$_{SP}$	CF$_{WP}$
CVEO Solar PV	RES_CD	CLC	1.00	1.00	1.00	1.00	1.00	0.80	0.00

Impact Factors for Calculating Net Savings:

Net-to-Gross values are set to 100% until an evaluation occurs.

Measure Name	Core Initiative	PA	FR	SO$_P$	SO$_{NP}$	NTG
CVEO Solar PV	RES_CD	CLC	0.00	0.00	0.00	1.00

Non-Energy Impacts:

There are no non-energy impacts identified with this measure.

1.22 HVAC - Central AC Quality Installation Verification (QIV)

Measure Code	RES-HVAC-CACQIV
Market	Residential
Program Type	Time of Sale
Category	Heating Ventilation and Air Conditioning

Measure Description:

The verification of proper charge and airflow during installation of new central air conditioning (AC) system.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Central Air QIV	Residential Retail (RES_RETAIL)	EA2c104

Algorithms for Calculating Primary Energy Impact:

Unit savings are deemed based on the following algorithms and assumptions:[1]
$\Delta kWh = \text{Tons} \times 12 \text{ kBtu/hr/Ton} \times (1/\text{SEER}) \times \text{Hours} \times 5\%$
$\Delta kW = \Delta kWh \times \text{Annual Maximum Demand Factor}$

Where:
Unit = Completed QIV of new central air conditioning system
Tons = Cooling capacity of AC equipment
SEER = Seasonal Energy Efficiency Ratio of AC equipment
Hours = Equivalent Full Load Hours (EFLH)
5% = Average demand reduction of 5.0%[2]

Savings for Central Air QIV

Measure Name	Energy Type	Average Capacity (tons)[3]	Average SEER[4]	Hours[5]	ΔkWh	Annual Max Demand Factor[6]	ΔkW
Central Air QIV	Electric	2.69	16.8	419	40.3	0.00143	0.06

Baseline Efficiency:

The baseline efficiency case is a new central air conditioning system (2.69 -ton and SEER 16.8), based on the average capacity and efficiency level of units rebated in the previous calendar year (2020), whose installation is inconsistent with manufacturer specifications.

High Efficiency:

The high efficiency case is the same air conditioning system whose installation is consistent with manufacturer specifications.

Measure Life:

The measure life is based on evaluation results.[7]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Central Air QIV	RES_RETAIL	All	18	N/A	N/A	18

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core	PA	ISR	RR$_F$	RR$_{NF}$	RR$_{SP}$	RR$_{WP}$	CF$_{SP}$	CF$_{WP}$
Central Air QIV		All	1.00	1.00	1.00	1.00	1.00	0.37	0.00

In-Service Rates:
All quality installation verifications are completed and documented and therefore have 100% in service rate.

Realization Rates:
Realization rates are set to 100% based on Massachusetts Common Assumptions.

Coincidence Factors:
Summer and winter coincidence factors are estimated using the demand allocation methodology described in the Demand Impact Model which is developed based on the Residential Baseline Study.[8]

Impact Factors for Calculating Net Savings:

Measure Name	Core Initiative	PA	FR	SO$_P$	SO$_{NP}$	NTG
Central Air QIV	RES_RETAIL	All	0.34	0.12	0.10	0.88

Non-Energy Impacts:

NEI values are rolled up and reflect a blend of replace on failure and early retirement, component values can be found in Appendix B.

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $	Annual $ per	One-time $	Annual $ per	One-time $ per

			per Unit	kWh	per kWh	Therm	Therm
Central Air QIV	RES_RETAIL	All	$1.53				

Endnotes:

1 : The calculation of unit savings can be found in MA PAs' 2022-2024 Plan Electric Heating and Cooling Savings Workbook (2021). MA_PAs_2022-2024 Planning Electric H&C Savings Workbook_2021-06-17

2 : Average capacity (tons) of central air conditioning units rebated in the full calendar year preceding the year in which this eTRM is published.

3 : Average SEER of central air conditioning units rebated in the full calendar year preceding the year in which this eTRM is published.

4 : Navigant Consulting (2018). RES 1 Baseline Load Shape Study.
2018_Navigant_Baseline_Loadshape_Comprehensive_Report

4 : Navigant Consulting (2018). RES 1 Baseline Load Shape Study.
2018_Navigant_Baseline_Loadshape_Comprehensive_Report

6 : Guidehouse (2020). Residential Baseline Study Phase 4
2020_Guidehouse_Residential_Baseline_Phase_4

7 : GDS Associates, Inc. (2007). Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures.
GDS_2007_Measure_Life_Report_Residential_and_CI_Lighting_and_HVAC_Measures

8 : Guidehouse (2020). Residential Baseline Study Phase 4
2020_Guidehouse_Residential_Baseline_Phase_4

1.23 HVAC - Combo Condensing Boiler/Water Heater

Measure Code	RES-HVAC-CCBWH
Market	Residential
Program Type	Early Retirement, Retrofit
Category	Heating Ventilation and Air Conditioning

Measure Description:

This measure promotes the installation of a combined high-efficiency boiler and water heating unit. Combined boiler and water heating systems are more efficient than separate systems because they eliminate the standby heat losses of an additional tank.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Combo Condensing Boiler/Water Heater, Other	Residential Retail (RES_RETAIL)	EA2c021
Moderate Income Qualified - Combo Condensing Boiler/Water Heater, Other	Residential Retail (RES_RETAIL)	EA2c338
Heating System, Combo Condensing Boiler/Water Heater, Gas 95%	Residential Retail (RES_RETAIL)	GA2c008
Moderate Income Qualified - Heating System, Combo Condensing Boiler/Water Heater, Gas 95%	Residential Retail (RES_RETAIL)	GA2c064

Algorithms for Calculating Primary Energy Impact:

Heating System, Combo Condensing Boiler/Water Heater, Gas 95% & Combo Condensing Boiler/Water Heater 95%, Other
Unit savings are deemed based on study results.[1] Savings have been adjusted to reflect the mix of replace and failure and early retirement based on study results.[2] The savings below are the adjusted values.[3]

Moderate Income Qualified - Combo Condensing Boiler/Water Heater, Other & Moderate Income Qualified - Heating System, Combo Condensing Boiler/Water Heater, Gas 95%
Unit savings are deemed based on study results. This measure is treated as a retrofit measure with savings being based on going from existing conditions to the high efficiency unit.

Measure Name	ΔMMBtu

Measure Name	ΔMMBtu
Heating System, Combo Condensing Boiler/Water Heater, Gas 95%	11.7
Moderate Income Qualified - Combo Condensing Boiler/Water Heater, Other	22.4
Combo Condensing Boiler/Water Heater 95%, Other	11.7
Moderate Income Qualified - Heating System, Combo Condensing Boiler/Water Heater, Gas 95%	22.4

Baseline Efficiency:

Heating System, Combo Condensing Boiler/Water Heater, Gas 95% & Combo Condensing Boiler/Water Heater 95%, Other

The baseline efficiency case is an 86.5% AFUE rated boiler (83.7% AFUE actual) with a 0.604 EF water heater. The ER baseline is an 85% AFUE rated boiler (77.4% AFUE actual) with either an indirect water heater or with a 0.58 EF water heater. 24% were indirect and 76% were storage water heaters.[4]

High Efficiency:

The high efficiency case is an 95% AFUE condensing boiler (actual was 89.4%) and a 0.95 EF water heater (actual was 89.4%). [8]

Measure Life:

The measure life is 20 years.[5] for non-moderate income which is due to a blending of savings between early retirement and end of life. For moderate income, the full life of the measure is used which is 23 years. [6]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Heating System, Combo Condensing Boiler/Water Heater, Gas 95%	RES_RETAIL	Statewide	23	n/a	7	20
Moderate Income Qualified - Heating System, Combo Condensing Boiler/Water Heater, Gas 95%	RES_RETAIL	Statewide	23	n/a	n/a	23
Combo Condensing Boiler/Water Heater 95%, Other	RES_RETAIL	Statewide	23	n/a	7	20
Moderate Income Qualified - Combo Condensing Boiler/Water Heater, Other	RES_RETAIL	Statewide	23	n/a	n/a	23

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR$_E$	RR$_{NE}$	RR$_{SP}$	RR$_{WP}$	CF$_{SP}$	CF$_{WP}$
Heating System, Combo Condensing Boiler/Water Heater, Gas 95%	RES_RETAIL	All	1.00	1.00	n/a	n/a	n/a	n/a	n/a
Moderate Income Qualified - Heating System, Combo Condensing Boiler/Water Heater, Gas 95%	RES_RETAIL	All	1.00	1.00	n/a	n/a	n/a	n/a	n/a
Combo Condensing Boiler/Water Heater 95%, Other	RES_RETAIL	All	1.00	1.00	n/a	n/a	n/a	n/a	n/a
Moderate Income Qualified - Combo Condensing Boiler/Water Heater, Other	RES_RETAIL	All	1.00	1.00	n/a	n/a	n/a	n/a	n/a

In-Service Rates
All installations have 100% in-service rates since programs include verification of equipment installations.

Realization Rates
All PAs use 100% energy realization rate. The summer and winter peak realization rates are not applicable for this measure since there are no electric savings claimed.

Coincidence Factors
Not applicable for this measure since no electric savings are claimed.

Impact Factors for Calculating Net Savings:

Net to Gross Factors [6]

Measure Name	Core Initiative	PA	FR	SO$_P$	SO$_{NP}$	NTG
Heating System, Combo Condensing Boiler/Water Heater, Gas 95%	RES_RETAIL	All	0.36	.13	0.00	0.76
Moderate Income Qualified - Heating System, Combo Condensing Boiler/Water Heater, Gas	RES_RETAIL	All	0.00	0.00	0.00	1.00

95%						
Combo Condensing Boiler/Water Heater 95%, Other	RES_RETAIL	All	0.33	.13	0.00	0.80
Moderate Income Qualified - Combo Condensing Boiler/Water Heater, Other	RES_RETAIL	All	0.00	0.00	0.00	1.00

Non-Energy Impacts:

NEIs are calculated. [7]

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per KWh	Annual $ per Therm	One-time $ per Therm
Heating System, Combo Condensing Boiler/Water Heater, Gas 95%	RES_RETAIL	All	$75.52					
Moderate Income Qualified - Heating System, Combo Condensing Boiler/Water Heater, Gas 95%	RES_RETAIL	All	$170.01					
Combo Condensing Boiler/Water Heater 95%, Other	RES_RETAIL	All	$75.52					
Moderate Income Qualified - Combo Condensing Boiler/Water Heater, Other	RES_RETAIL	All	$170.01					

Endnotes:

1 : The Cadmus Group (2015). High Efficiency Heating Equipment Impact Evaluation
CADMUS_2014_HEHE_Impact Evaluation
2 : The Cadmus Group (2013). 2012 Residential Heating, Water Heating, and Cooling Equipment
Evaluation: Net-to-Gross, Market Effects, and Equipment Replacement Timing
CADMUS_2013_HEHE_Cool Smart_NTG_Evaluation_Report
3 : Savings for gas calculations can be found in the following calculator, propane is set equal to gas -
MA_PAs_2022-2024 Annual Plan_Gas_HVAC_WH_Calculations_GH_2021-08-20
4 : The rated efficiency and actual efficiency for the heating portion can be found in the following study,

also included in this study is the % of indirect and storage water heaters -
2021_Guidehouse_TRM_Final_Report

8 : For details on the adjustment factor from rated to actual efficiency, please refer to the following study: CADMUS_2014_HEHE_Impact Evaluation

5 : The methodology used to calculate the blended measure life for gas can be found in the following calculator, Propane is assumed to have the same measure life. MA_PAs_2022-2024 Annual Plan_Gas_HVAC_WH_Calculations_GH_2021-08-20

6 : The measure life is assumed to be the same as for a gas boiler:
2021_Guidehouse_TRM_Final_Report

6 : For the non-moderate income measures, NTG can be verified with this evaluation study Guidehouse (2021). For moderate income, the NTG was negotiated between the EEAC and PAs.
2021_Guidehouse_Res_NTG_Final_Results_Memo

7 : NEI source and calculation methodology can be found in the following calculator - MA_PAs_2022-2024 Annual Plan_Gas_HVAC_WH_Calculations_GH_2021-08-20

1.24 HVAC - Combo Furnace/Water Heater

Measure Code	RES-HVAC-CFWH
Market	Residential
Program Type	Lost Opportunity, Retrofit
Category	Heating Ventilation and Air Conditioning

Measure Description:

Installation of a combination furnace.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Combo Condensing Furnace/Water Heater, Other	Residential Retail (RES_RETAIL)	EA2c282
Moderate Income Qualified - Combo Condensing Furnace/Water Heater, Other	Residential Retail (RES_RETAIL)	EA2c339
Heating System, Combo Condensing Furnace/Water Heater, Gas	Residential Retail (RES_RETAIL)	GA2c045
Moderate Income Qualified - Heating System, Combo Condensing Furnace/Water Heater, Gas	Residential Retail (RES_RETAIL)	GA2c065

Algorithms for Calculating Primary Energy Impact:

Heating System, Combo Condensing Furnace/Water Heater, Gas & Combo Condensing Furnace/Water Heater, Other

The heating load for furnaces is 584 therms. This is based on an evaluation of heating equipment installed through the HEHE program and assumed to be representative of single family homes.[1]

Δ Therms = heating load * (1/AFUEbase – 1/AFUEee) = 584 *(1/0.85 – 1/0.97) = 85 therms.

The water heating load is 139 therms.[2]

Δ Therms = water heating load * (1/UEFbase – 1/UEFee) = 139 *(1/0.63 – 1/0.90) = 66 therms.

For moderate income, there is not blending of savings and we are calculating savings based on existing conditions.

Measure Name	ΔMMBtu/Unit
Heating System, Combo Condensing Furnace/Water Heater, Gas	15.1
Combo Condensing Furnace/Water Heater, Other	15.1

Moderate Income Qualified - Heating System, Combo Condensing Furnace/Water Heater, Gas	23.7
Moderate Income Qualified - Combo Condensing Furnace/Water Heater, Other	23.7

Baseline Efficiency:

Heating System, Combo Condensing Furnace/Water Heater, Gas & Combo Condensing Furnace/Water Heater, Other: It is assumed that the baseline is an 85% AFUE furnace[3] and a separate high draw gas fired storage water heater with an efficiency rating of 0.63 UEF.

High Efficiency:

A new combination 97% AFUE furnace and 0.90 tankless water heater.

Measure Life:

The measure life is 17 years.[4]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Heating System, Combo Condensing Furnace/Water Heater, Gas 97%	RES_RETAIL	All	17	n/a	n/a	17
Combo Condensing Furnace/Water Heater, Other	RES_RETAIL	All	17	n/a	n/a	17
Moderate Income Qualified - Heating System, Combo Condensing Furnace/Water Heater, Gas	RES_RETAIL	All	17	n/a	n/a	17
Moderate Income Qualified - Combo Condensing Furnace/Water Heater, Other	RES_RETAIL	All	17	n/a	n/a	17

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Heating System, Combo Condensing Furnace/Water Heater, Gas 97%	RES_RETAIL	All	1.00	n/a	1.00	n/a	n/a	n/a	n/a

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Combo Condensing Furnace/Water Heater, Other	RES_RETAIL	All	1.00	n/a	1.00	n/a	n/a	n/a	n/a
Moderate Income Qualified - Heating System, Combo Condensing Furnace/Water Heater, Gas	RES_RETAIL	All	1.00	n/a	1.00	n/a	n/a	n/a	n/a
Moderate Income Qualified - Combo Condensing Furnace/Water Heater, Other	RES_RETAIL	All	1.00	n/a	1.00	n/a	n/a	n/a	n/a

In-Service Rates

All installations have 100% in-service rates since programs include verification of equipment installations.

Realization Rates

All PAs use 100% energy realization rate. The summer and winter peak realization rates are not applicable for this measure since there are no electric savings claimed.

Coincidence Factors

Not applicable for this measure since no electric savings are claimed.

Impact Factors for Calculating Net Savings:

Impact Factors for Calculating Net Savings [5]

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Heating System, Combo Condensing Furnace/Water Heater, Gas 97%	RES_RETAIL	All	0.36	0.13	0.00	0.76
Combo Condensing Furnace/Water Heater, Other	RES_RETAIL	All	0.33	0.13	0.00	0.80
Moderate Income Qualified - Heating System, Combo Condensing Furnace/Water Heater, Gas	RES_RETAIL	All	0.00	0.00	0.00	1.00
Moderate Income Qualified - Combo	RES_RETAIL	All	0.00	0.00	0.00	1.00

Condensing Furnace/Water Heater, Other							

Non-Energy Impacts:

Non-Energy Impacts are calculated. NEI values are rolled up, component values can be found in Appendix B.

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per kWh	Annual $ per Therm	One-time $ per Therm
Heating System, Combo Condensing Furnace/Water Heater, Gas 97%	RES_RETAIL	All	$30.84	$0.00	$0.00	$0.00	$0.00	$0.00
Combo Condensing Furnace/Water Heater, Other	RES_RETAIL	All	$30.84	$0.00	$0.00	$0.00	$0.00	$0.00
Moderate Income Qualified - Heating System, Combo Condensing Furnace/Water Heater, Gas	RES_RETAIL	All	$170.01	$0.00	$0.00	$0.00	$0.00	$0.00
Moderate Income Qualified - Combo Condensing Furnace/Water Heater, Other	RES_RETAIL	All	$170.01	$0.00	$0.00	$0.00	$0.00	$0.00

Endnotes:

1 : The Cadmus Group (2015). High Efficiency Heating Equipment Impact Evaluation.
CADMUS_2014_HEHE_Impact Evaluation
2 : Navigant Consulting (2018). Water Heater, Boiler, and Furnace Cost Study
2018_Navigant_Water_Heater_Analysis_Memo
3 : Negotiated value.
4 : The measure life is set equal to the measure life for a natural gas furnace:
2021_Guidehouse_TRM_Final_Report
5 : Guidehouse (2021). Residential Programs Net-to-Gross Research of RCD and Select Products

Measures Workbook for the non-moderate income measures. For moderate income measures, the PAs and EEAC negotiated a 100% NTG value. 2021_Guidehouse_MA_Res_NTG_Final_Report

1.25 HVAC - Communicating Thermostat

Measure Code	RES-HVAC-WT
Market	Residential
Program Type	Retrofit
Category	Heating Ventilation and Air Conditioning

Measure Description:

A communicating thermostat which allows remote set point adjustment and control via remote application. System requires an outdoor air temperature algorithm in the control logic to operate heating and cooling systems

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Wi-Fi Thermostat, Electric (Single Family)	Residential Coordinated Delivery (RES_CD)	EA2a290
Wi-Fi Thermostat, AC Only (Single Family)	Residential Coordinated Delivery (RES_CD)	EA2a064
Wi-Fi Thermostat, Gas (Single Family)	Residential Coordinated Delivery (RES_CD)	EA2a065
Wi-Fi Thermostat, Oil (Single Family)	Residential Coordinated Delivery (RES_CD)	EA2a067
Wi-Fi Thermostat, Other (Single Family)	Residential Coordinated Delivery (RES_CD)	EA2a069
Wi-Fi Thermostat, Electric (Attached Low Rise)	Residential Coordinated Delivery (RES_CD)	EA2a289
Wi-Fi Thermostat, AC Only (Attached Low Rise)	Residential Coordinated Delivery (RES_CD)	EA2a268
Wi-Fi Thermostat, Gas (Attached Low Rise)	Residential Coordinated Delivery (RES_CD)	EA2a148
Wi-Fi Thermostat, Oil (Attached Low Rise)	Residential Coordinated Delivery (RES_CD)	EA2a269
Wi-Fi Thermostat, Other (Attached Low Rise)	Residential Coordinated Delivery	EA2a149

Measure Name	Core Initiative	BCR Measure ID
	(RES_CD)	
Wi-Fi Thermostat, AC Only (High Rise)	Residential Coordinated Delivery (RES_CD)	EA2a235
Wi-Fi Thermostat, Oil (High Rise)	Residential Coordinated Delivery (RES_CD)	EA2a236
Wi-Fi Thermostat, Other (High Rise)	Residential Coordinated Delivery (RES_CD)	EA2a237
Wi-Fi Thermostat, Electric	Residential Retail (RES_RETAIL)	EA2c275
Wi-Fi Thermostat, AC Only	Residential Retail (RES_RETAIL)	EA2c058
Wi-Fi Thermostat, Gas	Residential Retail (RES_RETAIL)	EA2c060
Wi-Fi Thermostat, Oil	Residential Retail (RES_RETAIL)	EA2c062
Wi-Fi Thermostat, Other	Residential Retail (RES_RETAIL)	EA2c064
Wi-Fi Thermostat, Gas, gas heat only (Single Family)	Residential Coordinated Delivery (RES_CD)	GA2a013
Wi-Fi Thermostat, Gas (Attached Low Rise)	Residential Coordinated Delivery (RES_CD)	GA2a058
Wi-Fi Thermostat, Gas (High Rise)	Residential Coordinated Delivery (RES_CD)	GA2a092
Wi-Fi Thermostat, Gas	Residential Retail (RES_RETAIL)	GA2c030

Algorithms for Calculating Primary Energy Impact:

Unit savings are deemed based on study results. The evaluated electric savings of 64 kWh were adjusted for homes with fossil fuel heat to reflect the percent of homes that have cooling. That proportion is 28 percent, based on the Residential Baseline study.

Measure Name	Core Initiative	ΔkWh[1]	ΔkW[2]	Δ MMBtu[3]

Measure Name	Core Initiative	ΔkWh[1]	ΔkW[2]	Δ MMBtu[3]
Wi-Fi Thermostat, Electric (Single Family)	RES_CD	64	0.07	
Wi-Fi Thermostat, AC Only (Single Family)	RES_CD	64	0.09	
Wi-Fi Thermostat, Gas (Single Family)	RES_CD	18	0.03	2.79
Wi-Fi Thermostat, Oil (Single Family)	RES_CD	18	0.03	2.78
Wi-Fi Thermostat, Other (Single Family)	RES_CD	18	0.03	2.78
Wi-Fi Thermostat, Electric (Attached Low Rise)	RES_CD	64	0.07	
Wi-Fi Thermostat, AC Only (Attached Low Rise)	RES_CD	64	0.09	
Wi-Fi Thermostat, Gas (Attached Low Rise)	RES_CD	18	0.03	2.79
Wi-Fi Thermostat, Oil (Attached Low Rise)	RES_CD	18	0.03	2.78
Wi-Fi Thermostat, Other (Attached Low Rise)	RES_CD	18	0.03	2.78
Wi-Fi Thermostat, AC Only (High Rise)	RES_CD	64	0.09	
Wi-Fi Thermostat, Oil (High Rise)	RES_CD	18	0.03	2.78
Wi-Fi Thermostat, Other (High Rise)	RES_CD	18	0.03	2.78
Wi-Fi Thermostat, Gas (High Rise)	RES_CD	18	0.03	2.79
Wi-Fi Thermostat, Electric	RES_RETAIL	64	0.07	
Wi-Fi Thermostat, AC Only	RES_RETAIL	64	0.09	
Wi-Fi Thermostat, Gas	RES_RETAIL	18	0.03	2.79
Wi-Fi Thermostat, Oil	RES_RETAIL	18	0.03	2.78
Wi-Fi Thermostat, Other	RES_RETAIL	18	0.03	2.78
Wi-Fi Thermostat (instant rebate)**	RES_RETAIL	PA-specific	PA-specific	PA-specific

**Note: Savings for instant rebate Wi-Fi thermostats (for which the fuel is unknown) are weighted for each PA, based on the evaluated savings of retail thermostats and that PAs proportion of rebated thermostats of each fuel type in that PAs Residential Retail program.

Baseline Efficiency:

The baseline efficiency case is an HVAC system with either a manual or a programmable thermostat.

High Efficiency:

The high efficiency case is an HVAC system that has a Wi-Fi thermostat installed.

Measure Life:

The measure life is 15 years.[4]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Wi-Fi Thermostat	RES_CD	All	15	n/a	n/a	15
Wi-Fi Thermostat	RES_RETAIL	All	15	n/a	n/a	15

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Wi-Fi Thermostat, Electric (Single Family)	RES_CD	All	0.79	1.00	1.00	1.00	1.00	0.34	0.20
Wi-Fi Thermostat, AC Only (Single Family)	RES_CD	All	0.79	1.00	1.00	1.00	1.00	0.35	0.00
Wi-Fi Thermostat, Gas (Single Family)	RES_CD	All	0.79	1.00	1.00	1.00	1.00	0.35	0.00
Wi-Fi Thermostat, Oil (Single Family)	RES_CD	All	0.79	1.00	1.00	1.00	1.00	0.35	0.00
Wi-Fi Thermostat, Other (Single Family)	RES_CD	All	0.79	1.00	1.00	1.00	1.00	0.35	0.00
Wi-Fi Thermostat, Electric (Attached Low Rise)	RES_CD	All	0.79	1.00	1.00	1.00	1.00	0.34	0.20
Wi-Fi Thermostat, AC Only (Attached Low Rise)	RES_CD	All	0.79	1.00	1.00	1.00	1.00	0.35	0.00
Wi-Fi Thermostat, Gas (Attached Low Rise)	RES_CD	All	0.79	1.00	1.00	1.00	1.00	0.35	0.00

Measure Name	Core Initiative	PA	ISR	RR$_E$	RR$_{NE}$	RR$_{SP}$	RR$_{WP}$	CF$_{SP}$	CF$_{WP}$
Wi-Fi Thermostat, Oil (Attached Low Rise)	RES_CD	All	0.79	1.00	1.00	1.00	1.00	0.35	0.00
Wi-Fi Thermostat, Other (Attached Low Rise)	RES_CD	All	0.79	1.00	1.00	1.00	1.00	0.35	0.00
Wi-Fi Thermostat, AC Only (High Rise)	RES_CD	All	1.00	1.00	1.00	1.00	1.00	0.35	0.00
Wi-Fi Thermostat, Oil (High Rise)	RES_CD	All	1.00	1.00	1.00	1.00	1.00	0.35	0.00
Wi-Fi Thermostat, Other (High Rise)	RES_CD	All	1.00	1.00	1.00	1.00	1.00	0.35	0.00
Wi-Fi Thermostat, Gas (High Rise)	RES_CD	All	1.00	1.00	1.00	1.00	1.00	0.35	0.00
Wi-Fi Thermostat, Electric	RES_RETAIL	All	1.00	1.00	1.00	1.00	1.00	0.34	0.20
Wi-Fi Thermostat, AC Only	RES_RETAIL	All	1.00	1.00	1.00	1.00	1.00	0.35	0.00
Wi-Fi Thermostat, Gas	RES_RETAIL	All	1.00	1.00	1.00	1.00	1.00	0.35	0.00
Wi-Fi Thermostat, Oil	RES_RETAIL	All	1.00	1.00	1.00	1.00	1.00	0.35	0.00
Wi-Fi Thermostat, Other	RES_RETAIL	All	1.00	1.00	1.00	1.00	1.00	0.35	0.00
Wi-Fi Thermostat (instant rebate)	RES_RETAIL	All	1.00	1.00	1.00	1.00	1.00	0.35	0.00

In-Service Rates:
For RCD Single Family and Attached Low Rise in-services rate is blended based on evaluation results.[5]
[6] For Retail and High Rise all PAs assume 100% in service rate.

Realization Rates:
Realization rates are set to 100% for deemed measures.

Coincidence Factors:
Summer and winter coincidence factors are estimated using the demand allocation methodology described in the Demand Impact Model which is developed based on the Residential Baseline Study.[7]

Impact Factors for Calculating Net Savings:

Net to gross factors for attached low rise and high rise are based on evaluation results.[8]

Measure Name	Core Initiative	PA	FR	SO$_P$	SO$_{NP}$	NTG
Wi-Fi Thermostat (Single Family) – electric, oil, and other	RES_CD	All	0.13	0.12	0	0.99
Wi-Fi Thermostat (Single Family) – gas	RES_CD	All	0.25	0.12	0	0.87
Wi-Fi Thermostat (Attached Low Rise) – electric, oil, and other	RES_CD	All	0.13	0.12	0	0.99
Wi-Fi Thermostat (Attached Low Rise) - gas	RES_CD	All	0.25	0.12	0	0.87
Wi-Fi Thermostat (High Rise) – electric, oil and other	RES_CD	All	0.14	0	0	0.86
Wi-Fi Thermostat (High Rise) - gas	RES_CD	All	0.14	0	0	0.86
Wi-Fi Thermostat – electric, oil, and other	RES_RETAIL	All	0.13	0.12	0	0.99
Wi-Fi Thermostat – gas	RES_RETAIL	All	0.25	0.12	0	0.87

Non-Energy Impacts:

NEI values are rolled up, component values can be found in Appendix B. The thermostat NEI values are per household and the PAs adjust the total value by the average number of thermostats per account depending on the initiative.

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per KWh	Annual $ per Therm	One-time $ per Therm
Wi-Fi Thermostat (Single Family)	RES_CD	All	$5.45					
Wi-Fi Thermostat (Attached Low Rise)	RES_CD	All	$5.45					
Wi-Fi Thermostat (High Rise)	RES_CD	All	$14.35					
Wi-Fi Thermostat	RES_RETAIL	All	$5.45					

Endnotes:

1 : Navigant Consulting (2018). Wi-Fi Thermostat Impact Evaluation--Secondary Research Study Memo. 2018_Navigant_Wi-Fi_Thermostat_Impact_Evaluation_Secondary_Literature_Study

2 : Guidehouse (2020). Residential Baseline Study Phase 4
2020_Guidehouse_Residential_Baseline_Phase_4

3 : Guidehouse Inc (2021) Residential Wifi and Programmable Thermostat Impacts Report
2021_Guidehouse_Thermostat_Impact_Study

4 : Assumed to have the same lifetime as a regular programmable thermostat. Environmental Protection Agency (2010). Life Cycle Cost Estimate for ENERGY STAR Programmable Thermostat.
EPA_2010_Lifecycle_Cost_Estimate_for_ENERGY_STAR_Programmable_Thermostats

5 : Guidehouse (2021). Virtual Home Energy Assessment Study.
2021_Guidehouse_VHEA_Report_FINAL

6 : Guidehouse (2021). RCD ISR Analysis. 2021_Guidehouse_RCD ISR 2020 Analysis_FINAL

7 : Guidehouse (2020). Residential Baseline Study Phase 4
2020_Guidehouse_Residential_Baseline_Phase_4

8 : Guidehouse (2021). Residential Programs Net-to-Gross Research of RCD and Select Products Measures Workbook 2021_Guidehouse_Res_NTG_Final_Results_Memo

1.26 HVAC - Down Size ½ Ton

Measure Code	RES-HVAC-DSHT
Market	Residential
Program Type	Time of Sale
Category	Heating Ventilation and Air Conditioning

Measure Description:

Reduction in system size consistent with manual J calculations.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Down Size 1/2 Ton	Residential Retail (RES_RETAIL)	EA2c006

Algorithms for Calculating Primary Energy Impact:

Unit savings are deemed based on evaluation results of DOE2 modeling where a unit is equal to a completed job:[1]

Units = Completed job
ΔkWh/Ton = Average annual energy reduction per ton
ΔkW/Ton = Average demand reduction per ton

Savings for Down Size 1/2 Ton:

Measure Name	Energy Type	ΔkWh	ΔkW
Down Size 1/2 Ton	Electric	203	0.29

Baseline Efficiency:

The baseline efficiency case is a system that is not sized in accordance with manual J calculation.

High Efficiency:

The high efficiency case is a system that is sized in accordance with manual J calculation.

Measure Life:

The measure life is based on evaluation results.[3]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML

Down Size 1/2 Ton	RES_RETAIL	All	18	N/A	N/A	18

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Down Size 1/2 Ton	RES_RETAIL	All	1.00	1.00	1.00	1.00	1.00	0.37	0.00

In-Service Rates:
All installations have 100% in-service rates.

Realization Rates:
Realization rates are set to 100% since deemed savings are based on evaluation results.

Coincidence Factors:
Summer and winter coincidence factors are estimated using the demand allocation methodology described in the Demand Impact Model which is developed based on the Residential Baseline Study.[4]

Impact Factors for Calculating Net Savings:

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Down Size 1/2 Ton[5]	RES_RETAIL	All	0.34	0.12	0.10	0.88

Non-Energy Impacts:

NEI values are rolled up, component values can be found in Appendix B.

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per kWh	Annual $ per Therm	One-time $ per Therm
Down Size 1/2 Ton	RES_RETAIL	All	$0.64					

Endnotes:

1 : RLW Analytics (2002). Market Research for the Rhode Island, Massachusetts, and Connecticut Residential HVAC Market. Prepared for National Grid, Northeast Utilities, NSTAR, Fitchburg Gas and Electric Light Company and United Illuminating; Page 3, Table 2
RLW_2002_Market_Research_for_RI_MA_CT_Residential_HVAC_Market

3 : GDS Associates, Inc. (2007). Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures.

GDS_2007_Measure_Life_Report_Residential_and_CI_Lighting_and_HVAC_Measures

4 : Guidehouse (2020). Residential Baseline Study Phase 4

2020_Guidehouse_Residential_Baseline_Phase_4

5 : NTG values were derived from the following study:

2021_Guidehouse_MA_Res_NTG_Final_Report

1.27 HVAC - Duct Insulation

Measure Code	RES-HVAC-DI
Market	Residential
Program Type	Retrofit
Category	Heating Ventilation and Air Conditioning

Measure Description:

For existing ductwork in non-conditioned spaces, insulate ductwork.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Duct Insulation, Electric (Single Family)	Residential Coordinated Delivery (RES_CD)	EA2a036
Duct Insulation, Gas (Single Family)	Residential Coordinated Delivery (RES_CD)	EA2a037
Duct Insulation, Oil (Single Family)	Residential Coordinated Delivery (RES_CD)	EA2a038
Duct Insulation, Other (Single Family)	Residential Coordinated Delivery (RES_CD)	EA2a039
Duct Insulation, Elec (Attached Low Rise)	Residential Coordinated Delivery (RES_CD)	EA2a117
Duct Insulation, Gas (Attached Low Rise)	Residential Coordinated Delivery (RES_CD)	EA2a118
Duct Insulation, Oil (Attached Low Rise)	Residential Coordinated Delivery (RES_CD)	EA2a119
Duct Insulation, Other (Attached Low Rise)	Residential Coordinated Delivery (RES_CD)	EA2a120
Duct Insulation, Elec (High Rise)	Residential Coordinated Delivery (RES_CD)	EA2a205
Duct Insulation, Gas (High Rise)	Residential Coordinated Delivery (RES_CD)	EA2a206
Duct Insulation, Oil (High Rise)	Residential Coordinated Delivery (RES_CD)	EA2a207

Duct Insulation, Other (High Rise)	Residential Coordinated Delivery (RES_CD)	EA2a208
Duct Insulation, Gas (Single Family)	Residential Coordinated Delivery (RES_CD)	GA2a003
Duct Insulation, Gas (Attached Low Rise)	Residential Coordinated Delivery (RES_CD)	GA2a048
Duct Insulation, Gas (High Rise)	Residential Coordinated Delivery (RES_CD)	GA2a082

Algorithms for Calculating Primary Energy Impact:

Single Family and Attached Low Rise:

Unit savings are deemed based on study results[1]:

Measure Name	ΔkWh	ΔkW[2]	Δ MMBtu
Duct Insulation, Electric (Single Family)	726	0.51	
Duct Insulation, Gas (Single Family)			7.3
Duct Insulation, Oil (Single Family)			7.4
Duct Insulation, Other (Single Family)			7.3
Duct Insulation, Elec (Attached Low Rise)	726	0.51	
Duct Insulation, Gas (Attached Low Rise)			7.3
Duct Insulation, Oil (Attached Low Rise)			7.4
Duct Insulation, Other (Attached Low Rise)			7.3
Duct Insulation, Gas (Single Family)			7.3
Duct Insulation, Gas (Attached Low Rise)			7.3

High Rise:

Unit savings are deemed based on study results:
ΔMMBtu = MMBtu x Units

Where:
Unit = Number of square feet of ductwork treated
MMBtu = Average annual MMBtu savings per unit: 0.035[3]

Baseline Efficiency:

The baseline efficiency case is existing, un-insulated ductwork in unconditioned spaces (e.g. attic or basement) .

High Efficiency:

The high efficiency condition is insulated ductwork in unconditioned spaces.

Measure Life:

The measure life is 20 years.[4]

PA	Measure Name	Core Initiative	EUL	OYF	RUL	AML
All	Duct Insulation	RCD	20	n/a	n/a	20

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Duct Insulation (Single Family)	RCD	All	1.00	1.00	1.00	1.00	1.00	0.24	0.25
Duct Insulation (Attached Low Rise)	RCD	All	1.00	1.00	1.00	1.00	1.00	0.24	0.25
Duct Insulation (High Rise)	RCD	All	1.00	0.86	0.86	0.86	0.86	0.24	0.25

In-Service Rates:

All installations have 100% in-service rates since programs include verification of equipment installations.

Realization Rates:

For single family and attached low rise realization rates are set to 100% since savings are deemed. For high rise realization rates are based on evaluation results.[5]

Coincidence Factors:

Summer and winter coincidence factors are estimated using the demand allocation methodology described in the Demand Impact Model which is developed based on the Residential Baseline Study.[6]

Impact Factors for Calculating Net Savings:

Net-to-gross factors are from evaluation results.[7]

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG

Duct Insulation (Single Family)	RES_CD	All	0.04	0.12	0.00	1.08
Duct Insulation (Attached Low Rise)	RES_CD	All	0.04	0.12	0.0	1.08
Duct Insulation (High Rise)	RES_CD	All	0.14	0.0	0.0	0.86

Non-Energy Impacts:

There are no non-energy impacts identified for this measure.

Endnotes:

1 : Navigant Consulting (2018). Home Energy Services (HES) Impact Evaluation.
2018_Navigant_HES_Impact_Evaluation
2 : Guidehouse (2020). Residential Baseline Study Phase 4
2020_Guidehouse_Residential_Baseline_Phase_4
3 : National Grid Staff Estimate (2010) MA SBS-DI Duct Sealing and Insulation Scenario and Deemed
Savings. NGrid_MA_SBS-DI_Duct_Sealing_and_Insulation_Scenario_and_Deemed_Savings_6-22-10
4 : GDS Associates, Inc. (2007). Measure Life Report: Residential and Commercial/Industrial Lighting
and HVAC Measures.
GDS_2007_Measure_Life_Report_Residential_and_CI_Lighting_and_HVAC_Measures
5 : Navigant Consulting (2018). Multi-Family Program Impact and Net-to-Gross Evaluation.
2018_Navigant_Multifamily_Program_Impact_Evaluation
6 : Guidehouse (2020). Residential Baseline Study Phase 4
2020_Guidehouse_Residential_Baseline_Phase_4
7 : Guidehouse (2021). Residential Programs Net-to-Gross Research of RCD and Select Products.
2021_Guidehouse_MA_Res_NTG_Final_Report

1.28 HVAC - Duct Sealing

Measure Code	RES-HVAC-DSAF
Market	Residential
Program Type	Retrofit
Category	Heating Ventilation and Air Conditioning

Measure Description:

For existing ductwork in non-conditioned spaces, seal ductwork. This could include sealing leaky fixed ductwork with mastic or aerosol.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Duct Sealing, Electric (Single Family)	Residential Coordinated Delivery (RES_CD)	EA2a040
Duct Sealing, Gas (Single Family)	Residential Coordinated Delivery (RES_CD)	EA2a041
Duct Sealing, Oil (Single Family)	Residential Coordinated Delivery (RES_CD)	EA2a042
Duct Sealing, Other (Single Family)	Residential Coordinated Delivery (RES_CD)	EA2a043
Duct Sealing, Elec (Attached Low Rise)	Residential Coordinated Delivery (RES_CD)	EA2a113
Duct Sealing, Gas (Attached Low Rise)	Residential Coordinated Delivery (RES_CD)	EA2a114
Duct Sealing, Oil (Attached Low Rise)	Residential Coordinated Delivery (RES_CD)	EA2a115
Duct Sealing, Other (Attached Low Rise)	Residential Coordinated Delivery (RES_CD)	EA2a116
Duct Sealing, Elec (High Rise)	Residential Coordinated Delivery (RES_CD)	EA2a201
Duct Sealing, Gas (High Rise)	Residential Coordinated Delivery (RES_CD)	EA2a202
Duct Sealing, Oil (High Rise)	Residential Coordinated Delivery	EA2a203

	(RES_CD)	
Duct Sealing, Other (High Rise)	Residential Coordinated Delivery (RES_CD)	EA2a204
Duct Sealing, Gas (Single Family)	Residential Coordinated Delivery (RES_CD)	GA2a004
Duct Sealing, Gas (Attached Low Rise)	Residential Coordinated Delivery (RES_CD)	GA2a049
Duct Sealing, Gas (High Rise)	Residential Coordinated Delivery (RES_CD)	GA2a083

Algorithms for Calculating Primary Energy Impact:

Single Family:

Unit savings are deemed based on study results.[1] [2]

Measure Name	ΔkWh	ΔkW[3]	Δ MMBtu
Duct Sealing, Electric (Single Family)	442	0.31	
Duct Sealing, Gas (Single Family)			3.9
Duct Sealing, Oil (Single Family)			4.0
Duct Sealing, Other (Single Family)			3.9

Attached Low Rise and High Rise:

Savings (MMBtu) = Consumption x % SAVE x 1/1,000,000

Where:
Consumption = The total annual heating consumption for the facility (Btu)
%SAVE = Average reduction in energy consumption.
1/1,000,000 = Conversion from Btu to MMBtu.

Savings Factors for Multifamily Duct Sealing:

Measure Type	%SAVE[4]
Surface Area < 50 SQFT	7%
Surface Area > 50 SQFT and < 200 SQFT	3%
Surface Area > 200 SQFT	1%

Baseline Efficiency:

The baseline efficiency case is existing, non-sealed (leaky) ductwork in unconditioned spaces (e.g. attic or basement).
For duct sealing (retail), the baseline efficiency case assumes 15% leakage.

High Efficiency:

The high efficiency condition is air sealed ductwork in unconditioned spaces.

For duct sealing (retail), the high efficiency case is a system with duct leakage reduced by 66% to 5% leakage.

Measure Life:

The measure life is 20 years. [5]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Duct Sealing	RES_CD	All	20	n/a	n/a	20

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Duct Sealing, Electric (Single Family)	RES_CD	All	1.00	1.00	1.00	1.00	1.00	0.24	0.25
Duct Sealing, Gas (Single Family)	RES_CD	All	1.00	1.00	1.00	n/a	n/a	n/a	n/a
Duct Sealing, Oil (Single Family)	RES_CD	All	1.00	1.00	1.00	n/a	n/a	n/a	n/a
Duct Sealing, Other (Single Family)	RES_CD	All	1.00	1.00	1.00	n/a	n/a	n/a	n/a
Duct Sealing, Elec (Attached Low Rise)	RES_CD	All	1.00	0.86	1.00	0.86	0.86	0.24	0.25
Duct Sealing, Gas (Attached Low Rise)	RES_CD	All	1.00	1.00	0.86	n/a	n/a	n/a	n/a

Duct Sealing, Oil (Attached Low Rise)	RES_CD	All	1.00	1.00	0.86	n/a	n/a	n/a	n/a
Duct Sealing, Other (Attached Low Rise)	RES_CD	All	1.00	1.00	0.86	n/a	n/a	n/a	n/a
Duct Sealing, Elec (High Rise)	RES_CD	All	1.00	0.86	0.86	0.86	0.86	0.24	0.25
Duct Sealing, Gas (High Rise)	RES_CD	All	1.00	1.00	0.86	n/a	n/a	n/a	n/a
Duct Sealing, Oil (High Rise)	RES_CD	All	1.00	1.00	0.86	n/a	n/a	n/a	n/a
Duct Sealing, Other (High Rise)	RES_CD	All	1.00	1.00	0.86	n/a	n/a	n/a	n/a

In-Service Rates:

All installations have 100% in service rate since programs include verification of equipment installations.

Realization Rates:

For single family realization rates are set to 100% since deemed savings are based on evaluated results. For attached low rise and high rise realization rates are based on evaluation results.[6]

Coincidence Factors:

Summer and winter coincidence factors are estimated using the demand allocation methodology described in the Demand Impact Model which is developed based on the Residential Baseline Study.[7]

Impact Factors for Calculating Net Savings:

Net-to-Gross values are based on evaluation results.[8]

Measure Name	Core Initiative	PA	FR	SO$_P$	SO$_{NP}$	NTG
Duct Sealing (Single Family)	RES_CD	All	0.04	0.12	0.00	1.08
Duct Sealing (Attached Low Rise)	RES_CD	All	0.04	0.12	0.00	1.08
Duct Sealing (High Rise)	RES_CD	All	0.14	0.0	0.0	0.86

Non-Energy Impacts:

NEI values are rolled up, component values can be found in Appendix B.

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per kWh	Annual $ per Therm	One-time $ per Therm
Duct Sealing	RES_CD	All	$0.23					

Endnotes:

1 : Navigant Consulting (2018). Home Energy Services (HES) Impact Evaluation.
2018_Navigant_HES_Impact_Evaluation
2 : Duct sealing (retail) savings based on results of DOE2 modeling as reported in RLW Analytics (2002), Market Research for the Rhode Island, Massachusetts, and Connecticut Residential HVAC Market, Page 3, Table 2. RLW_2002_Market_Research_for_RI_MA_CT_Residential_HVAC_Market
3 : Guidehouse (2020). Residential Baseline Study Phase 4
2020_Guidehouse_Residential_Baseline_Phase_4
4 : Savings assumptions from National Grid program vendor
5 : GDS Associates, Inc. (2007). Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures.
GDS_2007_Measure_Life_Report_Residential_and_CI_Lighting_and_HVAC_Measures
6 : Navigant Consulting (2018). Multi-Family Program Impact and Net-to-Gross Evaluation.
2018_Navigant_Multifamily_Program_Impact_Evaluation
7 : Guidehouse (2020). Residential Baseline Study Phase 4
2020_Guidehouse_Residential_Baseline_Phase_4
8 : Guidehouse (2021). Residential Programs Net-to-Gross Research of RCD and Select Products Measures: Results Memo 2021_Guidehouse_Res_NTG_Final_Results_Memo

1.29 HVAC - Ductless Mini-Split Heat Pump (DMSHP) Quality Installation Verification (QIV)

Measure Code	RES-HVAC-MSHPQIV
Market	Residential
Program Type	Time of Sale
Category	Heating Ventilation and Air Conditioning

Measure Description:

The verification of proper charge and airflow during installation of new Ductless Mini-Split Heat Pump (DMSHP) systems.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
MSHP QIV	Residential Retail (RES_RETAIL)	EA2c106

Algorithms for Calculating Primary Energy Impact:

Unit savings are deemed based on the following algorithms and assumptions:[1]

$\Delta kWh = \Delta kWh_{cool} + \Delta kWh_{heat}$ = [Tons x 12kBtu/hr/Ton x (1/SEER) x HOURS$_C$ x 5%] + [Tons x 12kBtu/hr/Ton x (1/HSPF) X HOURS$_H$ x 5%]

$\Delta kWcool = \Delta kWh_{cool} \times$ Annual Maximum Demand Factor (cool)

$\Delta kWheat = \Delta kWh_{heat} \times$ Annual Maximum Demand Factor (heat)

$\Delta kW = max (\Delta kW_{cool}, \Delta kW_{heat})$

Where:

Unit = Completed QIV of new DMSHP system

Tons = Capacity of DMSHP equipment

SEER = Seasonal Energy Efficiency Ratio of DMSHP equipment

HSPF = Heating Seasonal Performance Factor of DMSHP equipment

Hours$_C$ = Equivalent Full Load Hours (EFLH) for cooling

Hours$_H$ = EFLH for heating

5% = Average demand reduction of 5%[2]

Savings for Mini Split Heat Pump QIV:

Measure Name	Energy Type	Average Capacity (tons)[3]	Average SEER[4]	Average HSPF[5]	Cooling Hours[6] Heating Hours[6]	ΔkWh	Annual Max Demand Factor	ΔkW

MSHP QIV	Electric	2.3	19.7	11.2	218 (cool) 535 (heat)	82.3	0.001660 (cool) 0.000438 (heat)	0.10

Baseline Efficiency:

The baseline efficiency case is a new MSHP system (2.3-ton, SEER 19.7, and HSPF 11.2), based on the quantity-weighted average capacity and efficiency levels of units rebated in the previous calendar year, whose installation is inconsistent with manufacturer specifications.

High Efficiency:

The high efficiency case is the same MSHP system whose installation is consistent with manufacturer specifications.

Measure Life:

The measure life is based on evaluation results.[7]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
MSHP QIV	RES_RETAIL	All	18	N/A	N/A	18

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
MSHP QIV	RES_RETAIL	All	1.00	1.00	1.00	1.00	1.00	0.38	0.05

In-Service Rates:
All quality installation verifications are completed and documented and therefore have 100% in service rate.

Realization Rates:
Realization rates are set to 100% based on Massachusetts Common Assumptions.

Coincidence Factors:
Summer and winter coincidence factors are estimated using the demand allocation methodology described in the Demand Impact Model which is developed based on the Residential Baseline Study. [8]

Impact Factors for Calculating Net Savings:

Measure Name	Core Initiative	PA	FR	SO$_P$	SO$_{NP}$	NTG
MSHP QIV	RES_RETAIL	All	0.0%	0.0%	0.0%	88.0%[9]

Non-Energy Impacts:

NEI values are rolled up, component values can be found in Appendix B.

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per kWh	Annual $ per Therm	One-time $ per Therm
MSHP QIV	RES_RETAIL	All	$1.53					

Endnotes:

1 : The calculation of the unit savings can be found in MA PAs' 2022-2024 Plan Annual Report Electric Heating and Cooling Savings Workbook (2021). MA_PAs_2022-2024 Planning Electric H&C Savings Workbook_2021-06-17

2 : Average capacity (tons) of heat pump units (weighted by the quantity of heat pump units in each rebate tier) rebated in the full calendar year preceding the year in which this eTRM is published.

3 : Average SEER of heat pump units (weighted by the quantity of heat pump units in each rebate tier) rebated in the full calendar year preceding the year in which this eTRM is published.

4 : Average HSPF of heat pump units (weighted by the quantity of heat pump units in each rebate tier) rebated in the full calendar year preceding the year in which this eTRM is published.

5 : Cooling hours from Cadmus Group (2016). Ductless Mini-Split Heat Pump Impact Evaluation Cadmus_2016_DMSHP_Impact_Evaluation

6 : Heating hours from Navigant Consulting (2018), Quick Hit Study: Ductless Mini-Split Heat Pump Survey (RES 29), March 30, 2018. Assumes higher heating hours for displacement of electric heat based on top 25% EFLH (heating) reported in Cadmus Group (2016), Ductless Mini-Split Heat Pump Impact Evaluation Navigant_2018_DMSHP_Survey

7 : GDS Associates, Inc. (2007). Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures. GDS_2007_Measure_Life_Report_Residential_and_CI_Lighting_and_HVAC_Measures

8 : Guidehouse (2020). Residential Baseline Study Phase 4 2020_Guidehouse_Residential_Baseline_Phase_4

9 : For this measure, the PAs are applying the REs HVAC electric NTG value. 2021_Guidehouse_MA_Res_NTG_Final_Report

1.30 HVAC - Ductless Mini-Split Heat Pump (DMSHP), No Integrated Controls

Measure Code	RES-HVAC-DMHP
Market	Residential
Program Type	Replace on Burnout, Retrofit, Time of Sale
Category	Heating Ventilation and Air Conditioning

Measure Description:

The installation of a more efficient ductless mini-split heat pump (DMSHP) system.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
DMSHP, No Integrated Controls	Residential Retail (RES_RETAIL)	EA2c004

Algorithms for Calculating Primary Energy Impact:

DMSHP unit savings are deemed based on the following algorithms and assumptions:

$\Delta kWh/ton = \Delta kWh_{cool} / ton + \Delta kWh_{heat} / ton = [12kBtu/hr/Ton \times (1/SEER_{BASE} - 1/SEER_{EE}) \times HOURS_C]$
$+ [12kBtu/hr/Ton \times (1/HSPF_{BASE} - 1/HSPF_{EE}) \times HOURS_H]$

$\Delta kW / ton = max (\Delta kW_{cool} / ton, \Delta kW_{heat} / ton)$

$\Delta kW_{cool} = \Delta kWh_{cool} \times$ Annual Maximum Demand Factor (cool)

$\Delta kW_{heat} = \Delta kWh_{heat} \times$ Annual Maximum Demand Factor (heat)

Where:

Unit = Savings per ton
Tons = Capacity of DMSHP equipment
$SEER_{BASE}$ = Seasonal Energy Efficiency Ratio of baseline DMSHP equipment
$SEER_{EE}$ = Seasonal Energy Efficiency Ratio of new efficient DMSHP equipment.
$HSPF_{BASE}$ = Heating Seasonal Performance Factor of baseline DMSHP equipment
$HSPF_{EE}$ = Heating Seasonal Performance Factor of new efficient DMSHP equipment.
$Hours_C$ = Equivalent Full Load Hours (EFLH) for cooling
$Hours_H$ = EFLH for heating

Unit savings are counted as the efficiency savings for the high efficiency DMSHP system compared to a code-compliant DMSHP system for the full life of the new high efficiency DMSHP system.

Savings for Residential Ductless Mini-Split Heat Pumps [1]

Measure Name	Energy Type	Average Capacity (tons)	Average SEER	Average HSPF	Cooling Hours Heating Hours	ΔkWh / Ton	Annual Max Demand Factor[2]	ΔkW / Ton
DMSHP, No Integrated Controls	Electric	2.33	19.7	11.2	218 (cool) 535 (heat)	251	0.00117	0.29

Baseline Efficiency:

The baseline is an industry standard SEER 15.0, HSPF 8.2 DMSHP system.

High Efficiency:

The minimum program qualifications for the high efficiency case is a 16 SEER 9.5 DMSHP system. For savings the high efficiency is based on the average capacity and efficiency levels of systems rebated in the previous calendar year which is 19.7 SEER and 11.2 HSPF.

Measure Life:

The measure life is based on evaluation results.[3]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
DMSHP, No Integrated Controls	RES_RETAIL	All	18	n/a	n/a	18

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure	Core Initiative	PA	ISR	RR$_E$	RR$_{NE}$	RR$_{SP}$	RR$_{WP}$	CF$_{SP}$	CF$_{WP}$
DMSHP, No Integrated Controls	RES_RETAIL	All	1.00	1.00	1.00	1.00	1.00	0.38	0.05

In-Service Rates:

All installations have 100% in service rate since all PAs programs include verification of equipment installations.

Realization Rates:

Realization rates are set to 100% since deemed savings are based on evaluation results.

Coincidence Factors:
Summer and winter coincidence factors are estimated using the demand allocation methodology described in the Demand Impact Model which is developed based on the Residential Baseline Study.[4]

Impact Factors for Calculating Net Savings:

Net to gross factors are based on evaluation results.[5]

Measure Name	Core Initiative	PA	FR	SO$_P$	SO$_{NP}$	NTG
DDMSHP, No Integrated Controls	RES_RETAIL	All	0.34	0.12	0.10	0.88

Non-Energy Impacts:

The PAs do not claim any NEIs for this measure. The NEIs are claimed as part of the fuel displacement to heat pump measures.

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per kWh	Annual $ per Therm	One-time $ per Therm
DMSHP, No Integrated Controls	RES_RETAIL	All	$0.00	$0.00	$0.00	$0.00	N/A	N/A

Endnotes:

1 : The calculation of unit savings can be found in MA PAs' 2022-2024 Plan Electric Heating and Cooling Savings Workbook (2021). Savings are based on a per ton. MA_PAs_2022-2024 Planning Electric H&C Savings Workbook_2021-06-17
2 : Guidehouse (2020). Residential Baseline Study Phase 4
2020_Guidehouse_Residential_Baseline_Phase_4
3 : GDS Associates, Inc. (2007). Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures.
GDS_2007_Measure_Life_Report_Residential_and_CI_Lighting_and_HVAC_Measures
4 : Guidehouse (2020). Residential Baseline Study Phase 4
2020_Guidehouse_Residential_Baseline_Phase_4
5 : NTG values were derived from the following study:
2021_Guidehouse_Res_NTG_Final_Results_Memo

1.31 HVAC - ECM Circulator Pump

Measure Code	RES-HVAC-ECMCP
Market	Residential
Program Type	Time of Sale
Category	Heating Ventilation and Air Conditioning

Measure Description:

Installation of high efficiency residential boiler circulator pumps, including electronically commutated variable speed air supply motors.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Circulator Pump	Residential Retail (RES_RETAIL)	EA2c009

Algorithms for Calculating Primary Energy Impact:

Unit savings are deemed based on evaluation results.[1]

Measure Name	ΔkWh	ΔkW
Circulator Pump	75.2	0.05

Baseline Efficiency:

The baseline efficiency case is the installation of a standard circulator pump.

High Efficiency:

The high efficiency case is the installation of an ECM circulator pump.

Measure Life:

The measure life is based on evaluation results.[2]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Circulator Pump	RES_RETAIL	All	20	N/A	N/A	20

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Circulator Pump	RES_RETAIL	All	1.00	1.00	1.00	1.00	1.00	0.00	0.43

In-Service Rates:

All installations have 100% in service rate since all PAs programs include verification of equipment installations.

Realization Rates:

Realization rates are set to 100% since deemed savings are based on evaluation results.

Coincidence Factors:

Summer and winter coincidence factors are based on evaluation results.

Impact Factors for Calculating Net Savings:

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Circulator Pump[3]	RES_RETAIL	All	34.0%	12.0%	10.0%	88.0%

Non-Energy Impacts:

There are no non-energy impacts for this measure.

Endnotes:

1 : Savings were derived from the ECM Circulator Study: 2021_Guidehouse_ECM Circulator
2 : Assumed to be consistent with C&I Electric Motors & Drives – Energy & Resources Solutions (2005). Measure Life Study. Prepared for The Massachusetts Joint Utilities; Table 1-1.
ERS_2005_Measure_Life_Study
3 : 2021_Guidehouse_MA_Res_NTG_Final_Report

1.32 HVAC - Forced Hot Water Boiler, Propane

Measure Code	RES-HVAC-BFHW
Market	Residential
Program Type	Retrofit
Category	Heating Ventilation and Air Conditioning

Measure Description:

Installation of a new high efficiency boiler for space heating.

BCR Measure IDs:

Core Initiative	Measure Name	BCR Measure ID
Heating System, Boiler, Propane (non-condensing to condensing)	Residential Retail (RES_RETAIL)	EA2c012
Moderate Income Qualified - Heating System, Boiler, Propane	Residential Retail (RES_RETAIL)	EA2c334
Heating System, Boiler, Propane (condensing to condensing)	Residential Retail (RES_RETAIL)	EA2c353
Moderate Income Qualified - Heating System, Boiler, Propane (condensing to condensing)	Residential Retail (RES_RETAIL)	EA2c355

Algorithms for Calculating Primary Energy Impact:

Unit savings are calculated based on deemed inputs.
MMBtu = heating load MMBTUs * (1/AFUE base – 1/AFUEee)

Where:
Heating load = 96.51 MMBTUs
Energy Savings for Primary Impact[1]

Measure Name	ΔMMBtu
Heating System, Boiler, Propane (non-condensing to condensing)	12.1
Moderate Income Qualified - Heating System, Boiler, Propane	16.5
Heating System, Boiler, Propane (condensing to condensing)	0.69

Moderate Income Qualified - Heating System, Boiler, Propane (condensing to condensing)	0.69

Baseline Efficiency:

Heating System, Boiler, Propane (non-condensing to condensing)
For propane the baseline is an industry standard practice (ISP) non-condensing boiler (AFUE = 83.16%) adjusted by a degradation factor (0.967) to account for its metered efficiency (AFUE=80.42%).

Moderate Income Qualified - Heating System, Boiler, Propane
For propane the baseline is an existing non-condensing boiler (AFUE = 80%) adjusted by a degradation factor (0.967) to account for its metered efficiency (AFUE=77%).

Heating System, Boiler, Propane (condensing to condensing) - Both standard and moderate income
For propane the baseline is an industry standard practice (ISP) non-condensing boiler (AFUE = 94.4%) adjusted by a degradation factor (0.941) to account for its metered efficiency (AFUE=88.8%).

High Efficiency:

For the 95 AFUE qualifying propane unit the high efficiency case AFUE 95% adjusted by a degradation factor (0.941) to account for its metered efficiency (AFUE=89.4%) for all measures.

Measure Life:

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Heating System, Boiler, Propane (All Measures)[2]	RES_RETAIL	All	23	n/a	n/a	23

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Heating System, Boiler, Propane (All Measures)	RES_RETAIL	All	1.00	n/a	1.00	n/a	n/a	n/a	n/a

In-Service Rates:
All installations have 100% in service rate since all PAs programs include verification of equipment installations.

Realization Rates:

Realization rates are set to 100% since deemed savings are based on evaluation results.

Coincidence Factors:

Not applicable for this measure since no electric savings are claimed.

Impact Factors for Calculating Net Savings:

Net to gross factors are based study results.

Measure Name	Core Initiative	PA	FR	SO$_P$	SO$_{NP}$	NTG
Heating System, Boiler, Propane[3] (All Standard Measures)	RES_RETAIL	All	0.33	0.13	0.00	0.80
Moderate Income Qualified - Heating System, Boiler, Propane[4] (All Moderate Income Measures)	RES_RETAIL	All	0.00	0.00	0.00	1.00

Non-Energy Impacts:

NEI values are rolled up, component values can be found in Appendix B.[5]

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per KWh	Annual $ per Therm	One-time $ per Therm
Heating System, Boiler, Propane (non-condensing to condensing)	RES_RETAIL	All	$30.84					
Heating System, Boiler, Propane (condensing to condensing)	RES_RETAIL	All	$0.00					
Moderate Income Qualified - Heating System, Boiler, Propane	RES_RETAIL	All	$170.01					
Moderate Income Qualified - Heating System, Boiler, Propane (condensing to condensing)	RES_RETAIL	All	$0.00					

Endnotes:

1 : Oil/Propane Savings Calculator MA_PAs_2022-2024 Annual Report_Oil_Propane_HVAC_Calculations_2022-02-22

2 : ML set equal to gas measure life using the following source: 2021_Guidehouse_TRM_Final_Report

3 : NTG study results can be found here: 2021_Guidehouse_Res_NTG_Final_Results_Memo

4 : An agreed upon assumption between the PAs and EEAC.

5 : MA PAs (2021). 2022-2024 Oil and Propane HVAC Calculations Workbook MA_PAs_2022-2024 Annual Report_Oil_Propane_HVAC_Calculations_2021-08-20

1.33 HVAC - Furnace, Oil/Propane

Measure Code	RES-HVAC-FOP
Market	Residential
Program Type	Lost Opportunity, Retrofit
Category	Heating Ventilation and Air Conditioning

Measure Description:

Installation of a new high efficiency space heating furnace. Electric savings can be attributed to reduced fan run time.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Heating System, Furnace, Oil	Residential Retail (RES_RETAIL)	EA2c013
Heating System, Furnace, Propane (non-condensing to condensing)	Residential Retail (RES_RETAIL)	EA2c014
Heating System, Furnace, Propane (condensing to condensing)	Residential Retail (RES_RETAIL)	EA2c354
Moderate Income Qualified - Heating System, Furnace, Oil	Residential Retail (RES_RETAIL)	EA2c336
Moderate Income Qualified - Heating System, Furnace, Propane (non-condensing to condensing)	Residential Retail (RES_RETAIL)	EA2c337
Moderate Income Qualified - Heating System, Furnace, Propane (condensing to condensing)	Residential Retail (RES_RETAIL)	EA2c356

Algorithms for Calculating Primary Energy Impact:

Heating System, Furnace, Propane

Unit savings are calculated based on deemed inputs.

MMBtu = heating load MMBTUs * (1/AFUE base – 1/AFUEee)

Where:
Heating load Propane = 58.35[1]

Energy Savings for Primary Energy Impact [2]

Heating System, Furnace, Oil
MMBtu = heating load MMBTUs * (1/AFUE base – 1/AFUEee)
Heating load Oil = 68.41 MMBTUs

Moderate Income Qualified - Heating System, Furnace, Propane
MMBtu = heating load MMBTUs * (1/AFUE base – 1/AFUEee)
Heating load Propane = 58.35[3]

Measure Name	ΔMMBtu	ΔkWh	ΔkW
Heating System, Furnace, Oil	4.7	48	0.035
Heating System, Furnace, Propane (non-condensing to condensing)	10.8	0	0
Moderate Income Qualified - Heating System, Furnace, Oil	8.2	48	0.035
Moderate Income Qualified - Heating System, Furnace, Propane (non-condensing to condensing)	15.7	0	0
Heating System, Furnace, Propane (condensing to condensing)	1.2	0	0
Moderate Income Qualified - Heating System, Furnace, Propane (condensing to condensing)	1.2	0	0

Baseline Efficiency:

Heating System, Furnace, Propane (non-condensing to condensing)
The baseline efficiency case is an 80% AFUE rated non-condesning efficiency adjusted to a 80.96% AFUE actual efficiency propane furnace. [4]There is not early retirement savings being claimed for the propane furnace.

Moderate Income Qualified - Heating System, Furnace, Oil
The baseline efficiency case is an existing 77% AFUE rated furnace adjusted to a 78.0% AFUE actual efficiency propane furnace.

Moderate Income Qualified - Heating System, Furnace, Other
The baseline efficiency case is an existing 75% AFUE rated furnace adjusted to a 75.7% AFUE actual efficiency propane furnace.

Heating System, Furnace, Propane (condensing to condensing) - Both standard and Moderate Income
The baseline efficiency case is an existing 93.2% AFUE rated furnace adjusted to a 93.4% AFUE actual efficiency propane furnace.

High Efficiency:

The high efficiency case is a new 86% AFUE oil furnace or a 95% AFUE propane furnace adjusted to a 95.2 actual efficiency propane furnace.

Measure Life:

This measure has a blend of early retirement savings and end of life savings. [5]

Measure Name	Core Initiative	PA	EUL[5]	OYF	RUL	AML
Heating System, Furnace, Oil	RES_RETAIL	All	17	n/a	n/a	17
Heating System, Furnace, Propane (All Propane Measures)	RES_RETAIL	All	17	n/a	n/a	17

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Heating System, Furnace, Propane (All Propane Measures)	RES_RETAIL	All	1.00	1.00	1.00	1.00	1.00	0.00	0.00
Heating System, Furnace, Oil	RES_RETAIL	All	1.00	1.00	1.00	1.00	1.00	0.00	0.43

In-Service Rates:
All installations have 100% in service rate since all PAs programs include verification of equipment installations.

Realization Rates:
Realization rates are set to 100% since deemed savings are based on evaluation results.

Coincidence Factors:
N/A

Impact Factors for Calculating Net Savings:

Net to gross factors are based on evaluation results. [6]

Measure Name	Core Initiative	PA	FR	SOP	SONP	NTG

Heating System, Furnace, (All Standard Measures)	RES_RETAIL	All	32.5%	12.7%	0%	80.2%
Moderate Income Qualified - Heating System, Furnace, (All Moderate Income Measures)	RES_RETAIL	All	0.0%	0.0%	0.0%	100.0%

Non-Energy Impacts:

NEI values are rolled up, component values can be found in Appendix B.[7]

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per KWh	Annual $ per Therm	One-time $ per Therm
Heating System, Furnace, Oil	RES_RETAIL	All	$30.85					
Heating System, Furnace, Propane (non-condensing to condensing)	RES_RETAIL	All	$30.85					
Moderate Income Qualified - Heating System, Furnace, Oil	RES_RETAIL	All	$170.01					
Moderate Income Qualified - Heating System, Furnace, Other	RES_RETAIL	All	$170.01					
Heating System, Furnace, Propane (condensing to condensing)	RES_RETAIL	All	$0					
Moderate Income Qualified - Heating System, Furnace, Propane (condensing to condensing)	RES_RETAIL	All	$0					

Endnotes:

3 : MA PAs (2021). 2022-2024 Annual Plan Oil and Propane HVAC Calculations Workbook.
MA_PAs_2022-2024 Annual Report_Oil_Propane_HVAC_Calculations_2022-02-22
2 : Calculations can be found in the MA PAs (2021). 2022-2024 Plan Oil and Propane HVAC
Calculations Workbook. MA_PAs_2022-2024 Annual
Report_Oil_Propane_HVAC_Calculations_2022-02-22

3 : MA PAs (2021). 2022-2024 Annual Plan Oil and Propane HVAC Calculations Workbook.
MA_PAs_2022-2024 Annual Report_Oil_Propane_HVAC_Calculations_2022-02-22
4 : Industry Standard Practice 2021_Guidehouse_TRM_Final_Report
5 : The ML is set equal to that of an gas furnace using the following source:
2021_Guidehouse_TRM_Final_Report
6 : NTG values can be found in the following summary file:
2021_Guidehouse_MA_Res_NTG_Final_Report
7 : MA PAs (2021). 2022-2024 Annual Plan Oil and Propane HVAC Calculations Workbook.
MA_PAs_2022-2024 Annual Report_Oil_Propane_HVAC_Calculations_2022-02-22

1.34 HVAC - Furnace/Boiler, Gas

Measure Code	RES-HVAC-FG
Market	Residential
Program Type	Retrofit
Category	Heating Ventilation and Air Conditioning

Measure Description:

Installation of a new high efficiency space heating furnace with an electronically commutated motor (ECM) for the fan.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Furnace, Non-Condensing to Condensing 95 AFUE	Residential Retail (RES_RETAIL)	GA2c036
Furnace, Non-Condensing to Condensing 97 AFUE	Residential Retail (RES_RETAIL)	GA2c037
Gas Furnace - Condensing to High-Eff Condensing Tier 1	Residential Retail (RES_RETAIL)	GA2c080
Gas Furnace - Condensing to High-Eff Condensing Tier 2	Residential Retail (RES_RETAIL)	GA2c081
Boiler, Non-Condensing to Condensing 95 AFUE	Residential Retail (RES_RETAIL)	GA2c038
Gas Boiler - Condensing to High-Eff Condensing	Residential Retail (RES_RETAIL)	GA2c082
Moderate Income Qualified - Furnace, Non-Condensing to Condensing 95 AFUE	Residential Retail (RES_RETAIL)	GA2c066
Moderate Income Qualified - Furnace, Non-Condensing to Condensing 97 AFUE	Residential Retail (RES_RETAIL)	GA2c067
Moderate Income Gas Furnace - Condensing to High-Eff Condensing Tier 1	Residential Retail (RES_RETAIL)	GA2c083

Measure Name	Core Initiative	BCR Measure ID
Moderate Income Gas Furnace - Condensing to High-Eff Condensing Tier 2	Residential Retail (RES_RETAIL)	GA2c084
Moderate Income Qualified - Boiler, Non-Condensing to Condensing 95 AFUE	Residential Retail (RES_RETAIL)	GA2c068
Moderate Income Gas Boiler - Condensing to High-Eff Condensing	Residential Retail (RES_RETAIL)	GA2c085

Algorithms for Calculating Primary Energy Impact:

For all non-condensing to condensing measures, unit savings are calculated based on deemed inputs and assumed the program has verified that the existing unit was a non-condensing boiler/furnace. [1] All other installations are assumed to be condensing to condensing equipment.

For all moderate income non-condensing to condensing measures, unit savings is set equal to the savings for the single family income eligible equivalent measure. For moderate income furnaces going from non-condensing to condensing, there is also ECM furnace savings. For condensing to condensing measures, the savings are the same for moderate and standard income.

Measure Name	ΔMMBtu	ΔkWh	Max Demand Factor	ΔkW
Furnace, Non-Condensing to Condensing 95 AFUE	10.8	N/A	N/A	N/A
Furnace, Non-Condensing to Condensing 97 AFUE	12.0	N/A	N/A	N/A
Gas Furnace - Condensing to High-Eff Condensing Tier 1	1.2	N/A	N/A	N/A
Gas Furnace - Condensing to High-Eff Condensing Tier 2	2.5	N/A	N/A	N/A
Boiler, Non-Condensing to Condensing 95 AFUE	12.1	N/A	N/A	N/A
Gas Boiler - Condensing to High-Eff Condensing	0.7	N/A	N/A	N/A
Moderate Income Qualified - Furnace, Non-Condensing to Condensing 95 AFUE	20.7	172	0.00073	0.13
Moderate Income Qualified - Furnace, Non-Condensing to Condensing 97 AFUE	20.7	172	0.00073	0.13
Moderate Income Gas Furnace - Condensing to High-Eff	1.2	172	0.00073	0.13

Condensing Tier 1				
Moderate Income Gas Furnace - Condensing to High-Eff Condensing Tier 2	2.5	172	0.00073	0.13
Moderate Income Qualified - Boiler, Non-Condensing to Condensing 95 AFUE	19.4	N/A	N/A	N/A
Moderate Income Gas Boiler - Condensing to High-Eff Condensing	0.7	N/A	N/A	N/A

Baseline Efficiency:

For all non-moderate income non-condensing to condensing furnace measures, the baseline efficiency case is an 80% AFUE non-condensing furnace adjusted to 81% AFUE actual efficiency. For all condensing to condensing furnaces, the baseline efficiency is a 93.2% condensing furnace adjust to 93.4% AFUE actual efficiency. For the non-condensing to condensing boiler, the baseline efficiency case is an 83.2% AFUE non-condensing boiler adjusted to 80.4% AFUE actual efficiency. For the condensing to condensing boiler, the baseline efficiency case is an 94.4% condensing boiler adjusted to 88.8% AFUE actual efficiency. [2]

For all non-condensing to condensing moderate income measures, the baseline is equal to an existing furnace or boiler. For condensing to condensing measures, the baseline is the same for moderate income and standard income.

High Efficiency:

The high efficiency case is either a new furnace with AFUE >= 95% (actual 95.2% AFUE) with an electronically commutated motor installed or AFUE >= 97% (Actual 97.2% AFUE) with an electronically commutated motor installed. For the boiler measures, the high efficiency case is a new 95% or greater AFUE boiler (Actual 89.4% AFUE).

Measure Life:

The measure life is 17 years for the furnace and 23 years for the boiler. [3]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Furnace, All Furnace Measures	RES_RETAIL	All	17	n/a	n/a	17
Boiler, All Boiler Measures	RES_RETAIL	All	23	n/a	n/a	23

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Furnace, All Standard Income	RES_RETAIL	All	1.00	1.00	1.00	1.00	1.00	0.00	0.00
Boiler, All Standard and Moderate Income	RES_RETAIL	All	1.00	1.00	1.00	1.00	1.00	0.00	0.00
Moderate Income Qualified - Furnace, Non-Condensing to Condensing 95 AFUE	RES_RETAIL	All	1.00	1.00	1.00	1.00	1.00	0.00	0.43
Moderate Income Qualified - Furnace, Non-Condensing to Condensing 97 AFUE	RES_RETAIL	All	1.00	1.00	1.00	1.00	1.00	0.00	0.43
Moderate Income Qualified - Furnace (Both 95 and 97 AFUE condensing to condensing)	RES_RETAIL	All	1.00	1.00	1.00	1.00	1.00	0.00	0.00

In-Service Rates:

All installations have 100% in service rate since programs include verification of equipment installations.

Realization Rates:

All PAs use 100% energy realization rate.

Coincidence Factors:

N/A

Impact Factors for Calculating Net Savings:

Net to gross factors are based on evaluation results.[4]

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Furnace, (All Standard Income)	RES_RETAIL	All	0.36	0.13	0.00	0.76
Boiler, (All Standard Income)	RES_RETAIL	All	0.36	0.13	0.00	0.76
Moderate Income Qualified - Furnace, (All Moderate Income)	RES_RETAIL	All	0.00	0.00	0.00	1.00
Moderate Income Qualified - Boiler, (All Moderate Income)	RES_RETAIL	All	0.00	0.00	0.00	1.00

Non-Energy Impacts:

NEI values are rolled up, component values can be found in Appendix B. [5]

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per KWh	Annual $ per Therm	One-time $ per Therm
Furnace, Non-Condensing to Condensing 95 AFUE	RES_RETAIL	All	$30.84					
Furnace, Non-Condensing to Condensing 97 AFUE	RES_RETAIL	All	$30.84					
Furnace, Condensing to Condensing 97 AFUE	RES_RETAIL	All	$0					
Furnace, Condensing to Condensing 95 AFUE	RES_RETAIL	All	$0					
Boiler, Non-Condensing to Condensing 95 AFUE	RES_RETAIL	All	$30.84					
Boiler, Condensing to Condensing 95 AFUE	RES_RETAIL	All	$0					
Moderate Income Qualified - Furnace, Non-Condensing to Condensing 95 AFUE	RES_RETAIL	All	$170.01					
Moderate Income Qualified - Furnace, Non-Condensing to Condensing 97 AFUE	RES_RETAIL	All	$170.01					
Moderate Income Qualified - Furnace, Condensing to Condensing 97 AFUE	RES_RETAIL	All	$0					
Moderate Income Qualified - Furnace, Condensing to Condensing 97 AFUE	RES_RETAIL	All	$0					

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per KWh	Annual $ per Therm	One-time $ per Therm
Moderate Income Qualified - Boiler, Non-Condensing to Condensing 95 AFUE	RES_RETAIL	All	$170.01					
Moderate Income Qualified - Boiler, Non-Condensing to Condensing 95 AFUE	RES_RETAIL	All	$0					

Endnotes:

1 : The calculation of the adjustment can be found in MA PAs (2022). 2022-2024 Annual Report Gas HVAC and Water Heating Calculations Workbook. MA_PAs_2022-2024 Annual Plan_Gas_HVAC_WH_Calculations_GH_2022-02-22

2 : For more information both on the baseline and the adjustment from rated efficiency to actual efficiency, please refer to the following spreedsheet: MA_PAs_2022-2024 Annual Plan_Gas_HVAC_WH_Calculations_GH_2022-02-22

3 : Lifetime values for all measures were derived from the following study: 2021_Guidehouse_TRM_Final_Report

4 : Guidehouse (2021). Residential Programs Net-to-Gross Research of RCD and Select Products Measures Workbook 2021_Guidehouse_Res_NTG_Final_Results_Memo

5 : The calculation of the adjustment can be found in MA PAs (2022). 2022-2024 Annual Plan Gas HVAC and Water Heating Calculations Workbook. MA_PAs_2022-2024 Annual Plan_Gas_HVAC_WH_Calculations_GH_2022-02-22

1.35 HVAC - Heat Pump - Custom

Measure Code	RES-HVAC-HP-C
Market	Residential
Program Type	Retrofit
Category	Heating Ventilation and Air Conditioning

Measure Description:

Installation of a heat pump displacing electric, oil, or propane heat.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Custom - Heat Pumps displacing Electric Heat	Residential Coordinated Delivery (RES_CD)	EA2a248
Custom - Heat Pumps displacing Oil	Residential Coordinated Delivery (RES_CD)	EA2a276
Custom - Heat Pumps displacing Propane	Residential Coordinated Delivery (RES_CD)	EA2a277
CVEO Heat Pumps, Electric Heat	Residential Coordinated Delivery (RES_CD)	CVEO1
CVEO Heat Pumps, Oil	Residential Coordinated Delivery (RES_CD)	CVEO2
CVEO Heat Pumps, Propane	Residential Coordinated Delivery (RES_CD)	CVEO3

Algorithms for Calculating Primary Energy Impact:

For custom, heat pump savings will be calculated by the vendor based on existing site conditions.

For CVEO, heat pump savings will be calculated using the same assumptions and methods as the measures shown in the following table. In addition, all assumptions for these measures will be based on the BCR Measure Data Source.

Measure Name	Core Initiative	BCR Measure ID	PA	BCR Measure Data Source

Measure Name	Core Initiative	BCR Measure ID	PA	BCR Measure Data Source
CVEO Heat Pumps, Electric Heat	Residential Coordinated Delivery (RES_CD)	CVEO1	CLC	EA2C315
CVEO Heat Pumps, Oil	Residential Coordinated Delivery (RES_CD)	CVEO2	CLC	EA2c270 EA2C268 EA2c273 EA2c290 EA2c317 EA2c323 EA2c325 EA2c327
CVEO Heat Pumps, Propane	Residential Coordinated Delivery (RES_CD)	CVEO3	CLC	EA2c269 EA2c267 EA2c274 EA2c291 EA2c318 EA2c324 EA2c326 EA2c328

Baseline Efficiency:

For custom, the baseline efficiency case is the existing site conditions.

High Efficiency:

For custom, the high efficiency case will vary by site.

Measure Life:

The measure life will vary depending on the type of equipment installed.

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Custom Heat Pumps, Displacing Electric Heat	RES_CD	All	1.00	1.00	1.00	1.00	1.00	0.00	0.43

(High Rise)								
Custom Heat Pumps, Displacing Oil (High Rise)	RES_CD	All	1.00	1.00	1.00	1.00	1.00	0.37	0.22
Custom Heat Pumps, Displacing Propane (High Rise)	RES_CD	All	1.00	1.00	1.00	1.00	1.00	0.37	0.22

In-Service Rates:

All installations have 100% in service rate since all PAs programs include verification of equipment installations.

Realization Rates:

Realization rates are set to 100% because the measure is new and has not been evaluated.

Coincidence Factors:

Summer and winter coincidence factors are estimated using the demand allocation methodology described in the Demand Impact Model which is developed based on the Residential Baseline Study.[1]

Impact Factors for Calculating Net Savings:

NTG rates are based on an evaluation study.[2]

Measure Name	Core Initiative	PA	FR	SO$_P$	SO$_{NP}$	NTG
Custom Heat Pumps, Displacing Electric Heat (High Rise)	RES_CD	All	0.14	0.00	0.00	0.86
Custom Heat Pumps, Displacing Oil (High Rise)	RES_CD	All	0.14	0.00	0.00	0.86
Custom Heat Pumps, Displacing Propane (High Rise)	RES_CD	All	0.14	0.00	0.00	0.86

Non-Energy Impacts:

NEIs are rolled up. Component values can be found in Appendix B.[3]

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per kWh	Annual $ per Therm	One-time $ per Therm
Custom Heat Pumps, Displacing Electric Heat (High	RES_CD	All	$5.98					

Rise)								
Custom Heat Pumps, Displacing Oil (High Rise)	RES_CD	All	$5.98					
Custom Heat Pumps, Displacing Propane (High Rise)	RES_CD	All	$5.98					

Endnotes:

1 : Guidehouse (2020). Residential Baseline Study Phase 4
2020_Guidehouse_Residential_Baseline_Phase_4
2 : Guidehouse (2021). Residential Programs Net-to-Gross Research of RCD and Select Products
Measures Workbook 2021_Guidehouse_Res_NTG_Final_Results_Memo
3 : NMR Group, Inc., Tetra Tech (2011). Massachusetts Special and Cross-Sector Studies Area,
Residential and Low-Income Non-Energy Impacts (NEI) Evaluation.
Tetra_Tech_and_NMR_2011_MA_Res_and_LI_NEI_Evaluation

1.36 HVAC - Heat Pump Digital Check-up/Tune-up

Measure Code	RES-HVAC-HPDCU
Market	Residential
Program Type	Operations and Maintenance
Category	Heating Ventilation and Air Conditioning

Measure Description:

Tune-up of an existing air source central heat pump system.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Heat Pump Digital Check-up/Tune-Up	Residential Retail (RES_RETAIL)	EA2c007

Algorithms for Calculating Primary Energy Impact:

Unit savings are deemed based on the following algorithms and assumptions:[1]
ΔkWh = ΔkWh$_{cool}$ + ΔkWh$_{heat}$ = [Tons x 12kBtu/hr/Ton x (1/SEER) x HOURS$_C$ x 5%] + [Tons x 12kBtu/hr/Ton x (1/HSPF) X HOURS$_H$ x 5%]
ΔkWcool = ΔkWh$_{cool}$ $\times$ Annual Maximum Demand Factor (cool)
ΔkWheat = ΔkWh$_{heat}$ $\times$ Annual Maximum Demand Factor (heat)
ΔkW = max (ΔkW$_{cool}$, ΔkW$_{heat}$)

Where:

Unit = Completed tune-up of existing heat pump system
Tons = Capacity of existing HP equipment
SEER = Seasonal Energy Efficiency Ratio of existing HP equipment
HSPF = Heating Seasonal Performance Factor of existing HP equipment
Hours$_C$ = Equivalent Full Load Hours (EFLH) for cooling
Hours$_H$ = EFLH for heating
5% = Average demand reduction of 5%[2]

Savings for Heat Pump Digital Check-up/Tune-Up:

Measure Name	Energy Type	Average Capacity (tons)[3]	SEER	HSPF	Hours[4]	ΔkWh	Annual Max Demand Factor[5]	ΔkW
Heat Pump Digital Check-Up/Tune-Up	Electric	3.03	13.0	7.7	419 (cool) 1,200 (heat)	342	0.00117	0.40

Baseline Efficiency:

The baseline efficiency case is an existing, inefficient central heat pump system (SEER 13 and HSPF 7.7) that is not operating according to manufacturer specifications.

High Efficiency:

The high efficiency case is the same central heat pump system that is operating according to manufacturer specifications.

Measure Life:

The measure life is based on evaluation results.[6]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Heat Pump Digital Check-Up/Tune-Up	RES_RETAIL	All	5	N/A	N/A	5

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Heat Pump Digital Check-up/Tune-Up	RES_RETAIL	All	1.00	1.00	1.00	1.00	1.00	0.38	0.05

<u>**In-Service Rates:**</u>
All installations have 100% in service rate.

<u>**Realization Rates:**</u>
Realization rates are set to 100% based on Massachusetts Common Assumptions.

<u>**Coincidence Factors:**</u>
Summer and winter coincidence factors are estimated using the demand allocation methodology described in the Demand Impact Model which is developed based on the Residential Baseline Study.[7]

Impact Factors for Calculating Net Savings:

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Heat Pump Digital Check-up/Tune-Up	RES_RETAIL	All	34.0%	12.0%	10.0%	88.0%

Non-Energy Impacts:

NEI values are rolled up, component values can be found in Appendix B.

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per kWh	Annual $ per Therm	One-time $ per Therm
Heat Pump Digital Check-up/Tune-up	RES_RETAIL	All	$1.53					

Endnotes:

1 : The calculation of the unit savings can be found in MA PAs' 2022-2024 Electric Heating and Cooling Savings Workbook (2021). MA_PAs_2022-2024 Planning Electric H&C Savings Workbook_2021-06-17

2 : Massachusetts Common Assumptions.

4 : Navigant Consulting (2018). RES 1 Baseline Load Shape Study (cooling hours). 2018_Navigant_Baseline_Loadshape_Comprehensive_Report

5 : Guidehouse (2020). Residential Baseline Study Phase 4 2020_Guidehouse_Residential_Baseline_Phase_4

6 : GDS Associates, Inc. (2007). Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures. GDS_2007_Measure_Life_Report_Residential_and_CI_Lighting_and_HVAC_Measures

7 : Guidehouse (2020). Residential Baseline Study Phase 4 2020_Guidehouse_Residential_Baseline_Phase_4

1.37 HVAC - Heat Pump Fully Displacing Existing Boiler

Measure Code	RES-HVAC-FS-DMSHP
Market	Residential
Program Type	Retrofit
Category	Heating Ventilation and Air Conditioning

Measure Description:

Full displacement of a boiler with a high efficiency ductless minisplit heat pump for heating.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
MSHP displacing Electric Heat	Residential Retail (RES_RETAIL)	EA2c256
Air-to-Water Heat Pump displacing Electric Heat	Residential Retail (RES_RETAIL)	EA2c371
MSHP fully displacing Oil Heat (weatherized)	Residential Retail (RES_RETAIL)	EA2c273
MSHP fully displacing Oil Heat (weatherization unverified)	Residential Retail (RES_RETAIL)	EA2c363
MSHP fully displacing Propane Heat (weatherized)	Residential Retail (RES_RETAIL)	EA2c274
MSHP fully displacing Propane Heat (weatherization unverified)	Residential Retail (RES_RETAIL)	EA2c364
MSHP with Integrated Controls Fully Displacing Existing Boiler, Gas (Verified Wx)	Residential Retail (RES_RETAIL)	GA2c073
MSHP with Integrated Controls Fully Displacing Existing Boiler, Gas (Unverified Wx)	Residential Retail (RES_RETAIL)	GA2c096
Air-to-Water Heat Pump displacing Oil Heat (weatherized)	Residential Retail (RES_RETAIL)	EA2c290
Air-to-Water Heat Pump displacing Oil Heat (weatherization unverified)	Residential Retail (RES_RETAIL)	EA2c365

Measure Name	Core Initiative	BCR Measure ID
Air-to-Water Heat Pump displacing Propane Heat (weatherized)	Residential Retail (RES_RETAIL)	EA2c291
Air-to-Water Heat Pump displacing Propane Heat (weatherization unverified)	Residential Retail (RES_RETAIL)	EA2c366
Air-to-Water Heat Pump displacing Existing Boiler, Gas (Verified Wx)	Residential Retail (RES_RETAIL)	GA2c074
Air-to-Water Heat Pump displacing Existing Boiler, Gas (Unverified Wx)	Residential Retail (RES_RETAIL)	GA2c088
Moderate Income Qualified - MSHP displacing Electric Heat	Residential Retail (RES_RETAIL)	EA2c315
Moderate Income Qualified - Air-to-Water Heat Pump displacing Electric Heat	Residential Retail (RES_RETAIL)	EA2c374
Moderate Income Qualified - MSHP fully displacing Oil Heat	Residential Retail (RES_RETAIL)	EA2c325
Moderate Income Qualified - MSHP fully displacing Propane Heat	Residential Retail (RES_RETAIL)	EA2c326
Moderate Income Qualified - Air-to-Water Heat Pump displacing Oil Heat	Residential Retail (RES_RETAIL)	EA2c327
Moderate Income Qualified - Air-to-Water Heat Pump displacing Propane Heat	Residential Retail (RES_RETAIL)	EA2c328
CVEO Moderate - MSHP displacing Electric Heat	Residential Coordinated Delivery (RES_CD)	CVEO1
CVEO Affordable - MSHP displacing Electric Heat	Residential Coordinated Delivery (RES_CD)	CVEO15
CVEO Moderate - MSHP fully displacing Oil Heat	Residential Coordinated Delivery (RES_CD)	CVEO26
CVEO Affordable - MSHP fully displacing Oil Heat	Residential Coordinated Delivery (RES_CD)	CVEO30
CVEO Moderate - MSHP fully displacing Propane Heat	Residential Coordinated Delivery (RES_CD)	CVEO27
CVEO Affordable - MSHP fully displacing Propane Heat	Residential Coordinated Delivery (RES_CD)	CVEO31

Algorithms for Calculating Primary Energy Impact:

Unit savings are deemed based on a per ton savings. Cooling savings are based on survey responses and include central air conditioning, room air conditioning and no AC. These different types of AC are weighted to supply the overall AC savings.[1]   Savings were calculated via simulation model runs assuming the existing heating system or zones will be fully displaced.[2]

The same savings are used for moderate income, CVEO and standard income projects. CVEO is a CLC specific measure offering. The savings and all other impacts factors are the same for (weatherized) and (weatherization unverified). This includes both MSHP measures and air-to-water HPs.

Measure Name	Saved MMBtu Oil/ Propane/Gas Per Ton	ΔkW Per Ton	ΔkWh Per Ton
MSHP displacing Electric Heat	3.8	2.32	1670
MSHP fully displacing Oil Heat	17.8	-0.75	-1982
MSHP fully displacing Propane Heat	17.8	-0.75	-1982
MSHP Fully Displacing Existing Boiler, Gas	17.8	-0.75	-1982

For Air to Water Heat Pump

Information on the savings analysis can be found here [3] [4] . This is for all Air-to-water heat pump measures including moderate income; oil, gas and propane.

Measure Name	ΔkWh/ton	ΔkW/ton	ΔMMBTU Fuel Savings/ton
Air-to-Water Heat Pump displacing Any fuel except electric resistance heat	-1911	-2.04	22.8
Air-to-Water Heat Pump displacing Electric Heat[5]	3613	0	0
Moderate Income Qualified - Air-to-Water Heat Pump displacing Electric Heat	3613	0	0

Baseline Efficiency:

For propane the baseline is an existing inefficient boiler at 77.4% AFUE when the customer survey responses stated that the existing unit was functioning properly and a 83.7% AFUE efficiency when the customer survey responses stated the customer would have installed a new boiler without program intervention. For oil the baseline is an existing inefficient boiler at 79.4% AFUE when the customer survey responses stated that the existing unit was functioning properly and a 86% AFUE efficiency

when the customer survey responses stated the customer would have installed a new boiler without program intervention. For electric resistance, the baseline is a 100% efficient or 3.41 COP.

The cooling baseline is a weighted average of the existing inefficient Central AC at 12 SEER, 11.4 EER Room AC and a load building no AC situation when the customer survey responses stated that the existing unit was functioning properly and a weighted average 14 SEER Central AC, 11 EER Room AC and a load building no AC situation when the customer survey responses stated the customer would have installed a new AC unit without program intervention. [6]

The baseline for air to water HP is a standard new oil, propane or gas boiler - AFUE 84 %, Baseline for air to water HP replacing electric resistance is 100% efficiency.

High Efficiency:

MSHP Fully displacing any fuel
For the minimum program qualifications, the high efficiency case is a new 16 SEER/9.5 HSPF ductless mini split heat pumps. Due to expected program changes, savings will only be claimed going up to a standard heat pump (15 SEER and 8.2 HSPF) for all the listed measures. The remaining savings or going from a code/ISP heat pump to the 16 SEER/9.5 HSPF heat pump will be claimed under the standard heat pump offering (HVAC - Ductless Mini-Split Heat Pump (MSHP), No Integrated Controls).

Air to Water Heat Pump displacing any fuel
The high efficiency measures is installing a high efficiency air-to-water heat pump with a minimum COP of 1.7 used for heating.

Measure Life:

The same measure life is used for both moderate income and standard income projects

Measure Name	Core Initiative	PA	EUL[7]	OYF	RUL	AML
MSHP Fully displacing any fuel	RES_RETAIL	All	18	n/a	n/a	18
Air to Water Heat Pump displacing any fuel	RES_RETAIL	All	17	n/a	n/a	17

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

CF_{Sp} = kW system On Peak (Summer) / kW Max peak (winter)
CF_{wp} = kW system On Peak (Winter) / kW Max Peak (winter)
CVEO and moderate income will use the same savings factors for the measures shown below.

Measure Name	Core Initiative	PA	ISR	RR$_E$	RR$_{NE}$	RR$_{SP}$	RR$_{WP}$	CF$_{SP}$	CF$_{WP}$
MSHP displacing Electric Heat	RES_RETAIL	All	1.00	1.00	1.00	1.00	1.00	-0.04	0.27
MSHP fully displacing Oil Heat	RES_RETAIL	All	1.00	1.00	1.00	1.00	1.00	0.08	0.66
MSHP fully displacing Propane Heat	RES_RETAIL	All	1.00	1.00	1.00	1.00	1.00	0.08	0.66
MSHP Fully Displacing Existing Boiler, Gas	RES_RETAIL	All	1.00	1.00	1.00	1.00	1.00	0.08	0.66
Air-to-Water Heat Pump displacing Oil Heat	RES_RETAIL	All	1.00	1.00	1.00	1.00	1.00	-0.02	0.65
Air-to-Water Heat Pump displacing Propane Heat	RES_RETAIL	All	1.00	1.00	1.00	1.00	1.00	-0.02	0.65
Air-to-Water Heat Pump displacing Existing Boiler, Gas	RES_RETAIL	All	1.00	1.00	1.00	1.00	1.00	-0.02	0.65
Air-to-Water Heat Pump displacing Electric Heat	RES_RETAIL	All	1.00	1.00	1.00	1.00	1.00	0.00	0.43
Moderate Income Qualified - MSHP displacing Electric Heat	RES_RETAIL	All	1.00	1.00	1.00	1.00	1.00	-0.04	0.27
Moderate Income Qualified - MSHP fully displacing Oil Heat	RES_RETAIL	All	1.00	1.00	1.00	1.00	1.00	0.08	0.66
Moderate Income Qualified - MSHP fully displacing Propane Heat	RES_RETAIL	All	1.00	1.00	1.00	1.00	1.00	0.08	0.66
Moderate Income Qualified - Air-to-Water Heat Pump displacing Oil Heat	RES_RETAIL	All	1.00	1.00	1.00	1.00	1.00	-0.02	0.65

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Moderate Income Qualified - Air-to-Water Heat Pump displacing Propane Heat	RES_RETAIL	All	1.00	1.00	1.00	1.00	1.00	-0.02	0.65
Moderate Income Qualified - Air-to-Water Heat Pump displacing Electric Heat	RES_RETAIL	All	1.00	1.00	1.00	1.00	1.00	0.00	0.43

In-Service Rates:
All installations have 100% in-service rates since all PAs programs include verification of equipment installations.

Realization Rates:
Realization rates are set to 100% since deemed savings are based on evaluation results.

Coincidence Factors:
Coincidence factors are custom calculated.

Impact Factors for Calculating Net Savings:

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG[8]
MSHP displacing Electric Heat	RES_RETAIL	All	0.34	0.12	0.10	0.88
MSHP fully displacing Oil Heat	RES_RETAIL	All	0.31	0.22	0.00	0.91
MSHP fully displacing Propane Heat	RES_RETAIL	All	0.31	0.22	0.00	0.91
MSHP Fully Displacing Existing Boiler, Gas	RES_RETAIL	All	0.31	0.22	0.00	0.91
Air-to-Water Heat Pump displacing Oil Heat	RES_RETAIL	All	0.31	0.22	0.00	0.91
Air-to-Water Heat Pump displacing Propane Heat	RES_RETAIL	All	0.31	0.22	0.00	0.91
Air-to-Water Heat Pump displacing Existing Boiler, Gas	RES_RETAIL	All	0.31	0.22	0.00	0.91
Air-to-Water Heat Pump displacing Electric Heat	RES_RETAIL	All	0.34	0.12	0.10	0.88
Moderate Income Qualified - MSHP displacing Electric Heat	RES_RETAIL	All	0.00	0.00	0.00	1.00

Measure Name	Core Initiative	PA	FR	SO$_P$	SO$_{NP}$	NTG[8]
Moderate Income Qualified - MSHP fully displacing Oil Heat	RES_RETAIL	All	0.31	0.22	0.00	0.91
Moderate Income Qualified - MSHP fully displacing Propane Heat	RES_RETAIL	All	0.31	0.22	0.00	0.91
Moderate Income Qualified - Air-to-Water Heat Pump displacing Oil Heat	RES_RETAIL	All	0.31	0.22	0.00	0.91
Moderate Income Qualified - Air-to-Water Heat Pump displacing Propane Heat	RES_RETAIL	All	0.31	0.22	0.00	0.91
Moderate Income Qualified - Air-to-Water Heat Pump displacing Electric Heat	RES_RETAIL	All	0.00	0.00	0.00	1.00

Non-Energy Impacts:

NEIs listed in the table below are applicable to both market rate measures and the equivalent moderate income measures as recommended in the evaluation study [9]. NEI values are based on a per ton similiar to energy savings values.

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per kWh	Annual $ per Therm	One-time $ per Therm
MSHP displacing Electric Heat	RES_RETAIL	All	196.46					
MSHP fully displacing Oil Heat	RES_RETAIL	All	94.14					
MSHP fully displacing Propane Heat	RES_RETAIL	All	94.14					
MSHP Fully Displacing Existing Boiler, Gas	RES_RETAIL	All	94.14					
Air-to-Water Heat Pump displacing Oil Heat	RES_RETAIL	All	46.85					
Air-to-Water Heat Pump displacing Propane Heat	RES_RETAIL	All	46.85					

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per kWh	Annual $ per Therm	One-time $ per Therm
Air-to-Water Heat Pump displacing Existing Boiler, Gas	RES_RETAIL	All	46.85					
Air-to-Water Heat Pump displacing Electric Heat	RES_RETAIL	All	0					

Endnotes:

1 : Savings were derived from energy simulation models that came from: 2021_Guidehouse_Fuel Displacement Report_HP

2 : 2021_Guidehouse_Fuel Displacement Report_HP

3 : Air to Water Source Heat Pump replacing Oil Calculations. Savings are divided by 4 tons in order for savings to be based on a per tonnage. 2020_New Measure Form - AtoWHP_Oil

4 : Air to Water Source Heat Pump replacing propane calculations. Savings are divided by 4 tons in order for savings to be based on a per tonnage. 2020_New Measure Form -AtoWhP_Propane

5 : Savings have been divided by 4 to make savings be based on a per ton. More information on savings can be found here: new_measure_form_electric_to_AWHP

6 : More information on both the baseline definitions and weights can be found in the following study: 2021_Guidehouse_Fuel Displacement Report_HP

7 : Measure life Air source heat Pump GDS Associates, Inc. (2007). Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures. GDS_2007_Measure_Life_Report_Residential_and_CI_Lighting_and_HVAC_Measures

8 : NTG results were derived from the following study: 2021_Guidehouse_MA_Res_NTG_Final_Report

9 : NMR (2022) - 2022_NMR_MA21X21-E-RHPNEI_Residential Heat Pump NEIs Study Final Report_2023

1.38 HVAC - Heat Pump Fully Displacing Existing Furnace

Measure Code	RES-HVAC-FSHP
Market	Residential
Program Type	Retrofit
Category	Heating Ventilation and Air Conditioning

Measure Description:

Full displacement of an existing inefficient propane or oil furnace with a high efficiency central ducted heat pump.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Central Heat Pump fully displacing Oil Heat (weatherized)	Residential Retail (RES_RETAIL)	EA2c272
Central Heat Pump fully displacing Oil Heat (weatherization unverified)	Residential Retail (RES_RETAIL)	EA2c361
Central Heat Pump fully displacing Propane Heat (weatherized)	Residential Retail (RES_RETAIL)	EA2c271
Central Heat Pump fully displacing Propane Heat (weatherization unverified)	Residential Retail (RES_RETAIL)	EA2c362
Central Ducted Heat Pump Fully Displacing Existing Furnace, Gas (Verified Wx)	Residential Retail (RES_RETAIL)	GA2c071
Central Ducted Heat Pump Fully Displacing Existing Furnace, Gas (Unverified Wx)	Residential Retail (RES_RETAIL)	GA2c093
Moderate Income Qualified - Central Heat Pump fully displacing Oil Heat	Residential Retail (RES_RETAIL)	EA2c321
Moderate Income Qualified - Central Heat Pump fully displacing Propane Heat	Residential Retail (RES_RETAIL)	EA2c322
Closed Loop GSHP replacing Oil Heat (weatherized)	Residential Retail (RES_RETAIL)	EA2c292
Closed Loop GSHP replacing Oil Heat (weatherization	Residential Retail	EA2c367

Measure Name	Core Initiative	BCR Measure ID
unverified)	(RES_RETAIL)	
Closed Loop GSHP replacing Propane Heat (weatherized)	Residential Retail (RES_RETAIL)	EA2c293
Closed Loop GSHP replacing Propane Heat (weatherization unverified)	Residential Retail (RES_RETAIL)	EA2c368
Closed Loop GSHP Replacing Furnace, Gas (Verified Wx)	Residential Retail (RES_RETAIL)	GA2c075
Closed Loop GSHP Replacing Furnace, Gas (Unverified Wx)	Residential Retail (RES_RETAIL)	GA2c094
Closed Loop GSHP replacing Electric Heat	Residential Retail (RES_RETAIL)	EA2c372
Open Loop GSHP replacing Oil Heat (weatherized)	Residential Retail (RES_RETAIL)	EA2c294
Open Loop GSHP replacing Oil Heat (weatherization unverified)	Residential Retail (RES_RETAIL)	EA2c369
Open Loop GSHP replacing Propane Heat (weatherized)	Residential Retail (RES_RETAIL)	EA2c295
Open Loop GSHP replacing Propane Heat (weatherization unverified)	Residential Retail (RES_RETAIL)	EA2c370
Open Loop GSHP Replacing Furnace, Gas (Verified Wx)	Residential Retail (RES_RETAIL)	GA2c076
Open Loop GSHP Replacing Furnace, Gas (Unverified Wx)	Residential Retail (RES_RETAIL)	GA2c095
Open Loop GSHP replacing Electric Heat	Residential Retail (RES_RETAIL)	EA2c373
Moderate Income Qualified - Closed Loop GSHP replacing Oil Heat	Residential Retail (RES_RETAIL)	EA2c329
Moderate Income Qualified - Closed Loop GSHP replacing Propane Heat	Residential Retail (RES_RETAIL)	EA2c330
Moderate Income Qualified - Closed Loop GSHP replacing Electric Heat	Residential Retail (RES_RETAIL)	EA2c375
Moderate Income Qualified - Open Loop GSHP	Residential Retail	EA2c331

Measure Name	Core Initiative	BCR Measure ID
replacing Oil Heat	(RES_RETAIL)	
Moderate Income Qualified - Open Loop GSHP replacing Propane Heat	Residential Retail (RES_RETAIL)	EA2c332
Moderate Income Qualified - Open Loop GSHP replacing Electric Heat	Residential Retail (RES_RETAIL)	EA2c376

Algorithms for Calculating Primary Energy Impact:

Unit savings are deemed based on a per ton savings. Cooling savings are based on survey responses and include central air conditioning, room air conditioning and no AC. These different types of AC are weighted to supply the overall AC savings.[1] Savings were calculated via simulation model runs assuming the existing heating system will be fully displaced.[2]

Same savings are used for both standard and moderate income.
Same savings and other impact factors are used for (weatherized) and (weatherization unverified). This includes both central heat pumps and ground source heat pumps.

Measure Name	Saved MMBtu Oil/Propane/Gas Per Ton	ΔkW/ Ton	ΔkWh/ Ton
Central Heat Pump fully displacing Propane Heat	17.9	-0.87	-2132
Central Heat Pump fully displacing Oil Heat	17.9	-0.87	-2132
Central Ducted Heat Pump Fully Displacing Existing Furnace, Gas	17.9	-0.87	-2132

For Ground Source Heat Pump

Information on the savings analysis for converting from oil and propane can be found here [3] Gas savings are set equal to the propane savings. For information on calculating savings for converting from electric can be found here [4]

Measure Name	ΔkWh	ΔkW	ΔMMBTU Fuel Savings
Closed Loop GSHP Replacing Oil Heat	-1430	-0.63	20.6
Closed Loop GSHP Replacing Propane and Gas Heat	-1430	-0.63	20.1
Closed Loop GSHP replacing Electric Heat	3555	1.5	0

Open Loop GSHP Replacing Oil Heat	-1211	-0.56	20.6
Open Loop GSHP Replacing Propane and Gas Heat	-1211	-0.56	20.1
Open Loop GSHP replacing Electric Heat	3774	1.6	0

Baseline Efficiency:

For Central Ducted Heat Pumps:
For propane the baseline is an existing inefficient furnace at 81% AFUE when the customer survey responses stated that the existing unit was functioning properly and a 90.1% AFUE efficiency when the customer survey responses stated the customer would have installed a new furnace without program intervention. For oil the baseline is an existing inefficient furnace at 77.7% AFUE when the customer survey responses stated that the existing unit was functioning properly and a 83% AFUE efficiency when the customer survey responses stated the customer would have installed a new furnace without program intervention.

The cooling baseline is a weighted average of the existing inefficient Central AC at 12 SEER, 11.4 EER Room AC and a load building no AC situation when the customer survey responses stated that the existing unit was functioning properly and a weighted average 14 SEER Central AC, 11 EER Room AC and a load building no AC situation when the customer survey responses stated the customer would have installed a new AC unit without program intervention. [5]

Baseline for the GSHP is an 83 AFUE oil boiler and an 85 AFUE propane boiler. For electric resistance, the baseline is a 100% efficiency electric baseboard unit.

High Efficiency:

For the minimum program qualifications, the high efficiency case is a new 16 SEER/9.5 HSPF central heat pump.

The high efficiency for a closed look GSHP minimum efficiency is a 3.6 COP and 17.1 EER. For an open loop GSHP the minimum efficiency is a 4.1 COP and a 21.1 EER.

Measure Life:

Same Measure life is used for all central heat pumps and all ground source heat pumps.

Measure Name	Core Initiative	PA	EUL[6]	OYF	RUL	AML
Central Ducted Heat Pump Fully Displacing Any Heat	RES_RETAIL	All	17	n/a	n/a	17
Ground Source Heat Pump Fully Replacing Any Heat	RES_RETAIL	All	30	n/a	n/a	30

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR$_E$	RR$_{NE}$	RR$_{SP}$	RR$_{WP}$	CF$_{SP}$	CF$_{WP}$
Central Heat Pump fully displacing Oil Heat	Residential Retail (RES_RETAIL)	All	1.00	1.00	1.00	1.00	1.00	0.02	0.65
Central Heat Pump fully displacing Propane Heat	Residential Retail (RES_RETAIL)	All	1.00	1.00	1.00	1.00	1.00	0.02	0.65
Central Ducted Heat Pump Fully Displacing Existing Furnace, Gas	Residential Retail (RES_RETAIL)	All	1.00	1.00	1.00	1.00	1.00	0.02	0.65
Closed Loop GSHP Replacing Gas, Oil or Propane Heating	Residential Retail (RES_RETAIL)	All	1.00	1.00	1.00	1.00	1.00	-0.01	0.21
Open Loop GSHP Replacing Gas, Oil or Propane Heating	Residential Retail (RES_RETAIL)	All	1.00	1.00	1.00	1.00	1.00	-0.05	0.21
Closed Loop GSHP replacing Electric Heat	Residential Retail (RES_RETAIL)	All	1.00	1.00	1.00	1.00	1.00	0.01	0.21
Open Loop GSHP replacing Electric Heat	Residential Retail (RES_RETAIL)	All	1.00	1.00	1.00	1.00	1.00	0.01	0.21

<u>**In-Service Rates:**</u>
All installations have 100% in-service rates since all PAs programs include verification of equipment installations.

<u>**Realization Rates:**</u>
Realization rates are set to 100% since deemed savings are based on evaluation results.

<u>**Coincidence Factors:**</u>
Coincidence factors are calculated to reflect blend of heating and cooling.

Impact Factors for Calculating Net Savings:

Measure Name[7]	Core Initiative	PA	FR	SO$_P$	SO$_{NP}$	NTG
Central Ducted Heat Pump Fully Displacing Oil Heat	RES_RETAIL	All	0.31	0.22	0.00	0.91
Central Ducted Heat Pump Fully Displacing Propane Heat	RES_RETAIL	All	0.31	0.22	0.00	0.91

Measure Name[7]	Core Initiative	PA	FR	SO$_P$	SO$_{NP}$	NTG
Central Ducted Heat Pump Fully Displacing Existing Furnace, Gas	RES_RETAIL	All	0.31	0.22	0.00	0.91
Moderate Income Qualified - Central Ducted Heat Pump Fully Displacing Oil Heat	RES_RETAIL	All	0.00	0.00	0.00	1.00
Moderate Income Qualified - Central Ducted Heat Pump Fully Displacing Propane Heat	RES_RETAIL	All	0.00	0.00	0.00	1.00
Closed Loop GSHP Replacing Oil Heat	RES_RETAIL	All	0.31	0.22	0.00	0.91
Closed Loop GSHP Replacing Propane Heat	RES_RETAIL	All	0.31	0.22	0.00	0.91
Closed Loop GSHP Replacing Furnace, Gas	RES_RETAIL	All	0.31	0.22	0.00	0.91
Closed Loop GSHP replacing Electric Heat	RES_RETAIL	All	0.34	0.12	0.10	0.88
Open Loop GSHP Replacing Oil Heat	RES_RETAIL	All	0.31	0.22	0.00	0.91
Open Loop GSHP Replacing Propane Heat	RES_RETAIL	All	0.31	0.22	0.00	0.91
Open Loop GSHP Replacing Furnace, Gas	RES_RETAIL	All	0.31	0.22	0.00	0.91
Open Loop GSHP replacing Electric Heat	RES_RETAIL	All	0.34	0.12	0.10	0.88
Moderate Income Qualified - Closed Loop GSHP Replacing Oil Heat	RES_RETAIL	All	0.00	0.00	0.00	1.00
Moderate Income Qualified - Closed Loop GSHP Replacing Propane Heat	RES_RETAIL	All	0.00	0.00	0.00	1.00
Moderate Income Qualified - Closed Loop GSHP replacing Electric Heat	RES_RETAIL	All	0.00	0.00	0.00	1.00
Moderate Income Qualified - Open Loop GSHP Replacing Oil Heat	RES_RETAIL	All	0.00	0.00	0.00	1.00
Moderate Income Qualified - Open Loop GSHP Replacing Propane Heat	RES_RETAIL	All	0.00	0.00	0.00	1.00
Moderate Income Qualified - Open Loop GSHP replacing Electric Heat	RES_RETAIL	All	0.00	0.00	0.00	1.00

Non-Energy Impacts:

NEIs listed in the table below are applicable to both market rate measures and the equivalent moderate income measures as recommended in the evaluation study [8] . NEI values are based on a per ton similiar to energy savings values.

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per KWh	Annual $ per Therm	One-time $ per Therm
Central Heat Pump fully displacing Oil Heat	RES_RETAIL	All	64.24					
Central Heat Pump fully displacing Propane Heat	RES_RETAIL	All	64.24					
Central Ducted Heat Pump Fully Displacing Existing Furnace, Gas	RES_RETAIL	All	67.24					
Closed Loop GSHP Replacing Oil Heating	RES_RETAIL	All	75.48					
Closed Loop GSHP Replacing Propane Heating	RES_RETAIL	All	75.48					
Closed Loop GSHP Replacing Gas Heating	RES_RETAIL	All	79.01					
Open Loop GSHP Replacing Oil Heating	RES_RETAIL	All	75.48					
Open Loop GSHP Replacing Propane Heating	RES_RETAIL	All	75.48					
Open Loop GSHP Replacing Gas Heating	RES_RETAIL	All	79.01					
Closed Loop GSHP replacing Electric Heat	RES_RETAIL	All	0					
Open Loop GSHP replacing Electric Heat	RES_RETAIL	All	0					

Endnotes:

1 : Savings were derived from energy simulation models that came from: 2021_Guidehouse_Fuel Displacement Report_HP

2 : More information on the savings calculations can be found in the following study:

2021_Guidehouse_Fuel Displacement Report_HP

3 : Details for the four GSHP offerings can be found in the new measure process form here:

new_measure_form_4 GSHP Measures-03-05-2021

4 : new_measure_form_elec to GSHP Measures-01-19-2022_JS

5 : More information on the baseline calculations can be found in the following study:

2021_Guidehouse_Fuel Displacement Report_HP

6 : GDS Associates, Inc. (2007). Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures.

GDS_2007_Measure_Life_Report_Residential_and_CI_Lighting_and_HVAC_Measures

7 : NTG results can be found in the following study results.

2021_Guidehouse_MA_Res_NTG_Final_Report

8 : 2022 NMR study - 2022_NMR_MA21X21-E-RHPNEI_Residential Heat Pump NEIs Study Final Report_2023

1.39 HVAC - Heat Pump Partially Displacing Existing Boiler

Measure Code	RES-HVAC-FS-DMSHP-P
Market	Residential
Program Type	Retrofit
Category	Heating Ventilation and Air Conditioning

Measure Description:

Partial displacement of a boiler with a high efficiency ductless minisplit heat pump for heating.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
MSHP Integrated Controls Retrofit Oil	Residential Retail (RES_RETAIL)	EA2c270
MSHP Integrated Controls Retrofit, Propane	Residential Retail (RES_RETAIL)	EA2c269
MSHP Integrated Controls Retrofit, Gas	Residential Retail (RES_RETAIL)	GA2c069
MSHP partially displacing Oil Heat (weatherized)	Residential Retail (RES_RETAIL)	EA2c268
MSHP partially displacing Oil Heat (weatherization unverified)	Residential Retail (RES_RETAIL)	EA2c359
MSHP partially displacing Propane Heat (weatherized)	Residential Retail (RES_RETAIL)	EA2c267
MSHP partially displacing Propane Heat (weatherization unverified)	Residential Retail (RES_RETAIL)	EA2c360
MSHP with Integrated Controls Partially Displacing Existing Boiler, Gas (Verified Wx)	Residential Retail (RES_RETAIL)	GA2c072
MSHP with Integrated Controls Partially Displacing Existing Boiler, Gas (Unverified Wx)	Residential Retail (RES_RETAIL)	GA2c087
Moderate Income Qualified - MSHP Integrated Controls Retrofit Oil	Residential Retail (RES_RETAIL)	EA2c317
Moderate Income Qualified - MSHP Integrated Controls Retrofit, Propane	Residential Retail (RES_RETAIL)	EA2c318

| Moderate Income Qualified - MSHP partially displacing Oil Heat | Residential Retail (RES_RETAIL) | EA2c323 |
| Moderate Income Qualified - MSHP partially displacing Propane Heat | Residential Retail (RES_RETAIL) | EA2c324 |

Algorithms for Calculating Primary Energy Impact:

Unit savings are deemed based on a per ton savings for installation of heat pumps. For integrated control measures, the savings are based on a per home. Cooling savings are based on survey responses and include central air conditioning, room air conditioning and no AC. These different types of AC are weighted to supply the overall AC savings. Savings were calculated via simulation model runs assuming using a weighted average of survey responses for the most accurate switch over temperature between the MSHP and the secondary heating source. Due to expected program changes, the weighting were updated for each year of the three year plan showing better control strategies for propane throughout the three year plan. [1] [2]

Same gross savings will be claimed for both moderate income and standard income measures. Savings and the other impact factors are the same between (weatherized unverified) and (weatherized).

Measure Name	Saved MMBtu Oil/Propane/Gas Per Ton	ΔkW Per Ton	ΔkWh Per Ton
MSHP partially displacing Oil Heat	16.1	-0.51	-1505
MSHP partially displacing Propane Heat	18.3	-0.58	-1743
MSHP with Integrated Controls Partially Displacing Existing Boiler, Gas	16.1	-0.51	-1505
MSHP Integrated Controls Retrofit Oil*	24.6	-0.71	-1678
MSHP Integrated Controls Retrofit, Propane*	25.2	-0.71	-1678
MSHP Integrated Controls Retrofit, Gas*	24.6	-0.71	-1678

* Control only measures have savings based on a per home basis. All other measures (installation of a heat pump) have savings based on a per ton.

Baseline Efficiency:

For propane the baseline is an existing inefficient boiler at 77.4% AFUE when the customer survey responses stated that the existing unit was functioning properly and a 83.7% AFUE efficiency when the

customer survey responses stated the customer would have installed a new boiler without program intervention. For oil the baseline is an existing inefficient boiler at 79.4% AFUE when the customer survey responses stated that the existing unit was functioning properly and a 86% AFUE efficiency when the customer survey responses stated the customer would have installed a new boiler without program intervention.

The cooling baseline is a weighted average of the existing inefficient Central AC at 12 SEER, 11.4 EER Room AC and a load building no AC situation when the customer survey responses stated that the existing unit was functioning properly and a weighted average 14 SEER Central AC, 11 EER Room AC and a load building no AC situation when the customer survey responses stated the customer would have installed a new AC unit without program intervention. For integrated controls retrofit measure, the baseline is a previously installed heat pump with no integrated controls. [3]

High Efficiency:

For the minimum program qualifications, the high efficiency case is a new 16 SEER/9.5 HSPF mini split heat pumps. Due to expected program changes, savings will only be claimed going up to a standard heat pump (15 SEER and 8.2 HSPF) for all the listed measures with the exception of the controls only retrofit measures. For the non-controls only measures, the remaining savings or going from a code/ISP heat pump to the 16 SEER/9.5 HSPF heat pump will be claimed under the standard heat pump offering (HVAC - Ductless Mini-Split Heat Pump (DMSHP), No Integrated Controls).

Measure Life:

Measure Name	Core Initiative	PA	EUL[4]	OYF	RUL	AML
MSHP partially displacing Any Fuel Heat	RES_RETAIL	All	18	n/a	n/a	18
DMSHP Integrated Controls Retrofit	RES_RETAIL	All	10	n/a	n/a	10

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RRE	RR$_{NE}$	RR$_{SP}$	RR$_{WP}$	CF$_{SP}$	CF$_{WP}$
MSHP Integrated Controls Retrofit Oil	RES_RETAIL	All	1.00	1.00	1.00	1.00	1.00	0.00	0.63
MSHP Integrated Controls Retrofit, Propane	RES_RETAIL	All	1.00	1.00	1.00	1.00	1.00	0.00	0.63
MSHP Integrated Controls Retrofit, Gas	RES_RETAIL	All	1.00	1.00	1.00	1.00	1.00	0.00	0.63

Measure Name	Core Initiative	PA	ISR	RRE	RRNE	RRSP	RRWP	CFSP	CFWP
MSHP partially displacing Oil Heat	RES_RETAIL	All	1.00	1.00	1.00	1.00	1.00	0.16	0.68
MSHP partially displacing Propane Heat	RES_RETAIL	All	1.00	1.00	1.00	1.00	1.00	0.14	0.68
MSHP with Integrated Controls Partially Displacing Existing Boiler, Gas	RES_RETAIL	All	1.00	1.00	1.00	1.00	1.00	0.16	0.69
Moderate Income Qualified - MSHP Integrated Controls Retrofit Oil	RES_RETAIL	All	1.00	1.00	1.00	1.00	1.00	0.00	0.63
Moderate Income Qualified - MSHP Integrated Controls Retrofit, Propane	RES_RETAIL	All	1.00	1.00	1.00	1.00	1.00	0.00	0.63
Moderate Income Qualified - MSHP partially displacing Oil Heat	RES_RETAIL	All	1.00	1.00	1.00	1.00	1.00	0.16	0.68
Moderate Income Qualified - MSHP partially displacing Propane Heat	RES_RETAIL	All	1.00	1.00	1.00	1.00	1.00	0.14	0.68

In-Service Rates:

All installations have 100% in-service rates since all PAs programs include verification of equipment installations.

Realization Rates:

Realization rates are set to 100% since deemed savings are based on evaluation results.

Coincidence Factors:

Coincidence factors are custom calculated.

Impact Factors for Calculating Net Savings:

Net-to-gross factors are per agreement with the MA EEAC Consultants.

Measure Name	Core Initiative	PA	FR	SOP	SONP	NTG[5]
MSHP Integrated Controls Retrofit Oil	RES_RETAIL	All	0.31	0.22	0.00	0.91
MSHP Integrated Controls Retrofit, Propane	RES_RETAIL	All	0.31	0.22	0.00	0.91

MSHP Integrated Controls Retrofit, Gas	RES_RETAIL	All	0.31	0.22	0.00	0.91
MSHP partially displacing Oil Heat	RES_RETAIL	All	0.31	0.22	0.00	0.91
MSHP partially displacing Propane Heat	RES_RETAIL	All	0.31	0.22	0.00	0.91
MSHP with Integrated Controls Partially Displacing Existing Boiler, Gas	RES_RETAIL	All	0.31	0.22	0.00	0.91
Moderate Income Qualified - MSHP Integrated Controls Retrofit Oil	RES_RETAIL	All	0.00	0.00	0.00	1.00
Moderate Income Qualified - MSHP Integrated Controls Retrofit, Propane	RES_RETAIL	All	0.00	0.00	0.00	1.00
Moderate Income Qualified - MSHP partially displacing Oil Heat	RES_RETAIL	All	0.00	0.00	0.00	1.00
Moderate Income Qualified - MSHP partially displacing Propane Heat	RES_RETAIL	All	0.00	0.00	0.00	1.00

Non-Energy Impacts:

NEIs listed in the table below are applicable to both market rate measures and the equivalent moderate income measures as recommended in the evaluation study [6] .

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per KWh	Annual $ per Therm	One-time $ per Therm
MSHP Integrated Controls Retrofit Oil*	RES_RETAIL	All	292.19					
MSHP Integrated Controls Retrofit, Propane*	RES_RETAIL	All	292.19					
MSHP Integrated Controls Retrofit, Gas*	RES_RETAIL	All	292.19					
MSHP partially displacing Oil Heat	RES_RETAIL	All	104.35					
MSHP partially displacing Propane Heat	RES_RETAIL	All	104.35					
MSHP with Integrated Controls Partially Displacing Existing Boiler, Gas	RES_RETAIL	All	104.35					

* NEI values are based on a full home for these measures. For the other measures, the NEIs are based on a per ton similiar to savings values.

Endnotes:

1 : Savings were derived from energy simulation models that came from the following study:
2021_Guidehouse_Fuel Displacement Report_HP

2 : For more information on the weighting and savings calculations please refer to the evaluation report:
2021_Guidehouse_Fuel Displacement Report_HP

3 : More information on the baseline methodology can be found in the following report:
2021_Guidehouse_Fuel Displacement Report_HP

4 : GDS Associates, Inc. (2007). Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures.
GDS_2007_Measure_Life_Report_Residential_and_CI_Lighting_and_HVAC_Measures

5 : For moderate income, the NTG is set at 100% and is a negotiated value. For the other measures, the following study used customer surveys to estimate the NTG:
2021_Guidehouse_MA_Res_NTG_Final_Report

6 : 2022 NMR study - 2022_NMR_MA21X21-E-RHPNEI_Residential Heat Pump NEIs Study Final Report_2023

1.40 HVAC - Heat Pump Partially Displacing Existing Furnace

Measure Code	RES-HVAC-FSHP-P
Market	Residential
Program Type	Retrofit
Category	Heating Ventilation and Air Conditioning

Measure Description:

Partial displacement of an existing oil or propane furnace with a high efficiency central ducted heat pump.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Central Heat Pump partially displacing Oil Heat (weatherized)	Residential Retail (RES_RETAIL)	EA2c266
Central Heat Pump partially displacing Oil Heat (weatherization unverified)	Residential Retail (RES_RETAIL)	EA2c357
Central Heat Pump partially displacing Propane Heat (weatherized)	Residential Retail (RES_RETAIL)	EA2c265
Central Heat Pump partially displacing Propane Heat (weatherization unverified)	Residential Retail (RES_RETAIL)	EA2c358
Central Ducted Heat Pump Partially Displacing Existing Furnace, Gas (Verified Wx)	Residential Retail (RES_RETAIL)	GA2c070
Central Ducted Heat Pump Partially Displacing Existing Furnace, Gas (Unverified Wx)	Residential Retail (RES_RETAIL)	GA2c086
Moderate Income Qualified - Central Heat Pump partially displacing Oil Heat	Residential Retail (RES_RETAIL)	EA2c319
Moderate Income Qualified - Central Heat Pump partially displacing Propane Heat	Residential Retail (RES_RETAIL)	EA2c320

Algorithms for Calculating Primary Energy Impact:

Unit savings are deemed based on a per ton savings. Cooling savings are based on survey responses and include central air conditioning, room air conditioning and no AC. These different types of AC are

weighted to supply the overall AC savings. Energy Savings were calculated via energy simulation models. The crossover temp was modeled at several different crossover temps via customer survey responses and the results were weighted by the distribution of responses.[1] [2]

Gross savings are the same between the standard and moderate income measure offerings.
Savings and the other impact factors are the same between (weatherized unverified) and (weatherized).

Measure Name	Saved MMBtu Oil/Propane/Gas Per Ton	ΔkW Per Ton	ΔkWh Per Ton
Central Heat Pump partially displacing Oil Heat	13.4	-0.47	-1233
Central Ducted Heat Pump Partially Displacing Existing Furnace, Gas	13.4	-0.47	-1233
Central Heat Pump partially displacing Propane Heat	18.2	-0.72	-1817

Baseline Efficiency:

For propane the baseline is an existing inefficient furnace at 81% AFUE when the customer survey responses stated that the existing unit was functioning properly and a 90.1% AFUE efficiency when the customer survey responses stated the customer would have installed a new furnace without program intervention. For oil the baseline is an existing inefficient furnace at 77.7% AFUE furnace when the customer survey responses stated that the existing unit was functioning properly and a 83% AFUE efficiency when the customer survey responses stated the customer would have installed a new furnace without program intervention.
The cooling baseline is a weighted average of the existing inefficient Central AC at 12 SEER, 11.4 EER Room AC and a load building no AC situation when the customer survey responses stated that the existing unit was functioning properly and a weighted average 14 SEER Central AC, 11 EER Room AC and a load building no AC situation when the customer survey responses stated the customer would have installed a new AC unit without program intervention. [3]

High Efficiency:

For the minimum program qualifications, the high efficiency case is a new 16 SEER/9.5 HSPF ducted central heat pump. Savings are calculated based on a standard efficiency heat pump (14 SEER and 8.2 HSPF). Savings going from a standard heat pump to a high efficiency heat pump is claimed under the HVAC - Air Source Central Heat Pump measure offering.

Measure Life:

The measure life is based on evaluation results.[4]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML

Central Ducted Heat Pump Partially Displacing Any Fuel Heating	RES_RETAIL	All	17	n/a	n/a	17

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR$_E$	RR$_{NE}$	RR$_{SP}$	RR$_{WP}$	CF$_{SP}$	CF$_{WP}$
Central Heat Pump partially displacing Oil Heat	RES_RETAIL	All	1.00	1.00	1.00	1.00	1.00	0.06	0.67
Central Heat Pump partially displacing Propane Heat	RES_RETAIL	All	1.00	1.00	1.00	1.00	1.00	0.05	0.67
Central Ducted Heat Pump Partially Displacing Existing Furnace, Gas	RES_RETAIL	All	1.00	1.00	1.00	1.00	1.00	0.06	0.68
Moderate Income Qualified - Central Heat Pump partially displacing Oil Heat	RES_RETAIL	All	1.00	1.00	1.00	1.00	1.00	0.06	0.67
Moderate Income Qualified - Central Heat Pump partially displacing Propane Heat	RES_RETAIL	All	1.00	1.00	1.00	1.00	1.00	0.05	0.67

In-Service Rates:
All installations have 100% in-service rates since all PAs programs include verification of equipment installations.

Realization Rates:
Realization rates are set to 100% since deemed savings are based on evaluation results.

Coincidence Factors:
Coincidence factors are PA-calculated to reflect the blend of heating and cooling provided by heat pumps.

Impact Factors for Calculating Net Savings:

Measure Name	Core Initiative	PA	FR	SO$_P$	SO$_{NP}$	NTG[5]
Central Heat Pump partially displacing Oil Heat	RES_RETAIL	All	0.31	0.22	0.00	0.91
Central Heat Pump partially displacing Propane Heat	RES_RETAIL	All	0.31	0.22	0.00	0.91
Central Ducted Heat Pump Partially Displacing Existing Furnace, Gas	RES_RETAIL	All	0.31	0.22	0.00	0.91
Moderate Income Qualified - Central Heat Pump partially displacing Oil Heat	RES_RETAIL	All	0.00	0.00	0.00	1.00
Moderate Income Qualified - Central Heat Pump partially displacing Propane Heat	RES_RETAIL	All	0.00	0.00	0.00	1.00

Non-Energy Impacts:

NEIs listed in the table below are applicable to both market rate measures and the equivalent moderate income measures as recommended in the evaluation study [6] . NEI values are based on a per ton similiar to energy savings values.

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per kWh	Annual $ per Therm	One-time $ per Therm
Central Heat Pump partially displacing Oil Heat	RES_RETAIL	All	56.18					
Central Heat Pump partially displacing Propane Heat	RES_RETAIL	All	56.18					
Central Ducted Heat Pump Partially Displacing Existing Furnace, Gas	RES_RETAIL	All	56.18					

Endnotes:

1 : Savings were derived from energy simulation models that came from the following study:
2021_Guidehouse_Fuel Displacement Report_HP
2 : More information on the savings methodology can be found in the report: 2021_Guidehouse_Fuel Displacement Report_HP

3 : More information on the baselines and the weighted methodology can be found in the report: 2021_Guidehouse_Fuel Displacement Report_HP

4 : GDS Associates, Inc. (2007). Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures. Prepared for The New England State Program Working Group; Page 1-3, Table 1. GDS_2007_Measure_Life_Report_Residential_and_CI_Lighting_and_HVAC_Measures

5 : For moderate income, the NTG is assumed to be 100%. For the other measures, NTG results came from the following study: 2021_Guidehouse_MA_Res_NTG_Final_Report

6 : NMR (2022) - 2022_NMR_MA21X21-E-RHPNEI_Residential Heat Pump NEIs Study Final Report_2023

1.41 HVAC - Heat Pump Quality Installation Verification (QIV)

Measure Code	RES-HVAC-HPQIV
Market	Residential
Program Type	Time of Sale
Category	Heating Ventilation and Air Conditioning

Measure Description:

The verification of proper charge and airflow during installation of new Heat Pump systems.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Heat Pump QIV	Residential Retail (RES_RETAIL)	EA2c105

Algorithms for Calculating Primary Energy Impact:

Unit savings are deemed based on the following algorithms and assumptions:[1]

$\Delta kWh = \Delta kWh_{cool} + \Delta kWh_{heat}$ = [Tons x 12kBtu/hr/Ton x (1/SEER) x $HOURS_C$ x 5%] + [Tons x 12kBtu/hr/Ton x (1/HSPF) X $HOURS_H$ x 5%]

$\Delta kW_{cool} = \Delta kWh_{cool} \times$ Annual Maximum Demand Factor (cool)

$\Delta kW_{heat} = \Delta kWh_{heat} \times$ Annual Maximum Demand Factor (heat)

$\Delta kW = \max (\Delta kW_{cool}, \Delta kW_{heat})$

Where:

Unit = Completed QIV of new central heat pump system

Tons = Capacity of HP equipment

SEER = Seasonal Energy Efficiency Ratio of HP equipment

HSPF = Heating Seasonal Performance Factor of HP equipment

$Hours_C$ = Equivalent Full Load Hours (EFLH) for cooling

$Hours_H$ = EFLH for heating

5% = Average demand reduction of 5%[2]

Savings for Heat Pump QIV:

Measure Name	Energy Type	Average Capacity (tons)[3]	Average SEER[4]	Average HSPF[5]	Hours[6]	ΔkWh	Annual Max Demand Factor[7]	ΔkW
Heat Pump QIV	Electric	3.03	17.6	9.81	419 (cool) 1,200 (heat)	266	0.00117	0.31

Baseline Efficiency:

The baseline efficiency case is a new central heat pump system (3.03-ton, SEER 17.6, and HSPF 9.81), based on the quantity-weighted average capacity and efficiency levels of units rebated in the previous calendar year, whose installation is inconsistent with manufacturer specifications.

High Efficiency:

The high efficiency case is the same heat pump system whose installation is consistent with manufacturer specifications.

Measure Life:

The measure life is based on evaluation results.[8]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Heat Pump QIV	RES_CD RES_RETAIL	All	18	N/A	N/A	18

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Heat Pump QIV	RES_RETAIL	All	1.00	1.00	1.00	1.00	1.00	0.38	0.05

In-Service Rates:
All quality installation verifications are completed and documented and therefore have 100% in service rate.

Realization Rates:
Realization rates are set to 100% based on Massachusetts Common Assumptions.

Coincidence Factors:
Summer and winter coincidence factors are estimated using the demand allocation methodology described in the Demand Impact Model which is developed based on the Residential Baseline Study.[9]

Impact Factors for Calculating Net Savings:

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Heat Pump QIV	RES_RETAIL	All	34.0%	12.0%	10.0%	88.0%

Non-Energy Impacts:

NEI values are rolled up, component values can be found in Appendix B.

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per kWh	Annual $ per Therm	One-time $ per Therm
Heat Pump QIV	RES_RETAIL	All	$1.53	$0.00	$0.00	$0.00	N/A	N/A

Endnotes:

1 : The calculation of the unit savings can be found in MA PA's 2022-2024 Plan Electric Heating and Cooling Savings Workbook (2021). MA_PAs_2022-2024 Planning Electric H&C Savings Workbook_2021-06-17
2 : Massachusetts Common Assumptions.
3 : Average capacity (tons) of heat pump units (weighted by the quantity of heat pump units in each rebate tier) rebated in the full calendar year preceding the year in which this eTRM is published.
4 : Average HSPF of heat pump units (weighted by the quantity of heat pump units in each rebate tier) rebated in the full calendar year preceding the year in which this eTRM is published.
6 : Navigant Consulting (2018). RES 1 Baseline Load Shape Study (cooling hours).
2018_Navigant_Baseline_Loadshape_Comprehensive_Report
7 : Demand savings are derived from the demand impact model which is developed as part of the Residential Baseline Study. 2020_Guidehouse_Residential_Baseline_Phase_4
8 : GDS Associates, Inc. (2007). Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures.
GDS_2007_Measure_Life_Report_Residential_and_CI_Lighting_and_HVAC_Measures
9 : Guidehouse (2020). Residential Baseline Study Phase 4
2020_Guidehouse_Residential_Baseline_Phase_4

1.42 HVAC - Heat Recovery Ventilator

Measure Code	RES-HVAC-HRV
Market	Residential
Program Type	Time of Sale
Category	Heating Ventilation and Air Conditioning

Measure Description:

Heat Recovery Ventilators (HRV) can help make mechanical ventilation more cost effective by reclaiming energy from exhaust airflows.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Heat Recovery Ventilator, Gas - Midstream	Residential Retail (RES_RETAIL)	EA2c279
Heat Recovery Ventilator, Oil - Midstream	Residential Retail (RES_RETAIL)	EA2c280
Heat Recovery Ventilator, Other - Midstream	Residential Retail (RES_RETAIL)	EA2c281
Heat Recovery Ventilator, Gas (Single Family)	Residential Coordinated Delivery (RES_CD)	GA2a040
Heat Recovery Ventilator, Gas (Attached Low Rise)	Residential Coordinated Delivery (RES_CD)	GA2a074
Heat Recovery Ventilator, Gas	Residential Retail (RES_RETAIL)	GA2c022
Heat Recovery Ventilator, Gas - Midstream	Residential Retail (RES_RETAIL)	GA2c049

Algorithms for Calculating Primary Energy Impact:

Unit savings are deemed based on evaluation results. [1]   An electric penalty results due to the electricity consumed by the system fans.

Measure Name	ΔMMBtu/Unit	ΔkWh/Unit	ΔkW/Unit
Heat Recovery Ventilator	8.6	-171	-0.12

Baseline Efficiency:

The baseline efficiency case is an ASHRAE 62.2-compliant exhaust fan system with no heat recovery.

High Efficiency:

The high efficiency case is an exhaust fan system with heat recovery.

Measure Life:

The measure life is based on evaluation results.[2]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Heat Recovery Ventilator	RES_RETAIL/RES_ RCD	All	20	n/a	n/a	20

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Heat Recovery Ventilator	RES_RETAIL/ RES_ RCD	All	1.00	1.00	1.00	1.00	1.00	0.37	0.22

In-Service Rates:

All installations have 100% in service rate since all PAs programs include verification of equipment installations.

Realization Rates:

Realization rates are set to 100% since deemed savings are based on evaluation results.

Coincidence Factors:

Summer and winter coincidence factors are estimated using the demand allocation methodology described in the Demand Impact Model which is developed based on the Residential Baseline Study.[3]

Impact Factors for Calculating Net Savings:

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Heat Recovery Ventilator, Gas - Midstream	Residential Retail (RES_RETAIL)	All	0.36	0.12	0.00	0.76

Measure Name	Core Initiative	PA	FR	SO$_P$	SO$_{NP}$	NTG
Heat Recovery Ventilator, Oil - Midstream	Residential Retail (RES_RETAIL)	All	0.33	0.12	0.01	0.80
Heat Recovery Ventilator, Other - Midstream	Residential Retail (RES_RETAIL)	All	0.33	0.12	0.01	0.80
Heat Recovery Ventilator, Gas (Single Family)	Residential Coordinated Delivery (RES_CD)	All	0.36	0.12	0.00	0.76
Heat Recovery Ventilator, Gas (Attached Low Rise)	Residential Coordinated Delivery (RES_CD)	All	0.36	0.12	0.00	0.76
Heat Recovery Ventilator, Gas	Residential Retail (RES_RETAIL)	All	0.36	0.12	0.00	0.76
Heat Recovery Ventilator, Gas - Midstream	Residential Retail (RES_RETAIL)	All	0.36	0.12	0.00	0.76

Non-Energy Impacts:

There are no non-energy impacts identified for this measure.

Endnotes:

1 : TRM Study Update 2021_Guidehouse_TRM_Final_Report
2 : GDS Associates, Inc. (2009). Natural Gas Energy Efficiency Potential in Massachusetts.
GDS_2009_Natural_Gas_Energy_Efficiency_Potential_in_MA
3 : Guidehouse (2020). Residential Baseline Study Phase 4
2020_Guidehouse_Residential_Baseline_Phase_4

1.43 HVAC - Pipe Wrap (Heating)

Measure Code	RES-HVAC-PW
Market	Residential
Program Type	Retrofit
Category	Heating Ventilation and Air Conditioning

Measure Description:

Insulation upgrades to existing heating system pipes.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Pipe Wrap (Heating), Gas (Single Family)	Residential Coordinated Delivery (RES_CD)	EA2a048
Pipe Wrap (Heating), Oil (Single Family)	Residential Coordinated Delivery (RES_CD)	EA2a049
Pipe Wrap (Heating), Other (Single Family)	Residential Coordinated Delivery (RES_CD)	EA2a050
Pipe Wrap (Heating), Gas (Attached Low Rise)	Residential Coordinated Delivery (RES_CD)	EA2a125
Pipe Wrap (Heating), Oil (Attached Low Rise)	Residential Coordinated Delivery (RES_CD)	EA2a126
Pipe Wrap (Heating), Other (Attached Low Rise)	Residential Coordinated Delivery (RES_CD)	EA2a127
Pipe Wrap (Heating), Gas (High Rise)	Residential Coordinated Delivery (RES_CD)	EA2a213
Pipe Wrap (Heating), Oil (High Rise)	Residential Coordinated Delivery (RES_CD)	EA2a214
Pipe Wrap (Heating), Other (High Rise)	Residential Coordinated Delivery (RES_CD)	EA2a215
Pipe Wrap (Heating), Gas (Single Family)	Residential Coordinated Delivery (RES_CD)	GA2a006
Pipe Wrap (Heating), Gas (Attached Low Rise)	Residential Coordinated Delivery (RES_CD)	GA2a051
Pipe Wrap (Heating), Gas (High Rise)	Residential Coordinated Delivery (RES_CD)	GA2a085

Algorithms for Calculating Primary Energy Impact:

Unit savings are deemed based on study results where unit is a household for single family with pipe wrap installed on heating pipes and per linear foot for attached low rise and high rise.[1]

Measure Name	Δ MMBtu
Pipe Wrap (Heating), Gas (Single Family)	1.4
Pipe Wrap (Heating), Oil (Single Family)	1.5
Pipe Wrap (Heating), Other (Single Family)	1.4
Pipe Wrap (Heating), Gas (Attached Low Rise)	0.16
Pipe Wrap (Heating), Oil (Attached Low Rise)	0.16
Pipe Wrap (Heating), Other (Attached Low Rise)	0.16
Pipe Wrap (Heating), Gas (High Rise)	0.16
Pipe Wrap (Heating), Oil (High Rise)	0.16
Pipe Wrap (Heating), Other (High Rise)	0.16

Baseline Efficiency:

The baseline efficiency case is the existing equipment prior to the installation of additional insulation.

High Efficiency:

The high efficiency case includes pipe wrap.

Measure Life:

The measure life is 15 years.[2]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Pipe Wrap (Heating)	RES_CD	All	15	n/a	n/a	15

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}

Pipe Wrap (Heating)	RES_CD	All	1.00	n/a	1.00	n/a	n/a	n/a	n/a

In-Service Rates:

All installations have 100% in service rate since all PAs programs include verification of equipment installations.

Realization Rates:

The realization rates are set to 100% since deemed savings are based on evaluation results.

Coincidence Factors:

Coincidence factors are set to zero since there are no electric savings for this measure.

Impact Factors for Calculating Net Savings:

Net to gross factors are based on evaluation results.[3]

Measure Name	Core Initiative	PA	FR	SO$_P$	SO$_{NP}$	NTG
Pipe Wrap (Heating) (Single Family)	RES_CD	All	0.04	0.12	0.00	1.08
Pipe Wrap (Heating) (Attached Low Rise)	RES_CD	All	0.04	0.12	0.00	1.08
Pipe Wrap (Heating) (High Rise)	RES_CD	All	0.14	0.0	0.0	0.86

Non-Energy Impacts:

There are no non energy impacts identified for this measure.

Endnotes:

1 : Navigant Consulting (2018). Home Energy Services (HES) Impact Evaluation. For Attached Low Rise and High Rise: Savings assumptions for Multifamily programs are from National Grid program vendor. 2018_Navigant_HES_Impact_Evaluation
2 : GDS Associates, Inc. (2007). Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures.
GDS_2007_Measure_Life_Report_Residential_and_CI_Lighting_and_HVAC_Measures
3 : Guidehouse (2021). Residential Programs Net-to-Gross Research of RCD and Select Products Measures: Results Memo 2021_Guidehouse_Res_NTG_Final_Results_Memo

1.44 HVAC - Programmable Thermostat

Measure Code	RES-HVAC-PT
Market	Residential
Program Type	Retrofit
Category	Heating Ventilation and Air Conditioning

Measure Description:

Installation of a programmable thermostat, which gives the ability to adjust heating or air-conditioning operating times according to a pre-set schedule.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Programmable Thermostat, Electric (Single Family)	Residential Coordinated Delivery (RES_CD)	EA2a059
Programmable Thermostat, Gas (Single Family)	Residential Coordinated Delivery (RES_CD)	EA2a060
Programmable Thermostat, Oil (Single Family)	Residential Coordinated Delivery (RES_CD)	EA2a061
Programmable Thermostat, Other (Single Family)	Residential Coordinated Delivery (RES_CD)	EA2a062
Programmable Thermostat, Electric (Attached Low Rise)	Residential Coordinated Delivery (RES_CD)	EA2a142
Programmable Thermostat, Gas (Attached Low Rise)	Residential Coordinated Delivery (RES_CD)	EA2a144
Programmable Thermostat, Oil (Attached Low Rise)	Residential Coordinated Delivery (RES_CD)	EA2a145
Programmable Thermostat, Other (Attached Low Rise)	Residential Coordinated Delivery (RES_CD)	EA2a146
Programmable Thermostat, Electric Resistance, No AC (High Rise)	Residential Coordinated Delivery (RES_CD)	EA2a230
Programmable Thermostat, Electric Resistance, With AC (High Rise)	Residential Coordinated Delivery (RES_CD)	EA2a231

Measure Name	Core Initiative	BCR Measure ID
Programmable Thermostat, AC Only (High Rise)	Residential Coordinated Delivery (RES_CD)	EA2a232
Programmable Thermostat, Heat Pump (High Rise)	Residential Coordinated Delivery (RES_CD)	EA2a233
Programmable Thermostat, Oil (High Rise)	Residential Coordinated Delivery (RES_CD)	EA2a234
Programmable Thermostat, Electric	Residential Retail (RES_RETAIL)	EA2c054
Programmable Thermostat, Gas	Residential Retail (RES_RETAIL)	EA2c055
Programmable Thermostat, Oil	Residential Retail (RES_RETAIL)	EA2c056
Programmable Thermostat, Other	Residential Retail (RES_RETAIL)	EA2c057
Programmable Thermostat, Gas (Single Family)	Residential Coordinated Delivery (RES_CD)	GA2a011
Programmable Thermostat, Gas (Attached Low Rise)	Residential Coordinated Delivery (RES_CD)	GA2a056
Programmable Thermostat, Gas (High Rise)	Residential Coordinated Delivery (RES_CD)	GA2a090
Programmable Thermostat, Gas	Residential Retail (RES_RETAIL)	GA2c029

Algorithms for Calculating Primary Energy Impact:

Unit kWh and MMBtu savings are deemed based on study results.[1][2][3] Demand savings are derived from the demand impact model which is developed as part of the Residential Baseline Study.[4]

Measure Name	ΔkWh	ΔkW	ΔMMBtu
Programmable Thermostat, Electric (Single Family)	278	0.19	
Programmable Thermostat, Gas (Single Family)	27	0.04	2.1
Programmable Thermostat, Oil (Single Family)	27	0.04	2.1
Programmable Thermostat, Other (Single Family)	27	0.04	2.1
Programmable Thermostat, Electric (Attached Low Rise)	278	0.19	
Programmable Thermostat, Gas (Attached Low Rise)	27	0.04	2.1

Measure Name	ΔkWh	ΔkW	ΔMMBtu
Programmable Thermostat, Oil (Attached Low Rise)	27	0.04	2.1
Programmable Thermostat, Other (Attached Low Rise)	27	0.04	2.1
Programmable Thermostat, Electric Resistance, No AC (High Rise)	257	0.19	
Programmable Thermostat, Electric Resistance, With AC (High Rise)	281	0.13	
Programmable Thermostat, AC Only (High Rise)	25	0.04	
Programmable Thermostat, Heat Pump (High Rise)	241	0.28	
Programmable Thermostat, Oil (High Rise)			2.1
Programmable Thermostat, Gas (High Rise)			2.1
Programmable Thermostat, Electric	278	0.19	
Programmable Thermostat, Gas	27	0.04	2.1
Programmable Thermostat, Oil	27	0.04	2.1
Programmable Thermostat, Other	27	0.04	2.1

Baseline Efficiency:

The baseline efficiency case is an HVAC system without a programmable thermostat.

High Efficiency:

The high efficiency case is an HVAC system that has a programmable thermostat installed.

Measure Life:

The measure life is 19 years.[5] For Attached Low Rise and High Rise the measure persistence was estimated to be 69%[6] so the effective measure life is 13 years (19 years * 69%).

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Programmable Thermostat (Single Family)	RES_CD	All	19	n/a	n/a	19
Programmable Thermostat (Attached Low Rise)	RES_CD	All	19	n/a	n/a	13

Programmable Thermostat (High Rise)	RES_CD	All	19	n/a	n/a	13	
Programmable Thermostat	RES_RETAIL	All	19	n/a	n/a	19	

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR$_E$	RR$_{NE}$	RR$_{SP}$	RR$_{WP}$	CF$_{SP}$	CF$_{WP}$
Programmable Thermostat, Electric (Single Family)	RES_CD	All	0.79	1.00	1.00	1.00	1.00	0.24	0.25
Programmable Thermostat, Gas (Single Family)	RES_CD	All	0.79	1.00	1.00	1.00	1.00	0.50	0.04
Programmable Thermostat, Oil (Single Family)	RES_CD	All	0.79	1.00	1.00	1.00	1.00	0.50	0.04
Programmable Thermostat, Other (Single Family)	RES_CD	All	0.79	1.00	1.00	1.00	1.00	0.50	0.04
Programmable Thermostat, Electric (Attached Low Rise)	RES_CD	All	0.79	1.00	1.00	1.00	1.00	0.24	0.25
Programmable Thermostat, Gas (Attached Low Rise)	RES_CD	All	0.79	1.00	1.00	1.00	1.00	0.50	0.04
Programmable Thermostat, Oil (Attached Low Rise)	RES_CD	All	0.79	1.00	1.00	1.00	1.00	0.50	0.04
Programmable Thermostat, Other	RES_CD	All	0.79	1.00	1.00	1.00	1.00	0.50	0.04

Measure Name	Core Initiative	PA	ISR	RR$_E$	RR$_{NE}$	RR$_{SP}$	RR$_{WP}$	CF$_{SP}$	CF$_{WP}$
(Attached Low Rise)									
Programmable Thermostat, Electric Resistance, No AC (High Rise)	RES_CD	All	1.00	1.00	1.00	1.00	1.00	0.00	0.43
Programmable Thermostat, Electric Resistance, With AC (High Rise)	RES_CD	All	1.00	1.00	1.00	1.00	1.00	0.06	0.45
Programmable Thermostat, AC Only (High Rise)	RES_CD	All	1.00	1.00	1.00	1.00	1.00	0.50	0.04
Programmable Thermostat, Heat Pump (High Rise)	RES_CD	All	1.00	1.00	1.00	1.00	1.00	0.39	0.14
Programmable Thermostat, Oil (High Rise)	RES_CD	All	1.00	1.00	1.00	1.00	1.00	n/a	n/a
Programmable Thermostat, Gas (High Rise)	RES_CD	All	1.00	1.00	1.00	1.00	1.00	n/a	n/a
Programmable Thermostat, Electric	RES_RETAIL	All	1.00	1.00	1.00	1.00	1.00	0.24	0.25
Programmable Thermostat, Gas	RES_RETAIL	All	1.00	1.00	1.00	1.00	1.00	0.50	0.04
Programmable Thermostat, Oil	RES_RETAIL	All	1.00	1.00	1.00	1.00	1.00	0.50	0.04
Programmable Thermostat, Other	RES_RETAIL	All	1.00	1.00	1.00	1.00	1.00	0.50	0.04

In-Service Rates:

RCD Single Family and Attached Low Rise in-service rates are blended and based on evaluation results.[7] [8] Retail and RCD High Rise assume 100% in service rate since all PAs programs include verification of equipment installations.

Realization Rates:

Realization rates are set to 100% since savings are deemed

Coincidence Factors:

Summer and winter coincidence factors are estimated using the demand allocation methodology described in the Demand Impact Model which is developed based on the Residential Baseline Study.[9]

Impact Factors for Calculating Net Savings:

Net to gross factors are based on evaluation results.[10]

Measure Name	Core Initiative	PA	FR	SO$_P$	SO$_{NP}$	NTG
Programmable Thermostat (Single Family) – electric, oil, and other	RES_CD	All	0.13	0.12	0	0.99
Programmable Thermostat (Single Family) – gas	RES_CD	All	0.25	0.12	0	0.87
Programmable Thermostat (Attached Low Rise) – electric, oil, and other	RES_CD	All	0.13	0.12	0	0.99
Programmable Thermostat (Attached Low Rise) - gas	RES_CD	All	0.25	0.12	0	0.87
Programmable Thermostat (High Rise) – electric, oil and other	RES_CD	All	0.14	0	0	0.86
Programmable Thermostat (High Rise) - gas	RES_CD	All	0.14	0	0	0.86
Programmable Thermostat – electric, oil, and other	RES_RETAIL	All	0.13	0.12	0	0.99
Programmable Thermostat – gas	RES_RETAIL	All	0.25	0.12	0	0.87

Non-Energy Impacts:

NEI values are rolled up, component values can be found in Appendix B. The thermostat NEI values are per household and the PAs adjust the total value by the average number of thermostats per account depending on the initiative.

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per	Annual $ per kWh	One-time $ per	Annual $ per Therm	One-time $ per

				Unit		**KWh**		**Therm**
Programmable Thermostat (Single Family)	RES_CD	All	$5.45					
Programmable Thermostat (Attached Low Rise)	RES_CD	All	$5.45					
Programmable Thermostat (High Rise)	RES_CD	All	$14.35					
Programmable Thermostat	RES_RETAIL	All	$5.45					

Endnotes:

1 : Guidehouse (2021). Residential Wi-Fi and Programmable Thermostat Impacts.
2021_Guidehouse_Thermostat_Impact_Study

2 : Navigant Consulting (2018). Home Energy Services (HES) Impact Evaluation.
2018_Navigant_HES_Impact_Evaluation

3 : The Cadmus Group (2012). Massachusetts Multifamily Program Impact Analysis July 2012 – Revised May 2013. CADMUS_2012_Multifamily_Impacts_Analysis_Report

4 : Guidehouse (2020). Residential Baseline Study Phase 4.
2020_Guidehouse_Residential_Baseline_Phase_4

5 : Guidehouse (2021). Comprehensive TRM Review. 2021_Guidehouse_TRM_Final_Report

6 : The Cadmus Group, Inc. (2012). Massachusetts 2011 Residential Retrofit Multifamily Program Analysis. CADMUS_2012_Multifamily_Impacts_Analysis_Report

7 : Guidehouse (2021). Virtual Home Energy Assessment Study.
2021_Guidehouse_VHEA_Report_FINAL

8 : Guidehouse (2021). RCD ISR Analysis. 2021_Guidehouse_RCD ISR 2020 Analysis_FINAL

9 : Guidehouse (2020). Residential Baseline Study Phase 4
2020_Guidehouse_Residential_Baseline_Phase_4

10 : Guidehouse (2021). Residential Programs Net-to-Gross Research of RCD and Select Products Measures Workbook 2021_Guidehouse_Res_NTG_Final_Results_Memo

1.45 HVAC - Quality Installation (QI) with Duct Modification

Measure Code	RES-HVAC-QIDM
Market	Residential
Program Type	Time of Sale
Category	Heating Ventilation and Air Conditioning

Measure Description:

50% reduction in duct leakage from 20% to 10%. This measure may also include duct modifications.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
QI w/ Duct modifications	Residential Retail (RES_RETAIL)	EA2c107

Algorithms for Calculating Primary Energy Impact:

Unit savings are deemed based on an evaluation study.[1]

Savings for Quality Installation with Duct Modification:

Measure Name	Energy Type	ΔkWh	ΔkW
QI w/ Duct modifications	Electric	230	0.33

Baseline Efficiency:

The baseline efficiency case is a system with an installation that is inconsistent with manufacturer specifications and may include leaky ducts.

High Efficiency:

The high efficiency case is a system with an installation that is consistent with manufacturer specifications and may have reduced duct leakage.

Measure Life:

The measure life is based on evaluation results.[2]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
QI w/ Duct modifications	RES_RETAIL	All	18	n/a	n/a	18

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RRE	RR$_{NF}$	RRSP	RRWP	CFSP	CFWP
OI w/ Duct modifications	RES_RETAIL	All	1.00	1.00	1.00	1.00	1.00	0.37	0.00

In-Service Rates:
All installations have 100% in service rate.

Realization Rates:
Realization rates are set to 100% since deemed savings are based on evaluation results.

Coincidence Factors:
Summer and winter coincidence factors are estimated using the demand allocation methodology described in the Demand Impact Model which is developed based on the Residential Baseline Study.[3]

Impact Factors for Calculating Net Savings:

Measure Name	Core Initiative	PA	FR	SO$_P$	SO$_{NP}$	NTG
QI w/Duct modifications	RES_RETAIL	All	0.34	0.12	0.10	0.88

Non-Energy Impacts:

NEI values are rolled up, component values can be found in Appendix B.

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per kWh	Annual $ per Therm	One-time $ per Therm
QI w/Duct modifications	RES_RETAIL	All	$1.53					

Endnotes:

1 : Final Study Results 2021_Guidehouse_TRM_Final_Report
2 : GDS Associates, Inc. (2007). Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures. Prepared for The New England State Program Working Group; Page 1-3, Table 1.
3 : Guidehouse (2020). Residential Baseline Study Phase 4
2020_Guidehouse_Residential_Baseline_Phase_4

1.46 HVAC - Room Air Conditioner

Measure Code	RES-PL-ROOMAC
Market	Residential
Program Type	Time of Sale
Category	Heating Ventilation and Air Conditioning

Measure Description:

Rebates provided for the purchase of an ENERGY STAR® qualified room air conditioner.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Room Air Conditioner	Residential Retail (RES_RETAIL)	EA2c086

Algorithms for Calculating Primary Energy Impact:

Unit savings are deemed based on the following algorithms and assumptions:
Annual kWh Savings = Annual kWh usage baseline – Annual kWh usage Energy Star
Annual kWh usage = Cooling Capacity / CEER * cooling equivalent full load equivalent hours/1000

Where:
Cooling Capacity = 8,000 Btu/hr
Federal Standard CEER = 10.9[1]
Energy Star CEER = 14.7[2]
Cooling EFLH = 348[3]

Demand savings are derived from the demand impact model which is developed as part of the Residential Baseline Study.[4]

Measure Name	kWh	kW
Room Air Conditioner	66	0.09

Baseline Efficiency:

The baseline efficiency case is a unit with a cooling capacity of 8,000 Btu/h meeting the current federal standard which is a CEER of 10.9.[5]

High Efficiency:

The high efficiency case is a 8,000 Btu/hr ENERGY STAR® qualified air conditioner with a CEER of 14.7.[6]

Measure Life:

The measure life is 12 years.[7]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Room Air Conditioner	RES_RETAIL	All	12	n/a	n/a	12

Other Resource Impacts:

There are no other resource impacts identified for this measure

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RE_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Room Air Conditioner	RES_RETAIL	All	1.00	1.00	n/a	1.00	1.00	0.37	0.00

In-Service Rates:

All installations are assumed to have 100% in service rate.[8]

Realization Rates:

Realization rates are set to 100% since unit savings are deemed.

Coincidence Factors:

Summer and winter coincidence factors are estimated using the demand allocation methodology described in the Demand Impact Model which is developed based on the Residential Baseline Study.[9]

Impact Factors for Calculating Net Savings:

Net to gross factors based on evaluation results.[10]

2022

Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Room Air Conditioner	RES_RETAIL	All	0.42	0.00	0.00	0.56

2023

Name	Core Initiative	PA	FR	SO$_P$	SO$_{NP}$	NTG
Room Air Conditioner	RES_RETAIL	All	0.46	0.00	0.00	0.54

2024

Name	Core Initiative	PA	FR	SO$_P$	SO$_{NP}$	NTG
Room Air Conditioner	RES_RETAIL	All	0.48	0.00	0.00	0.52

Non-Energy Impacts:

There are no non-energy impacts identified for this measure.

Endnotes:

1 : https://www.ecfr.gov/current/title-10/chapter-II/subchapter-D/part-430/subpart-C/section-430.32
2 :
https://www.energystar.gov/sites/default/files/asset/document/ENERGY%20STAR%20Version%205.0%20Room%20Air%20Conditioners%20Specification%20and%20Partner%20Commitments.pdf
3 : Navigant Consulting (2018). Res 1 Baseline Loadshape Study. Table 3
2018_Navigant_Baseline_Loadshape_Comprehensive_Report
4 : Guidehouse (2020). Residential Baseline Study Phase 4
2020_Guidehouse_Residential_Baseline_Phase_4
5 : https://www.ecfr.gov/current/title-10/chapter-II/subchapter-D/part-430/subpart-C/section-430.32
6 :
https://www.energystar.gov/sites/default/files/asset/document/ENERGY%20STAR%20Version%205.0%20Room%20Air%20Conditioners%20Specification%20and%20Partner%20Commitments.pdf
7 : Guidehouse (2021). Comprehensive TRM Review. 2021_Guidehouse_TRM_Final_Report
8 : NMR Group Inc. (2021). Residential Products In Service Rates Memo. 2021_NMR_Products_ISR
9 : Guidehouse (2020). Residential Baseline Study Phase 4
2020_Guidehouse_Residential_Baseline_Phase_4
10 : NMR Group, Inc. (2021). Residential Products NTG Report.
2021_NMR_Res_Products_NTG_Report

1.47 Hot Water - Condensing Water Heater

Measure Code	RES-WH-CWH
Market	Residential
Program Type	Retrofit
Category	Water Heating

Measure Description:

Condensing water heaters recover energy by using either a larger heat exchanger or a second heat exchanger to reduce the flue-gas temperature to the point that water vapor condenses, thus releasing even more energy.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Water Heater, Gas Storage Condensing	Residential Retail (RES_RETAIL)	GA2c025

Algorithms for Calculating Primary Energy Impact:

Unit savings are deemed based on study results.[1]

Measure Name	Δ MMBtu	Δ kWh	Δ kW
Water Heater, Condensing, Gas	7.0	-43	-0.01

There is an electric penalty associated with the gas storage condensing water heaters to account for increased electrical consumption for powered damper and electronic (not manual) pilot ignition.[2]

ΔkWh = Average annual energy reduction per unit: -43.0 kWh
ΔkW = Average demand reduction per unit: -0.01 kW

Baseline Efficiency:

The baseline efficiency case is a standalone tank water heater with an UEF of 0.60.

High Efficiency:

The high efficiency case is a condensing water heater with a UEF>= 0.80.

Measure Life:

The measure life is 15 years.[3]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Water Heater, Condensing, Gas	RES_RETAIL	All	15	n/a	n/a	15

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Water Heater, Condensing, Gas	RES_RETAIL	All	1.00	1.00	1.00	1.00	1.00	0.31	0.84

In-Service Rates
In-service rates are set to 100% since all PAs verify equipment installation.

Realization Rates
Realization rates are set to 100% for deemed measures.

Coincidence Factors
Summer and winter coincidence factors are estimated using the demand allocation methodology described in the Demand Impact Model which is developed based on the Residential Baseline Study.[4]

Impact Factors for Calculating Net Savings:

Net-to-gross is based on evaluation results.[5]

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Water Heater, Condensing, Gas	RES_RETAIL	All	0.36	0.12	0.00	0.76

Non-Energy Impacts:

NEI values are rolled up, component values can be found in Appendix B.

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per KWh	Annual $ per Therm	One-time $ per Therm
Water Heater, Condensing, Gas	RES_RETAIL	All	$0.70					

Endnotes:

1 : Navigant Consulting (2018). Water Heating, Boiler, and Furnace Cost Study (RES 19) Add-On Task 7: Residential Water Heater Analysis Memo. 2018_Navigant_Water_Heater_Analysis_Memo

2 : Navigant Consulting (2018). Water Heating, Boiler, and Furnace Cost Study (RES 19) Add-On Task 7: Residential Water Heater Analysis Memo. 2018_Navigant_Water_Heater_Analysis_Memo

3 : DOE (2008). ENERGY STAR® Residential Water Heaters: Final Criteria Analysis. Prepared for the DOE; Page 10 DOE_2008_ENERGY_STAR_Residential_Water_Heaters_Final_Criteria_Analysis

4 : Guidehouse (2020). Residential Baseline Study Phase 4 2020_Guidehouse_Residential_Baseline_Phase_4

5 : NTG results came from the following study: 2021_Guidehouse_Res_NTG_Final_Results_Memo

1.48 Hot Water - Faucet Aerator

Measure Code	RES-WH-FA
Market	Residential
Program Type	Retrofit
Category	Hot Water

Measure Description:

An existing faucet aerator with a high flow rate is replaced with a new low flow aerator.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Faucet Aerator, Electric (Single Family)	Residential Coordinated Delivery (RES_CD)	EA2a051
Faucet Aerator, Gas (Single Family)	Residential Coordinated Delivery (RES_CD)	EA2a052
Faucet Aerator, Oil (Single Family)	Residential Coordinated Delivery (RES_CD)	EA2a053
Faucet Aerator, Other (Single Family)	Residential Coordinated Delivery (RES_CD)	EA2a054
Faucet Aerator, Electric (Attached Low Rise)	Residential Coordinated Delivery (RES_CD)	EA2a128
Faucet Aerator, Gas (Attached Low Rise)	Residential Coordinated Delivery (RES_CD)	EA2a129
Faucet Aerator, Oil (Attached Low Rise)	Residential Coordinated Delivery (RES_CD)	EA2a130
Faucet Aerator, Other (Attached Low Rise)	Residential Coordinated Delivery (RES_CD)	EA2a131
Faucet Aerator, Electric (High Rise)	Residential Coordinated Delivery (RES_CD)	EA2a216
Faucet Aerator, Gas (High Rise)	Residential Coordinated Delivery (RES_CD)	EA2a217
Faucet Aerator, Oil (High Rise)	Residential Coordinated Delivery	EA2a218

	(RES_CD)	
Faucet Aerator, Other (High Rise)	Residential Coordinated Delivery (RES_CD)	EA2a219
Faucet Aerator, Gas (Single Family)	Residential Coordinated Delivery (RES_CD)	GA2a007
Faucet Aerator, Gas (Attached Low Rise)	Residential Coordinated Delivery (RES_CD)	GA2a052
Faucet Aerator, Gas (High Rise)	Residential Coordinated Delivery (RES_CD)	GA2a086

Algorithms for Calculating Primary Energy Impact:

Unit kWh and MMBtus savings are deemed based on study results.[1] [2] Demand savings are derived from the demand impact model which is developed as part of the Residential Baseline Study.[3]

Measure Name	ΔkWh	ΔkW	Δ MMBtu
Faucet Aerator, Electric (Single Family)	43.0	0.01	
Faucet Aerator, Gas (Single Family)			0.21
Faucet Aerator, Oil (Single Family)			0.22
Faucet Aerator, Other (Single Family)			0.21
Faucet Aerator, Electric (Attached Low Rise)	43.0	0.01	
Faucet Aerator, Gas (Attached Low Rise)			0.21
Faucet Aerator, Oil (Attached Low Rise)			0.22
Faucet Aerator, Other (Attached Low Rise)			0.21
Faucet Aerator, Electric (High Rise)	97.0	0.02	
Faucet Aerator, Gas (High Rise)			0.86
Faucet Aerator, Oil (High Rise)			0.86
Faucet Aerator, Other (High Rise)			0.86

Baseline Efficiency:

The baseline efficiency case is the existing faucet aerator with a high flow.

High Efficiency:

The high efficiency case is a low flow faucet aerator.

Measure Life:

The measure life is 7 years.

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Faucet Aerator	RES_CD	All	7	n/a	n/a	7

Other Resource Impacts:

Residential water savings for faucet aerators is 332 gallons per unit.[4]

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Faucet Aerator (Single Family)	RES_CD	All	0.74	1.00	1.00	1.00	1.00	0.15	0.42
Faucet Aerator (Attached Low Rise)	RES_CD	All	0.74	1.00	1.00	1.00	1.00	0.15	0.42
Faucet Aerator (High Rise	RES_CD	All	1.00	1.00	1.00	1.00	1.00	0.15	0.42

<u>**In-Service Rates:**</u>
For Single Family and Low Rise in service rates are blended and based on evaluation results.[5] [6] All high rise installations have 100% in service rate since programs include verification of equipment installations.

<u>**Realization Rates:**</u>
Realization rates are set to 100% for deemed measures.

<u>**Coincidence Factors:**</u>
Summer and winter coincidence factors are estimated using the demand allocation methodology described in the Demand Impact Model which is developed based on the Residential Baseline Study.[7]

Impact Factors for Calculating Net Savings:

Net to gross factors are based on evaluation results.[8]

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Faucet Aerator (Single Family)	RES_CD	All	0.04	0.12	0.00	1.08

Faucet Aerator (Attached Low Rise)	RES_CD	All	0.04	0.12	0.00	1.08
Faucet Aerator (High Rise)	RES_CD	All	0.14	0.0	0.0	0.86

Non-Energy Impacts:

NEI values are rolled up, component values can be found in Appendix B.

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per KWh	Annual $ per Therm	One-time $ per Therm
Faucet Aerator (Single Family)	RES_CD	All						
Faucet Aerator (Attached Low Rise)	RES_CD	All						
Faucet Aerator (High Rise)	RES_CD	All	$0.58					

Endnotes:

1 : Navigant Consulting (2018). Home Energy Services (HES) Impact Evaluation.
2018_Navigant_HES_Impact_Evaluation
2 : Navigant Consulting (2018). Multi-Family Program Impact and Net-to-Gross Evaluation.
2018_Navigant_Multifamily_Program_Impact_Evaluation
3 : Guidehouse (2020). Residential Baseline Study Phase 4
2020_Guidehouse_Residential_Baseline_Phase_4
4 : NMR Group, Inc., Tetra Tech (2011). Massachusetts Special and Cross-Sector Studies Area, Residential and Low-Income Non-Energy Impacts (NEI) Evaluation.
Tetra_Tech_and_NMR_2011_MA_Res_and_LI_NEI_Evaluation
5 : Guidehouse (2021). Virtual Home Energy Assessment Study.
2021_Guidehouse_VHEA_Report_FINAL
6 : Guidehouse (2021). RCD ISR Analysis. 2021_Guidehouse_RCD ISR 2020 Analysis_FINAL
7 : Guidehouse (2020). Residential Baseline Study Phase 4
2020_Guidehouse_Residential_Baseline_Phase_4
8 : Guidehouse (2021). Residential Programs Net-to-Gross Research of RCD and Select Products Measures: Results Memo 2021_Guidehouse_Res_NTG_Final_Results_Memo

1.49 Hot Water - Heat Pump Water Heater

Measure Code	RES-WH-HPWH
Market	Residential
Program Type	Time of Sale
Category	Water Heating

Measure Description:

Installation of a heat pump water heater (HPWH) instead of an electric resistance water heater.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Heat Pump Water Heater, <55 gallon displacing Oil	Residential Retail (RES_RETAIL)	EA2c286
Heat Pump Water Heater, >55 gallon displacing Oil	Residential Retail (RES_RETAIL)	EA2c385
Heat Pump Water Heater, <55 gallon displacing Propane	Residential Retail (RES_RETAIL)	EA2c287
Heat Pump Water Heater, >55 gallon displacing Propane	Residential Retail (RES_RETAIL)	EA2c386
Heat Pump Water Heater displacing Existing Water Heater, Gas (≤55 Gal)	Residential Retail (RES_RETAIL)	GA2c077
Heat Pump Water Heater displacing Existing Water Heater, Gas (>55 Gal)	Residential Retail (RES_RETAIL)	GA2c097
Water Heater, Heat Pump, <55 gallon, Energy Star	Residential Retail (RES_RETAIL)	EA2c018
Water Heater, Heat Pump, >55 gallon, UEF 2.70	Residential Retail (RES_RETAIL)	EA2c019

Algorithms for Calculating Primary Energy Impact:

Unit savings are deemed based on study results [1] for all the below < 55 gallon water heaters and the electric above 55 gallon water heaters. Saving for the fuel switching above 55 gallon water heaters are based on the new measure form. [2]

Measure Name	Water Heating Savings		Heating Savings (Penalty)		Total Savings			
	ΔkWh	ΔMMBTU	ΔkWh	ΔMMBTU	ΔkWh	Max Load Factor	ΔkW	ΔMMBTU
Water Heater, Heat Pump, <55 gallon, Energy Star	1799	0	-86.3	Gas = -0.50 Oil = -0.10 Propane = -0.07	1712	0.00025	0.43	Gas = -0.50 Oil = -0.10 Propane = -0.07
Water Heater, Heat Pump, >55 gallon, UEF 2.70	360	0	0	0	360	0.00025	0.09	0
Heat Pump Water Heater, <55 gallon displacing Oil	-1130	20.0	0	-0.67	-1130	0.00025	-0.28	19.3
Heat Pump Water Heater, >55 gallon displacing Oil	-1233	15.9	0	-0.67	-1233	0.00025	-0.31	15.23
Heat Pump Water Heater, <55 gallon displacing Propane	-831	17.1	0	-0.67	-831	0.00025	-0.21	16.4
Heat Pump Water Heater, >55 gallon displacing Propane	-914	14.0	0	-0.10	-914	0.00025	-0.23	13.9
Heat Pump Water Heater displacing Existing Water Heater, Gas (≤55 Gal)	-831	17.1	0	-0.67	-831	0.00025	-0.21	16.4
Heat Pump Water Heater displacing Existing Water Heater, Gas (>55 Gal)	-1121	17.1	0	-0.67	-1121	0.00025	-0.28	16.4

There are heating fuel penalties associated with the <=55 gallon heat pump water heater to account for additional consumption for space heating when replacing a standard electric water heater.[3]

There are fuel savings associated with going from either an oil water heating system or a propane water heating system to a HPWH. The penalties shown above are also included in the savings values for the two measures shown below. Savings for oil is reduced by 0.67 MMBTU and similarly are reduced for propane/natural gas with the same 0.67 MMBTU value.

Since the baseline for Water Heater, Heat Pump, >55 gallon, UEF 2.70 is already a heat pump water heater, this penalty would be experienced for both the baseline and the energy efficiency heat pump and due to this there is no heating penalty included.

Baseline Efficiency:

The baseline efficiency case is for the Water Heater, Heat Pump <55 gallon is a new, baseline code efficiency electric resistance hot water heater. The baseline efficiency case for the Water Heater, Heat Pump > 55 gallon is a new, baseline code heat pump water heater. The baseline for the oil water heater is a weighted average of an oil tankless coil water heater (75%) and a baseline code standard oil tank water heater (25%) for both < 55 gallon and greater than 55 gallon. The baseline for the propane water heater is a baseline code standard propane tank water heater with a UEF =0.62 for both < 55 gallon and greater than 55 gallon. The baseline for the gas water heater is a baseline code standard natural gas tank water heater with a UEF =0.62 for both < 55 gallon and greater than 55 gallon.

High Efficiency:

The high efficiency case for both the < 55 gallon and > 55 gallon is a 3.3 UEF or greater. Savings are based on 2020 production.

Measure Life:

The measure life is 13 years.[3]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Heat Pump Water Heater	IE_CD	All	13	n/a	n/a	13

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure	Core Initiative	PA	ISR	RR$_E$	RR$_{NE}$	RR$_{SP}$	RR$_{WP}$	CF$_{SP}$	CF$_{WP}$
Water Heater, Heat	RES_RETAIL	All	1.00	1.00	1.00	1.00	1.00	0.31	0.84

Measure	Core Initiative	PA	ISR	RR$_E$	RR$_{NE}$	RR$_{SP}$	RR$_{WP}$	CF$_{SP}$	CF$_{WP}$
Pump, <55 gallon, Energy Star									
Water Heater, Heat Pump, >55 gallon, UEF 2.70	RES_RETAIL	All	1.00	1.00	1.00	1.00	1.00	0.31	0.84
Heat Pump Water Heater displacing Existing Water Heater, Oil (both < 55 gallon and > 55 gallon)	RES_RETAIL	All	1.00	1.00	1.00	1.00	1.00	0.31	0.84
Heat Pump Water Heater displacing Existing Water Heater, Propane (both < 55 gallon and > 55 gallon)	RES_RETAIL	All	1.00	1.00	1.00	1.00	1.00	0.31	0.84
Heat Pump Water Heater displacing Existing Water Heater, Gas (both < 55 gallon and > 55 gallon)	RES_RETAIL	All	1.00	1.00	1.00	1.00	1.00	0.31	0.84

In-Service Rates:

All installations have 100% in service rate since all PAs programs include verification of equipment installations.

Realization Rates:
Realization rates are set to 100% since deemed savings are based on evaluation results.

Coincidence Factors:
Coincidence factors are based on evaluation results.

Impact Factors for Calculating Net Savings:

Impact factors for net savings:[4]

Measure Name	Core Initiative	PA	FR	SO$_P$	SO$_{NP}$	NTG
Water Heater, Heat Pump, <55 gallon, Energy Star	Residential Retail (RES_RETAIL)	All	0.30	0.12	0.00	0.82
Water Heater, Heat Pump, >55	Residential Retail	All	0.30	0.12	0.00	0.82

gallon, UEF 2.70	(RES_RETAIL)					
Heat Pump Water Heater displacing Existing Water Heater, Oil (both < 55 gallon and > 55 gallon)	Residential Retail (RES_RETAIL)	All	0.30	0.12	0.00	0.82
Heat Pump Water Heater displacing Existing Water Heater, Propane (both < 55 gallon and > 55 gallon)	Residential Retail (RES_RETAIL)	All	0.30	0.12	0.00	0.82
Heat Pump Water Heater displacing Existing Water Heater, Gas (both < 55 gallon and > 55 gallon)	Residential Retail (RES_RETAIL)	All	0.36	0.12	0.00	0.76

Non-Energy Impacts:

NEI values are rolled up, component values can be found in Appendix B.

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per kWh	Annual $ per Therm	One-time $ per Therm
Water Heater, Heat Pump, <55 gallon, Energy Star	RES_RETAIL	All	$0.70					
Water Heater, Heat Pump, >55 gallon, UEF 2.70	RES_RETAIL	All	$0.70					
Heat Pump Water Heater displacing Existing Water Heater, Oil (both < 55 gallon and > 55 gallon)	RES_RETAIL	All	$0.70					
Heat Pump Water Heater displacing Existing Water Heater, Propane, (both < 55 gallon and > 55 gallon)	RES_RETAIL	All	$0.70					
Heat Pump Water	RES_RETAIL	All	$0.70					

Heater displacing Existing Water Heater, Gas, (both < 55 gallon and > 55 gallon)							

Endnotes:

1 : Guidehouse 2021 - Savings Calculations MA21R39-E-HPWHQH_Task 3 Findings Spreadsheet-31Aug2021

2 : 2023_PAs_Resi HPWH MA New Measure Form 12 2022

3 : Guidehouse 2021 - Savings Calculations MA21R39-E-HPWHQH_Task 3 Findings Spreadsheet-31Aug2021

4 : Guidehouse (2021) - NTG Study 2021_Guidehouse_Res_NTG_Final_Results_Memo

1.50 Hot Water - Indirect Water Heater

Measure Code	RES-WH-IWH
Market	Residential
Program Type	Retrofit
Category	Water Heating

Measure Description:

Indirect water heaters use a storage tank that is heated by the main boiler. The energy stored by the water tank allows the boiler to turn off and on less often, saving considerable energy.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Water Heater, Indirect, Oil	Residential Retail (RES_RETAIL)	EA2c015
Water Heater, Indirect, Other	Residential Retail (RES_RETAIL)	EA2c016

Algorithms for Calculating Primary Energy Impact:

Unit savings are deemed based on study results.[1]

Measure Name	Δ MMBtu
Water Heater, Indirect, Oil	4.7
Water Heater, Indirect, Other	4.0

Baseline Efficiency:

The baseline efficiency case is the existing water heater.

High Efficiency:

The high efficiency case is an indirect water heater attached to an ENERGY STAR® rated forced hot water boiler.

Measure Life:

The measure life is 20 years. [2]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML

Water Heater, Indirect	RES_RETAIL	All	20	n/a	n/a	20

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Water Heater, Indirect	RES_RETAIL	All	1.00	1.00	1.00	n/a	n/a	n/a	n/a

In-Service Rates:
All installations have 100% in service rate since programs include verification of equipment installations.

Realization Rates:
Realization rates are set to 100% since savings are deemed

Coincidence Factors:
Not applicable for this measure since no electric savings are claimed.

Impact Factors for Calculating Net Savings:

Net to gross factors are based on multiple evaluation results.[3]

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Water Heater, Indirect, Oil	RES_RETAIL	All	0.30	0.12	0.00	0.82
Water Heater, Indirect, Other	RES_RETAIL	All	0.30	0.12	0.00	0.82

Non-Energy Impacts:

NEI values are rolled up, component values can be found in Appendix B.

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per KWh	Annual $ per Therm	One-time $ per Therm
Water Heater, Indirect, Oil	RES_RETAIL	All	$0.70					

Water Heater, Indirect, Other	RES_RETAIL	All	$0.70					

Endnotes:

1 : Navigant Consulting (2018). Home Energy Services (HES) Impact Evaluation.
2018_Navigant_HES_Impact_Evaluation
2 : GDS Associates, Inc. (2009). Natural Gas Energy Efficiency Potential in Massachusetts.
GDS_2009_Natural_Gas_Energy_Efficiency_Potential_in_MA
3 : Guidehouse (2021). Residential Programs Net-to-Gross Research of RCD and Select Products
Measures Workbook 2021_Guidehouse_MA_Res_NTG_Final_Report

1.51 Hot Water - Low-Flow Showerhead

Measure Code	RES-WH-S
Market	Residential
Program Type	Retrofit
Category	Hot Water

Measure Description:

An existing showerhead with a high flow rate is replaced with a new low flow showerhead.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Low-Flow Showerhead, Electric (Single Family)	Residential Coordinated Delivery (RES_CD)	EA2a055
Low-Flow Showerhead, Gas (Single Family)	Residential Coordinated Delivery (RES_CD)	EA2a056
Low-Flow Showerhead, Oil (Single Family)	Residential Coordinated Delivery (RES_CD)	EA2a057
Low-Flow Showerhead, Other (Single Family)	Residential Coordinated Delivery (RES_CD)	EA2a058
Low-Flow Showerhead, Electric (Attached Low Rise)	Residential Coordinated Delivery (RES_CD)	EA2a132
Low-Flow Showerhead, Gas (Attached Low Rise)	Residential Coordinated Delivery (RES_CD)	EA2a133
Low-Flow Showerhead, Oil (Attached Low Rise)	Residential Coordinated Delivery (RES_CD)	EA2a134
Low-Flow Showerhead, Other (Attached Low Rise)	Residential Coordinated Delivery (RES_CD)	EA2a135
Low-Flow Showerhead, Electric (High Rise)	Residential Coordinated Delivery (RES_CD)	EA2a220
Low-Flow Showerhead, Gas (High Rise)	Residential Coordinated Delivery (RES_CD)	EA2a221

Measure Name	Core Initiative	BCR Measure ID
Low-Flow Showerhead, Oil (High Rise)	Residential Coordinated Delivery (RES_CD)	EA2a222
Low-Flow Showerhead, Other (High Rise)	Residential Coordinated Delivery (RES_CD)	EA2a223
Low-Flow Showerhead, Gas (Single Family)	Residential Coordinated Delivery (RES_CD)	GA2a008
Low-Flow Showerhead, Gas (Attached Low Rise)	Residential Coordinated Delivery (RES_CD)	GA2a053
Low-Flow Showerhead, Gas (High Rise)	Residential Coordinated Delivery (RES_CD)	GA2a087
Low-Flow Showerhead, Gas	Residential Retail (RES_RETAIL)	GA2c034

Algorithms for Calculating Primary Energy Impact:

Unit kWh and MMBtu savings are deemed based on study results.[1] [2] Demand savings are derived from the demand impact model which is developed as part of the Residential Baseline Study.[3]

Measure Name	ΔkWh	ΔkW	Δ MMBtu
Low-Flow Showerhead, Electric (Single Family)	187.0	0.05	
Low-Flow Showerhead, Gas (Single Family)			0.92
Low-Flow Showerhead, Oil (Single Family)			0.98
Low-Flow Showerhead, Other (Single Family)			0.92
Low-Flow Showerhead, Electric (Attached Low Rise)	187.0	0.05	
Low-Flow Showerhead, Gas (Attached Low Rise)			0.92
Low-Flow Showerhead, Oil (Attached Low Rise)			0.98
Low-Flow Showerhead, Other (Attached Low Rise)			0.92
Low-Flow Showerhead, Electric (High Rise)	129.0	0.03	
Low-Flow Showerhead, Gas (High Rise)			1.14
Low-Flow Showerhead, Oil (High Rise)			1.14
Low-Flow Showerhead, Other (High Rise)			1.14
Low-Flow Showerhead, Gas (Single Family)			1.2

Baseline Efficiency:

The baseline efficiency case is the existing showerhead with a baseline flow rate of 2.5 GPM.

High Efficiency:

The high efficiency case is a low flow showerhead having a maximum flow rate between 1.5 and 1.7 GPM.

Measure Life:

The measure life is 15 years.[4]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Low-Flow Showerhead	RES_CD RES_RETAIL	All	15	n/a	n/a	15

Other Resource Impacts:

Water savings for Retail and Single Family are 2,401 gallons per unit and for Attached Low Rise and High Rise water savings are 2,165 gallons per unit.[5]

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Low-Flow Showerhead, Electric (Single Family)	RES_CD	All	0.66	1.00	1.00	n/a	n/a	0.15	0.42
Low-Flow Showerhead, Gas (Single Family)	RES_CD	All	0.66	1.00	1.00	n/a	n/a	n/a	n/a
Low-Flow Showerhead, Oil (Single Family)	RES_CD	All	0.66	1.00	1.00	n/a	n/a	n/a	n/a
Low-Flow Showerhead, Other (Single Family)	RES_CD	All	0.66	1.00	1.00	n/a	n/a	n/a	n/a
Low-Flow Showerhead, Electric (Attached Low Rise)	RES_CD	All	0.66	1.00	1.00	n/a	n/a	0.15	0.42
Low-Flow Showerhead, Gas (Attached Low Rise)	RES_CD	All	0.66	1.00	1.00	n/a	n/a	n/a	n/a
Low-Flow Showerhead, Oil (Attached Low Rise)	RES_CD	All	0.66	1.00	1.00	n/a	n/a	n/a	n/a
Low-Flow Showerhead,	RES_CD	All	0.66	1.00	1.00	n/a	n/a	n/a	n/a

Other (Attached Low Rise)									
Low-Flow Showerhead, Electric (High Rise)	RES_CD	All	1.00	1.00	1.00	n/a	n/a	0.15	0.42
Low-Flow Showerhead, Gas (High Rise)	RES_CD	All	1.00	1.00	1.00	n/a	n/a	n/a	n/a
Low-Flow Showerhead, Oil (High Rise)	RES_CD	All	1.00	1.00	1.00	n/a	n/a	n/a	n/a
Low-Flow Showerhead, Other (High Rise)	RES_CD	All	1.00	1.00	1.00	n/a	n/a	n/a	n/a
Low-Flow Showerhead, Gas	RES_RETAIL	All	1.00	1.00	1.00	n/a	n/a	n/a	n/a

In-Service Rates:

For Single Family and Low Rise in-service rates are blended and based on evaluation results.[6] [7] All High Rise installations have 100% in service rate since programs include verification of equipment installations.

Realization Rates:

All PAs use 100% energy realization rate.

Coincidence Factors:

Summer and winter coincidence factors are estimated using the demand allocation methodology described in the Demand Impact Model which is developed based on the Residential Baseline Study.[8]

Impact Factors for Calculating Net Savings:

Net to gross factors are based on evaluation results.[9]

Measure Name	Core Initiative	PA	FR	SO$_P$	SO$_{NP}$	NTG
Low-Flow Showerhead (Single Family)	RES_CD	All	0.04	0.12	0.00	1.08
Low-Flow Showerhead (Attached Low Rise)	RES_CD	All	0.04	0.12	0.00	1.08
Low-Flow Showerhead (High Rise)	RES_CD	All	0.14	0.0	0.0	0.86
Low-Flow Showerhead	RES_RETAIL	All	0.04	0.12	0.00	1.08

Non-Energy Impacts:

NEI values are rolled up, component values can be found in Appendix B.

Measure Name	Core	PA	Annual	One-	Annual	One-	Annual	One-

	Initiative		$ per Unit	time $ per Unit	$ per kWh	time $ per KWh	$ per Therm	time $ per Therm
Low-Flow Showerhead (Single Family)	RES_CD	All		$0.03				
Low-Flow Showerhead (Attached Low Rise)	RES_CD	All		$0.03				
Low-Flow Showerhead (High Rise)	RES_CD	All	$0.58					
Low-Flow Showerhead (Single Family)	RES_RETAIL	All		$0.03				

Endnotes:

1 : Navigant Consulting (2018). Home Energy Services (HES) Impact Evaluation.
2018_Navigant_HES_Impact_Evaluation
2 : The Cadmus Group (2012). Massachusetts Multifamily Program Impact Analysis July 2012 – Revised May 2013. CADMUS_2012_Multifamily_Impacts_Analysis_Report
3 : Guidehouse (2020). Residential Baseline Study Phase 4
2020_Guidehouse_Residential_Baseline_Phase_4
4 : Guidehouse (2021). Comprehensive TRM Review. 2021_Guidehouse_TRM_Final_Report
5 : Staff calculations based on the methodology from The Cadmus Group, Inc. (2012). Home Energy Services Impact Evaluation. CADMUS_2012__HES_Impact_Evaluation_Report
6 : Guidehouse (2021). Virtual Home Energy Assessment Study.
2021_Guidehouse_VHEA_Report_FINAL
7 : Guidehouse (2021). RCD ISR Analysis. 2021_Guidehouse_RCD ISR 2020 Analysis_FINAL
8 : Guidehouse (2020). Residential Baseline Study Phase 4
2020_Guidehouse_Residential_Baseline_Phase_4
9 : Guidehouse (2021). Residential Programs Net-to-Gross Research of RCD and Select Products Measures: Results Memo 2021_Guidehouse_Res_NTG_Final_Results_Memo

1.52 Hot Water - Low-Flow Showerhead with Thermostatic Valve

Measure Code	RES-WH-STV
Market	Residential
Program Type	Retrofit
Category	Hot Water

Measure Description:

An existing showerhead is replaced with a low-flow showerhead with an integrated thermostatic shut-off valve (TSV).

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Low-Flow Showerhead with TSV, Electric (High Rise)	Residential Coordinated Delivery (RES_CD)	EA2a224
Low-Flow Showerhead with TSV, Oil (High Rise)	Residential Coordinated Delivery (RES_CD)	EA2a225
Low-Flow Showerhead with TSV, Other (High Rise)	Residential Coordinated Delivery (RES_CD)	EA2a226
Low-Flow Showerhead with TSV, Electric	Residential Retail (RES_RETAIL)	EA2c078
Low-Flow Showerhead with TSV, Gas	Residential Retail (RES_RETAIL)	EA2c079
Low-Flow Showerhead with TSV, Oil	Residential Retail (RES_RETAIL)	EA2c080
Low-Flow Showerhead with TSV, Other	Residential Retail (RES_RETAIL)	EA2c081
Low-Flow Showerhead with TSV, Gas (High Rise)	Residential Coordinated Delivery (RES_CD)	GA2a088
Low-Flow Showerhead with TSV, Gas	Residential Retail (RES_RETAIL)	GA2c032

Algorithms for Calculating Primary Energy Impact:

Unit savings are deemed based on engineering analysis.[1] Demand savings are derived from the demand impact model which is developed as part of the Residential Baseline Study.[2]

Measure Name	ΔkWh	ΔkW	Δ MMBtu
Low-Flow Showerhead with TSV, Gas (High Rise)			1.41
Low-Flow Showerhead with TSV, Electric (High Rise)	183	0.05	
Low-Flow Showerhead with TSV, Oil (High Rise)			1.44
Low-Flow Showerhead with TSV, Other (High Rise)			1.41
Low-Flow Showerhead with TSV, Electric	247	0.06	
Low-Flow Showerhead with TSV, Gas			1.22
Low-Flow Showerhead with TSV, Oil			1.32
Low-Flow Showerhead with TSV, Other			1.22

Baseline Efficiency:

The Baseline Efficiency case is an existing standard-flow showerhead (2.5 GPM) with no thermostatic shut-off valve.

High Efficiency:

The high efficiency case is a low-flow showerhead (1.7 GPM) with integrated thermostatically actuated valve.

Measure Life:

The measure life is 15 years.[3]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Low-Flow Showerhead with TSV	RES_CD RES_RETAIL	All	15	n/a	n/a	15

Other Resource Impacts:

Water savings for Low-Flow Showerheads with TSV in RCD is 2,723 gallons per unit. Water savings for Low-Flow Showerheads with TSV in Res Retail is 3,022 gallons per unit.[4]

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR$_E$	RR$_{NE}$	RR$_{SP}$	RR$_{WP}$	CF$_{SP}$	CF$_{WP}$

Low-Flow Showerhead with TSV	RES_CD	All	1.00	1.00	1.00	1.00	1.00	0.31	0.84
Low-Flow Showerhead with TSV	RES_RETAIL	All	0.78	1.00	1.00	1.00	1.00	0.31	0.84

In-Service Rates:

In-Service rate for Res Retail is based on evaluation results.[5]

Realization Rates:

Realization rates are set to 100% for deemed measures.

Coincidence Factors:

Coincidence factors are estimated using the demand allocation methodology described in the Demand Impact Model.[6]

Impact Factors for Calculating Net Savings:

Net to gross factors are based on evaluation results.[7][8]

Measure Name	Core Initiative	PA	FR	SO$_P$	SO$_{NP}$	NTG
Low-Flow Showerhead with TSV (High Rise)	RES_CD	All	0.14	0.0	0.0	0.86
Low-Flow Showerhead with TSV	RES_RETAIL	All	0.03	0.0	0.00	0.97

Non-Energy Impacts:

NEI values are rolled up, component values can be found in Appendix B.

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per KWh	Annual $ per Therm	One-time $ per Therm
Low-Flow Showerhead with TSV (High Rise)	RES_CD	All	$0.58					

Endnotes:

1 : Guidehouse (2021). Comprehensive TRM Review. 2021_Guidehouse_TRM_Final_Report
2 : Guidehouse (2020). Residential Baseline Study Phase 4
2020_Guidehouse_Residential_Baseline_Phase_4
3 : Guidehouse (2021). Comprehensive TRM Review. 2021_Guidehouse_TRM_Final_Report
4 : National_Grid_2014_ShowerStart_Savings_Final_2015-2-9

National_Grid_2014_ShowerStart_Savings_Final_2015-2-9

5 : NMR Group Inc. (2021). Residential Products In Service Rates Memo. 2021_NMR_Products_ISR

6 : Guidehouse (2020). Residential Baseline Study Phase 4.
2020_Guidehouse_Residential_Baseline_Phase_4

7 : Guidehouse (2021). Residential Programs Net-to-Gross Research of RCD and Select Products
Measures: Results Memo 2021_Guidehouse_Res_NTG_Final_Results_Memo

8 : NMR Group, Inc. (2021). Residential Products NTG Report.
2021_NMR_Res_Products_NTG_Report

1.53 Hot Water - On Demand/Tankless Water Heater

Measure Code	RES-WH-ODTWH
Market	Residential
Program Type	Retrofit
Category	Water Heating

Measure Description:

Tankless water heaters circulate water through a heat exchanger to be heated for immediate use, eliminating the standby heat loss associated with a storage tank.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Water Heater, On-Demand, Other	Residential Retail (RES_RETAIL)	EA2c017
Water Heater, On Demand Tankless	Residential Retail (RES_RETAIL)	GA2c027

Algorithms for Calculating Primary Energy Impact:

Unit savings are deemed based on study results[1] . For gas the savings have been adjusted to reflect the mix of replace on failure and early replacement based. There is an electric penalty associated with the gas on-demand tankless water heater to account for additional electrical consumption for power venting and electronic pilot ignition.

Measure Name	Δ kWh	Δ kW[2]	Δ MMBtu
Water Heater, On Demand, Gas	-43.0	-0.01	7.0
Water Heater, On-Demand, Other	-43.0	-0.01	5.4

Baseline Efficiency:

The baseline efficiency case is a standalone tank water heater with a 0.63 UEF. For the early retirement portion, the baseline efficiency is an existing 0.60 UEF standalone water heater.[3]

High Efficiency:

The high efficiency case is an On Demand tankless water heater with an UEF >= 0.87

Measure Life:

The measure life is 19 years for gas equipment[4] and 20 years for propane equipment

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Water Heater, On Demand, Gas	RES_RETAIL	All	20	n/a	n/a	19
Water Heater, On-Demand, Other	RES_RETAIL	All	20	n/a	n/a	20

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Water Heater, On Demand, Gas	RES_RETAIL	All	1.00	1.00	1.00	1.00	1.00	0.31	0.84
Water Heater, On Demand, Other	RES_RETAIL	All	1.00	1.00	1.00	1.00	1.00	0.31	0.84

In-Service Rates:
All installations have 100% in service rate since programs include verification of equipment installations.

Realization Rates:
Realization rates are set to 100% for deemed measures.

Coincidence Factors:
Summer and winter coincidence factors are estimated using the demand allocation methodology described in the Demand Impact Model which is developed based on the Residential Baseline Study.[5]

Impact Factors for Calculating Net Savings:

Net to gross factors are based on evaluation results.[6]

Measure Name	Core Initiative	PA	FR	SOP	SONP	NTG
Water Heater, On Demand, Gas	RES_RETAIL	All	0.36	0.12	0.00	0.76
Water Heater, On-Demand, Other	RES_RETAIL	All	0.30	0.12	0.00	0.82

Non-Energy Impacts:

NEI values are rolled up, component values can be found in Appendix B.[7][8]

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per KWh	Annual $ per Therm	One-time $ per Therm
Water Heater, On Demand, Gas	RES_RETAIL	All	$1.23					
Water Heater, On Demand, Other	RES_RETAIL	All	$0.70					

Endnotes:

1 : Navigant Consulting (2018). Water Heating, Boiler, and Furnace Cost Study (RES 19) Add-On Task 7: Residential Water Heater Analysis Memo and The Cadmus Group (2013). 2012 Residential Heating, Water Heating, and Cooling Equipment Evaluation: Net-to-Gross, Market Effects, and Equipment Replacement Timing. The calculation of the adjustment can be found in MA PAs (2021). 2020 Annual Report Gas HVAC and Water Heating Calculations Workbook MA_PAs_2020 Annual Report_Gas_HVAC_WH_Calculations_GH_2021-03-08

2 : Demand savings were calculated taking the gross energy savings * the peak max load factor (-43*0.00025 = - 0.01) using the results from the following study: 2020_Guidehouse_Residential_Baseline_Phase_4

3 : Early Retirement baseline is considered to be the high draw value from the following source. 2021_Guidehouse_TRM_Final_Report

4 : DOE (2008). Energy Star Residential Water Heaters: Final Criteria Analysis and The Cadmus Group (2013). 2012 Residential Heating, Water Heating, and Cooling Equipment Evaluation: Net-to-Gross, Market Effects, and Equipment Replacement Timing. The calculation of the adjustment can be found in MA PAs (2021). 2020 Annual Report Gas HVAC and Water Heating Calculations Workbook. MA_PAs_2020 Annual Report_Gas_HVAC_WH_Calculations_GH_2021-03-08

5 : Guidehouse (2020). Residential Baseline Study Phase 4 2020_Guidehouse_Residential_Baseline_Phase_4

6 : Guidehouse (2021). Residential Programs Net-to-Gross Research of RCD and Select Products Measures Workbook 2021_Guidehouse_Res_NTG_Final_Results_Memo

7 : NMR Group, Inc., Tetra Tech (2011). Massachusetts Special and Cross-Sector Studies Area, Residential and Low-Income Non-Energy Impacts (NEI) Evaluation. Prepared for the Massachusetts Program Administrators. Adjusted based on NMR Group, Inc. (2013) Massachusetts Residential Non-Energy Impacts (NEIs): Deemed NEI Values Addressing Differences in NEIs for Heating, Cooling, and Water Heating Equipment that is Early Replacement Compared to Replace on Failure. Tetra_Tech_and_NMR_2011_MA_Res_and_LI_NEI_Evaluation

8 : NMR Group, Inc., Tetra Tech (2011). Massachusetts Special and Cross-Sector Studies Area, Residential and Low-Income Non-Energy Impacts (NEI) Evaluation. Prepared for the Massachusetts

Program Administrators. Adjusted based on NMR Group, Inc. (2013) Massachusetts Residential Non-Energy Impacts (NEIs): Deemed NEI Values Addressing Differences in NEIs for Heating, Cooling, and Water Heating Equipment that is Early Replacement Compared to Replace on Failure.
NMR_2013_Residential_HVAC_Replace_On_Failure NEIs

1.54 Hot Water - Pipe Insulation Self Install

Measure Code	RES-WH-PISI
Market	Residential
Program Type	Consumer Products
Category	Hot Water

Measure Description:

Installation of pipe wrap.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Pipe Insulation - Self Install	Residential Retail (RES_RETAIL)	EA2c379
Pipe Insulation - Self Install	Residential Retail (RES_RETAIL)	GA2c090

Algorithms for Calculating Primary Energy Impact:

Unit kWh and MMBtu savings are based on the hot water pipe wrap insulation from the most recent RCD impact evaluation and adjusted for differences in quantity of pipe insulation installed.[1] Savings attributed to the Electric PA as weighted based on household heating type from 2020 ACS data. Demand savings are derived from the demand impact model which is developed as part of the Residential Baseline Study.[2]

Savings for Pipe Insulation:

Measure Name	Fuel Type	ΔkWh	ΔkW	Δ MMBtu
Pipe Insulation - Self Install	Electric	28	0.01	0.33 Oil & 0.07 Other
Pipe Insulation - Self Install	Gas	n/a	n/a	0.87 Gas

Baseline Efficiency:

The baseline efficiency case is uninsulated pipes.

High Efficiency:

The high efficiency case includes pipe that have been insulated.

Measure Life:

The measure life is 15 years.[3]

PA	Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
All	Pipe Insulation - Self Install	RES_RETAIL	All	15	n/a	n/a	15

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Pipe Insulation - Self Install	RES_RETAIL	All	0.50	1.00	1.00	1.00	1.00	0.31	0.84

In-Service Rates:
A 50% installation rate is assumed.

Realization Rates:
The realization rates are set to 100% since deemed savings are based on evaluation results.

Coincidence Factors:
Summer and winter coincidence factors are estimated using the demand allocation methodology described in the Demand Impact Model which is developed based on the Residential Baseline Study.[4]

Impact Factors for Calculating Net Savings:

Net to gross factors are assumed.

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Pipe Insulation - Self Install	RES_CD	All	0.50	0.0	0.00	0.50

Non-Energy Impacts:

There are no non-energy impacts identified for this measure.

Endnotes:

1 : Navigant Consulting (2018). HES Impact Evaluation. 2018_Navigant_HES_Impact_Evaluation
2 : Guidehouse (2020). Residential Baseline Study Phase 4
2020_Guidehouse_Residential_Baseline_Phase_4
3 : GDS Associates, Inc. (2007). Measure Life Report: Residential and Commercial/Industrial and HVAC Measures.

GDS_2007_Measure_Life_Report_Residential_and_CI_Lighting_and_HVAC_Measures
4 : Guidehouse (2020). Residential Baseline Study Phase 4
2020_Guidehouse_Residential_Baseline_Phase_4

1.55 Hot Water - Pipe Wrap (Water Heating)

Measure Code	RES-WH-PW
Market	Residential
Program Type	Retrofit
Category	Hot Water

Measure Description:

Installation of DHW pipe wraps.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Pipe Wrap (Water Heating), Electric (Single Family)	Residential Coordinated Delivery (RES_CD)	EA2a044
Pipe Wrap (Water Heating), Gas (Single Family)	Residential Coordinated Delivery (RES_CD)	EA2a045
Pipe Wrap (Water Heating), Oil (Single Family)	Residential Coordinated Delivery (RES_CD)	EA2a046
Pipe Wrap (Water Heating), Other (Single Family)	Residential Coordinated Delivery (RES_CD)	EA2a047
Pipe Wrap (Water Heating), Electric (Attached Low Rise)	Residential Coordinated Delivery (RES_CD)	EA2a121
Pipe Wrap (Water Heating), Gas (Attached Low Rise)	Residential Coordinated Delivery (RES_CD)	EA2a122
Pipe Wrap (Water Heating), Oil (Attached Low Rise)	Residential Coordinated Delivery (RES_CD)	EA2a123
Pipe Wrap (Water Heating), Other (Attached Low Rise)	Residential Coordinated Delivery (RES_CD)	EA2a124
Pipe Wrap (Water Heating), Electric (High Rise)	Residential Coordinated Delivery (RES_CD)	EA2a209
Pipe Wrap (Water Heating), Gas (High Rise)	Residential Coordinated Delivery (RES_CD)	EA2a210
Pipe Wrap (Water Heating), Oil (High Rise)	Residential Coordinated Delivery (RES_CD)	EA2a211

Measure Name	Core Initiative	BCR Measure ID
Pipe Wrap (Water Heating), Other (High Rise)	Residential Coordinated Delivery (RES_CD)	EA2a212
Pipe Wrap (Water Heating), Gas (Single Family)	Residential Coordinated Delivery (RES_CD)	GA2a005
Pipe Wrap (Water Heating), Gas (Attached Low Rise)	Residential Coordinated Delivery (RES_CD)	GA2a050
Pipe Wrap (Water Heating), Gas (High Rise)	Residential Coordinated Delivery (RES_CD)	GA2a084

Algorithms for Calculating Primary Energy Impact:

Unit kWh and MMBtu savings are deemed based on study results where unit is a household with pipe wrap installed on hot water pipes.[1] [2] Demand savings are derived from the demand impact model which is developed as part of the Residential Baseline Study.[3]

Savings for Pipe Wrap (Water Heating):

Measure Name	ΔkWh	ΔkW	Δ MMBtu
Pipe Wrap (Water Heating), Electric (Single Family)	28	0.01	
Pipe Wrap (Water Heating), Gas (Single Family)			0.29
Pipe Wrap (Water Heating), Oil (Single Family)			0.20
Pipe Wrap (Water Heating), Other (Single Family)			0.30
Pipe Wrap (Water Heating), Electric (Attached Low Rise)	28	0.01	
Pipe Wrap (Water Heating), Gas (Attached Low Rise)			0.29
Pipe Wrap (Water Heating), Oil (Attached Low Rise)			0.20
Pipe Wrap (Water Heating), Other (Attached Low Rise)			0.30
Pipe Wrap (Water Heating), Electric (High Rise)	129	0.03	
Pipe Wrap (Water Heating), Gas (High Rise)			1.14
Pipe Wrap (Water Heating), Oil (High Rise)			1.14
Pipe Wrap (Water Heating), Other (High Rise)			1.14

Baseline Efficiency:

The baseline efficiency case is the existing hot water equipment.

High Efficiency:

The high efficiency case includes pipe wrap.

Measure Life:

The measure life is 15 years.[4]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Pipe Wrap (Water Heating)	RES_CD	All	15	n/a	n/a	15

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Pipe Wrap (Water Heating), Electric (Single Family)	RES_CD	All	1.00	1.00	1.00	1.00	1.00	0.31	0.84
Pipe Wrap (Water Heating), Gas (Single Family)	RES_CD	All	1.00	1.00	1.00	n/a	n/a	n/a	n/a
Pipe Wrap (Water Heating), Oil (Single Family)	RES_CD	All	1.00	1.00	1.00	n/a	n/a	n/a	n/a
Pipe Wrap (Water Heating), Other (Single Family)	RES_CD	All	1.00	1.00	1.00	n/a	n/a	n/a	n/a
Pipe Wrap (Water Heating), Electric (Attached Low Rise)	RES_CD	All	1.00	1.00	1.00	1.00	1.00	0.31	0.84
Pipe Wrap (Water Heating), Gas (Attached Low Rise)	RES_CD	All	1.00	1.00	1.00	n/a	n/a	n/a	n/a
Pipe Wrap (Water Heating), Oil (Attached Low Rise)	RES_CD	All	1.00	1.00	1.00	n/a	n/a	n/a	n/a
Pipe Wrap (Water Heating), Other (Attached Low Rise)	RES_CD	All	1.00	1.00	1.00	n/a	n/a	n/a	n/a
Pipe Wrap (Water Heating), Electric (High Rise)	RES_CD	All	1.00	1.00	1.00	1.00	1.00	0.31	0.84
Pipe Wrap (Water Heating), Gas (High Rise)	RES_CD	All	1.00	1.00	1.00	n/a	n/a	n/a	n/a

| Pipe Wrap (Water Heating), Oil (High Rise) | RES_CD | All | 1.00 | 1.00 | 1.00 | n/a | n/a | n/a | n/a |
| Pipe Wrap (Water Heating), Other (High Rise) | RES_CD | All | 1.00 | 1.00 | 1.00 | n/a | n/a | n/a | n/a |

In-Service Rates:

All installations have 100% in service rate since all PAs programs include verification of equipment installations.

Realization Rates:

The realization rates are set to 100% since deemed savings are based on evaluation results.

Coincidence Factors:

Summer and winter coincidence factors are estimated using the demand allocation methodology described in the Demand Impact Model which is developed based on the Residential Baseline Study.[5]

Impact Factors for Calculating Net Savings:

Net to gross factors are based on evaluation results.[6]

Measure Name	Core Initiative	PA	FR	SO$_P$	SO$_{NP}$	NTG
Pipe Wrap (Water Heating) (Single Family)	RES_CD	All	0.04	0.12	0.00	1.08
Pipe Wrap (Water Heating) (Attached Low Rise)	RES_CD	All	0.04	0.12	0.00	1.08
Pipe Wrap (Water Heating) (High Rise)	RES_CD	All	0.14	0.0	0.0	0.86

Non-Energy Impacts:

There are no non-energy impacts identified for this measure.

Endnotes:

1 : The Cadmus Group, Inc. (2015). Massachusetts Low Income Multifamily Impact Evaluation. CADMUS_2015_Low_Income_Multifamily_Impact_Evaluation
2 : Navigant Consulting (2018). HES Impact Evaluation. 2018_Navigant_HES_Impact_Evaluation
3 : Guidehouse (2020). Residential Baseline Study Phase 4 2020_Guidehouse_Residential_Baseline_Phase_4
4 : GDS Associates, Inc. (2007). Measure Life Report: Residential and Commercial/Industrial and HVAC Measures. GDS_2007_Measure_Life_Report_Residential_and_CI_Lighting_and_HVAC_Measures
5 : Guidehouse (2020). Residential Baseline Study Phase 4

2020_Guidehouse_Residential_Baseline_Phase_4

6 : Guidehouse (2021). Residential Programs Net-to-Gross Research of RCD and Select Products Measures: Results Memo 2021_Guidehouse_Res_NTG_Final_Results_Memo

1.56 Hot Water - Solar Hot Water

Measure Code	RES-S-HW
Market	Residential
Program Type	Retrofit, Time of Sale
Category	Hot Water

Measure Description:

Installation of Solar Hot Water in a residence with existing electric hot water.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Solar Hot Water	Residential Retail (RES_RETAIL)	EA2c340

Algorithms for Calculating Primary Energy Impact:

ΔkWh = [WHkwh_base] - [(HWHDkwh)*(1-%SHWdesign)]/(%WHsupp)]
Where
WHkwh_base = Federal standards for maximum allowable energy consumption.
HWHDkwh = The total household water heating demand in kWh.
%SHWdesign = The design percent of household water heating demand met by the solar hot water system.
%WHsupp = The efficiency of the supplemental hot water system for household water heating demand not met by the solar hot water system.

Baseline Efficiency:

WHkwh_base = (365 days/year)*(0.000293071 kWh/BTU)*(V)*(ρ)*(Cp)*(ΔT)/UEF
Where
V = Volume of hot water drawn based on draw pattern (Gallon), where V = 10 for the very-small-usage draw pattern, V= 38 for the low-usage draw pattern, V = 55 for the medium-usage draw pattern, V = 84 for high-usage draw pattern
ρ = Water density (lb/gallon) = 8.24
Cp = Specific heat of water (Btu/lb) = 1
ΔT = Difference between inlet and outlet temp (ΔT) = 67
UEF = Uniform Energy Factor (see table below)

Electric Storage Water Heater Conservation Standards[1]
Where:
Vr=Rated Storage Volume (Gallon)

Rated Storage Volume	Draw Pattern	Uniform Energy Factor
<20	Very Small	0.7836 - (0.0013 xVr)
	Low	0.8939 - (0.0008 xVr)
	Medium	0.9112 - (0.0007 xVr)
	High	0.9255 - (0.0006 xVr)
≥20 and ≤55	Very Small	0.8808 - (0.0008 xVr)
	Low	0.9254 - (0.0003 xVr)
	Medium	0.9307 - (0.0002 xVr)
	High	0.9349 - (0.0001 xVr)
>55 and ≤120	Very Small	1.9236 - (0.0011 xVr)
	Low	2.0440 - (0.0011 xVr)
	Medium	2.1171 - (0.0011 xVr)
	High	2.2418 - (0.0011 xVr)
>120	Very Small	0.6802 - (0.0003 xVr)
	Low	0.8620 - (0.0006 xVr)
	Medium	0.9042 - (0.0007 xVr)
	High	0.9437 - (0.0007 xVr)

High Efficiency:

The new system is a solar hot water heater paired with a supplemental electric water heating source.

Measure Life:

The measure life for a new solar hot water system is 20 years.[2]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Solar Hot Water	RES_RETAIL	All	20	n/a	n/a	20

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Solar Hot Water	RES_RETAIL	All	1.00	1.00	1.00	1.00	1.00	0.31	0.84

In-Service Rates:

All installations have 100% in service rate since programs include verification of equipment installations.

Realization Rates:

Realization rates are set to 100% until an evaluation occurs.

Coincidence Factors:

Summer and winter coincidence factors are estimated using the demand allocation methodology described in the Demand Impact Model which is developed based on the Residential Baseline Study.[3]

Impact Factors for Calculating Net Savings:

Net-to-Gross values are based on evaluation results.[4]

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Solar Hot Water	RES_RETAIL	All	0.30	0.12	0.00	0.82

Non-Energy Impacts:

There are no non-energy impacts identified with this measure.

Endnotes:

1 : https://www.federalregister.gov/documents/2020/05/21/2020-10564/energy-conservation-program-energy-conservation-standards-for-consumer-water-heaters
2 : GDS Associates, Inc. (2007). Measure Life Report Residential and C&I Lighting and HVAC Measures. GDS_2007_Measure_Life_Report_Residential_and_CI_Lighting_and_HVAC_Measures
3 : Guidehouse. (2020). MA Residential Baseline Study Phase 4. 2020_Guidehouse_Residential_Baseline_Phase_4
4 : Guidehouse. (2021). MA Residential Programs Net-to-Gross Research of RCD and Select Products Measures. 2021_Guidehouse_Res_NTG_Final_Results_Memo

1.57 Hot Water - Stand Alone Water Heater

Measure Code	RES-WH-SASWH
Market	Residential
Program Type	Retrofit
Category	Water Heating

Measure Description:

Stand-alone storage water heaters are high efficiency water heaters that are not combined with space heating devices.

BCR Measure IDs:

Core Initiative	Measure Name	BCR Measure ID
Water Heater, Gas Storage Water Heater (<=55 Gallons)	Residential Retail (RES_RETAIL)	GA2c026

Algorithms for Calculating Primary Energy Impact:

Savings are deemed and have been adjusted to reflect the mix of replace on failure and early replacement based on evaluation results.[1] Demand savings are derived from the demand impact model which is developed as part of the Residential Baseline Study.[2]

Measure Name	Core Initiative	Δ kWh	Δ kW	Δ MMBtu
Water Heater, Stand Alone Water Heater, Gas	RES_RETAIL	-43.0	-0.01	2.5

Baseline Efficiency:

The baseline efficiency case is a standalone tank water heater with an UEF of 0.63[3]. For the early retirement portion. the baseline efficiency is an existing 0.58[4] UEF standalone water heater.

High Efficiency:

The high efficiency case is a stand-alone storage water heater with an energy factor >= 0.66[4].

Measure Life:

The measure life is assumed to be 9 years.[5]

PA	Measure Name	Core Initiative	EUL	OYF	RUL	AML

All	Water Heater, Stand Alone Water Heater, Gas	RES_CD, RES_RETAIL	10	n/a	n/a	9

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Water Heater, Stand Alone Water Heater, Gas	RES_CD, RES_RETAIL	All	1.00	1.00	1.00	1.00	1.00	0.31	0.84

<u>**In-Service Rates:**</u>

All installations have 100% in service rate since programs include verification of equipment installations.

<u>**Realization Rates:**</u>

Realization rates are set to 100% for deemed measures.

<u>**Coincidence Factors:**</u>

Summer and winter coincidence factors are estimated using the demand allocation methodology described in the Demand Impact Model which is developed based on the Residential Baseline Study.[6]

Impact Factors for Calculating Net Savings:

Net to gross factors are based on evaluation results.[7]

Measure Name	Core Initiative	PA	FR	SOP	SONP	NTG
Water Heater, Stand Alone Water Heater, Gas	RES_RETAIL	All	0.36	0.12	0.00	0.76

No

n-Energy Impacts:

NEI values are rolled up, component values can be found in Appendix B.

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per	Annual $ per kWh	One-time $ per	Annual $ per Therm	One-time $ per

				Unit		**KWh**		**Therm**
Water Heater, Stand Alone Water Heater, Gas	RES_RETAIL	All	1.30	0.00	0.00	0.00	0.00	0.00

Endnotes:

1 : Navigant Consulting (2018). Water Heating, Boiler, and Furnace Cost Study (RES 19) Add-On Task 7: Residential Water Heater Analysis Memo and The Cadmus Group (2013). 2012 Residential Heating, Water Heating, and Cooling Equipment Evaluation: Net-to-Gross, Market Effects, and Equipment Replacement Timing. The calculation of the adjustment can be found in MA PAs (2021). 2020 Annual Report Gas HVAC and Water Heating Calculations Workbook. MA_PAs_2020 Annual Report_Gas_HVAC_WH_Calculations_GH_2021-03-08

2 : Guidehouse (2020). Residential Baseline Study Phase 4 2020_Guidehouse_Residential_Baseline_Phase_4

3 : This is the weighted average baseline UEF of the medium and high draw units based in 2016-2017 rebated units.

4 : This is the weighted average baseline UEF of the medium and high draw units based in 2016-2017 rebated units. Source for updated baseline can be found here - 2021_Guidehouse_TRM_Final_Report

4 : This is the weighted average efficient UEF of the medium and high draw units based in 2016-2017 rebated units.

5 : DOE (2008). Energy Star Residential Water Heaters: Final Criteria Analysis and The Cadmus Group (2013). 2012 Residential Heating, Water Heating, and Cooling Equipment Evaluation: Net-to-Gross, Market Effects, and Equipment Replacement Timing. The calculation of the adjustment can be found in MA PAs (2018). 2019-2021 Gas HVAC and Water Heating Calculations Workbook. MA_PAs_2020 Annual Report_Gas_HVAC_WH_Calculations_GH_2021-03-08

6 : Guidehouse (2020). Residential Baseline Study Phase 4 2020_Guidehouse_Residential_Baseline_Phase_4

7 : Guidehouse (2021). Residential Programs Net-to-Gross Research of RCD and Select Products Measures Workbook 2021_Guidehouse_Res_NTG_Final_Results_Memo

1.58 Hot Water - Thermostatic Valve

Measure Code	RES-WH-TV
Market	Residential
Program Type	Retrofit
Category	Hot Water

Measure Description:

A stand-alone valve that may be used with existing showerhead. Thermostatic shut-off valve technology is known by the trademarked name ShowerStart™.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Thermostatic Shut-off Valve, Electric (High Rise)	Residential Coordinated Delivery (RES_CD)	EA2a227
Thermostatic Shut-off Valve, Oil (High Rise)	Residential Coordinated Delivery (RES_CD)	EA2a228
Thermostatic Shut-off Valve, Other (High Rise)	Residential Coordinated Delivery (RES_CD)	EA2a229
Thermostatic Shutoff Valve, Elec	Residential Retail (RES_RETAIL)	EA2c082
Thermostatic Shutoff Valve, Gas	Residential Retail (RES_RETAIL)	EA2c083
Thermostatic Shutoff Valve, Oil	Residential Retail (RES_RETAIL)	EA2c084
Thermostatic Shutoff Valve, Other	Residential Retail (RES_RETAIL)	EA2c085
Thermostatic Shut-off Valve, Gas (High Rise)	Residential Coordinated Delivery (RES_CD)	GA2a089
Thermostatic Shut-off Valve, Gas	Residential Retail (RES_RETAIL)	GA2c033

Algorithms for Calculating Primary Energy Impact:

The unit savings are deemed based on engineering analysis.[1]

Measure Name	ΔkWh	ΔkW[2]	Δ MMBtu
Thermostatic Shut-off Valve, Electric (High Rise)	69	0.02	

Measure Name	ΔkWh	ΔkW[2]	Δ MMBtu
Thermostatic Shut-off Valve, Gas (High Rise)			0.34
Thermostatic Shut-off Valve, Oil (High Rise)			0.39
Thermostatic Shut-off Valve, Other (High Rise)			0.34
Thermostatic Shutoff Valve, Elec	76	0.02	
Thermostatic Shutoff Valve, Gas			0.38
Thermostatic Shutoff Valve, Oil			0.43
Thermostatic Shutoff Valve, Other			0.38

Baseline Efficiency:

The Baseline Efficiency case is an existing standard-flow showerhead (2.5 GPM) with no thermostatic shut-off valve.

High Efficiency:

The high efficiency case is a standard-flow showerhead (2.5 GPM) with the addition of the stand-alone thermostatic shut-off valve (the "Ladybug").

Measure Life:

The measure life is 15 years.[3]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Thermostatic Shut-off Valve	RES_CD RES_RETAIL	All	15	n/a	n/a	15

Other Resource Impacts:

In Res Retail the water savings are 621 gallons per unit. In RCD the water savings are 558 gallons per unit.[4]

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR$_E$	RR$_{NE}$	RR$_{SP}$	RR$_{WP}$	CF$_{SP}$	CF$_{WP}$
Thermostatic Shut-off Valve, Electric	RES_CD	All	1.00	1.00	1.00	1.00	1.00	0.31	0.84
Thermostatic Shut-off Valve, Gas	RES_CD	All	1.00	1.00	1.00	n/a	n/a	n/a	n/a

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Thermostatic Shut-off Valve, Oil	RES_CD	All	1.00	1.00	1.00	n/a	n/a	n/a	n/a
Thermostatic Shut-off Valve, Other	RES_CD	All	1.00	1.00	1.00	n/a	n/a	n/a	n/a
Thermostatic Shut-off Valve, Elec	RES_RETAIL	All	0.78	1.00	1.00	1.00	1.00	0.31	0.84
Thermostatic Shut-off Valve, Gas	RES_RETAIL	All	0.78	1.00	1.00	n/a	n/a	n/a	n/a
Thermostatic Shut-off Valve, Oil	RES_RETAIL	All	0.78	1.00	1.00	n/a	n/a	n/a	n/a
Thermostatic Shut-off Valve, Other	RES_RETAIL	All	0.78	1.00	1.00	n/a	n/a	n/a	n/a

In-Service Rates:
In RCD all installations have 100% in service rate. Res Retail in service rate is based on evaluation results.[5]

Realization Rates:
Realization rates are set to 100% since savings are deemed.

Coincidence Factors:
Coincidence factors are estimated using the demand allocation methodology described in the Demand Impact Model.[6]

Impact Factors for Calculating Net Savings:

Net to gross factors for High Rise based on evaluation results.[7] [8]

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Thermostatic Shut-off Valve (High Rise)	RES_CD	All	0.14	0.0	0.0	0.86
Thermostatic Shutoff Valve	RES_RETAIL	All	0.03	0.00	0.00	0.97

Non-Energy Impacts:

There are no non-energy impacts identified for this measure.

Endnotes:

1 : National Grid (2014). Review of ShowerStart evolve.
National_Grid_2014_ShowerStart_Savings_Final_2015-2-9
2 : Navigant Consulting (2018). Demand Impact Model Update.

2018_Navigant_Baseline_Loadshape_Comprehensive_Report

3 : Guidehouse (2021). Comprehensive TRM Review. 2021_Guidehouse_TRM_Final_Report

4 : National Grid (2014). Review of ShowerStart evolve.
National_Grid_2014_ShowerStart_Savings_Final_2015-2-9

5 : NMR Group Inc. (2021). Residential Products In Service Rates Memo. 2021_NMR_Products_ISR

6 : Navigant Consulting (2018). Demand Impact Model Update.
2018_Navigant_Baseline_Loadshape_Comprehensive_Report

7 : Guidehouse (2021). Residential Programs Net-to-Gross Research of RCD and Select Products
Measures Workbook 2021_Guidehouse_Res_NTG_Final_Results_Memo

8 : NMR Group, Inc. (2021). Residential Products NTG Report.
2021_NMR_Res_Products_NTG_Report

1.59 Lighting - Occupancy Sensors

Measure Code	RES-L-OS
Market	Residential
Program Type	Retrofit
Category	Lighting

Measure Description:

The installation of occupancy sensors for lighting fixtures. This measure involves installing an occupancy sensor that controls lighting fixtures and limits their use when the space is unoccupied.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Occupancy Sensor, Common Area (Attached Low Rise)	Residential Coordinated Delivery (RES_CD)	EA2a163
Occupancy Sensor, Common Area (High Rise)	Residential Coordinated Delivery (RES_CD)	EA2a247
Occupancy Sensor, Common Area (Residential End Use)	C&I Existing Building Retrofit (CI_RETRO)	EC2a098

Algorithms for Calculating Primary Energy Impact:

Unit savings are based on one of the following algorithms, as appropriate to the situation.

For on/off sensors, savings are as follows:
$\Delta kWh = (WattsControlled * Hours * SVG) / 1000$

Where:
Watts controlled = Connected load wattage controlled by Sensor
Hours = Run time of fixture before the installation of sensors
Svg = Percentage by which hours of operation are reduced due to the sensor; site specific

For high/low sensors, savings are as follows:
$\Delta kWh = ((HighWatts - LowWatts) * Hours) / 1000$

Where:
HighWatts = Full load of fixture

LowWatts = Wattage of fixture when no occupancy is detected; input by auditor, typically 50% of HighWatts

Hours = Run time of fixture (24 hours, fixtures are always on)

Baseline Efficiency:

The baseline condition for this measure is a lighting fixture that is not controlled by an occupancy sensor.

High Efficiency:

The high efficiency case is a lighting fixture that operates with connected occupancy sensors.

Measure Life:

The measure life is 10 years.

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Occupancy Sensor, Common Area	All	All	1.00	1.00	1.00	1.00	1.00	0.15	0.13

In-Service Rates:
In-service rates are set to 100% based on the assumption that all purchased units are installed

Realization Rates:
Realization rates are set to 100%.

Coincidence Factors:
Summer and winter coincidence factors are estimated using the demand allocation methodology described in the Demand Impact Model which is developed based on the Residential Baseline Study.[1]

Impact Factors for Calculating Net Savings:

Net to gross factors for Residential Coordinated Delivery are from the Guidehouse NTG evaluation.

Measure Name	Core	PA	FR	SO_P	SO_{NP}	NTG

	Initiative					
Occupancy Sensor, Common Area (Attached Low Rise) Occupancy Sensor, Common Area (High Rise) Occupancy Sensor, Common Area (Residential End Use)	RES_CD RES_CD CI_RETRO	All	0.14			0.86

Non-Energy Impacts:

NEI values are rolled up, component values can be found in Appendix B.

Measure Name	**Core Initiative**	**PA**	**Annual $ per Unit**	**One-time $ per Unit**	**Annual $ per kWh**	**One-time $ per KWh**	**Annual $ per Therm**	**One-time $ per Therm**
Occupancy Sensor, Common Area	RES_CD	All						

Endnotes:

1 : Guidehouse (2020). Residential Baseline Study Phase 4.
2020_Guidehouse_Residential_Baseline_Phase_4

1.60 Lighting - Residential

Measure Code	RES-L-LEDB
Market	Residential
Program Type	Lost Opportunity, New Construction, Retrofit
Category	Lighting

Measure Description:

The installation of Light-Emitting Diode (LED) bulbs and fixtures. LEDs offer comparable luminosity to incandescent and halogen bulbs at significantly less wattage and significantly longer lamp lifetimes.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
LED Bulb, Common Area, Other (Attached Low Rise)	Residential Coordinated Delivery (RES_CD)	EA2a159
LED Fixture, Common Area (Attached Low Rise)	Residential Coordinated Delivery (RES_CD)	EA2a160
LED Fixture, Common Area, Linear (Attached Low Rise)	Residential Coordinated Delivery (RES_CD)	EA2a161
LED Fixture, Common Area, Exterior (Attached Low Rise)	Residential Coordinated Delivery (RES_CD)	EA2a162
LED Bulb, Common Area (High Rise)	Residential Coordinated Delivery (RES_CD)	EA2a243
LED Fixture, Indoor Common Area (High Rise)	Residential Coordinated Delivery (RES_CD)	EA2a244
LED Fixture, Linear Indoor Common Area (High Rise)	Residential Coordinated Delivery (RES_CD)	EA2a245
LED Fixture, Outdoor Common Area (High Rise)	Residential Coordinated Delivery (RES_CD)	EA2a246
LED Bulb, Common Area (Residential End Use)	C&I Existing Building Retrofit (CI_RETRO)	EC2a094
LED Fixture, Indoor Common Area	C&I Existing Building Retrofit	EC2a095

Measure Name	Core Initiative	BCR Measure ID
(Residential End Use)	(CI_RETRO)	
LED Fixture, Linear Indoor Common Area (Residential End Use)	C&I Existing Building Retrofit (CI_RETRO)	EC2a096
LED Fixture, Outdoor Common Area (Residential End Usee)	C&I Existing Building Retrofit (CI_RETRO)	EC2a097
LED Bulb, Renters	Residential Retail (RES_Retail)	EA2c381
LED Bulb, Specialty, Renter	Residential Retail (RES_Retail)	EA2c382
Moderate Income Qualified - LED Bulb	Residential Retail (RES_Retail)	EA2c383
Moderate Income Qualified - LED Bulb, Specialty	Residential Retail (RES_Retail)	EA2c384
LED Bulb, Renters	Residential Retail (RES_Retail)	GA2c098
LED Bulb, Specialty, Renters	Residential Retail (RES_Retail)	GA2c099
Moderate Income Qualified - LED Bulb	Residential Retail (RES_Retail)	GA2c100
Moderate Income Qualified - LED Bulb, Specialty	Residential Retail (RES_Retail)	GA2c101

Algorithms for Calculating Primary Energy Impact:

Factors for Calculating Savings for Residential Lighting

Delta watts[1] and hours of use[2] noted in the table below for deemed measures are based on evaluation results. For vendor-calculated measures, delta watts are based on verification of pre-installation wattage, and hours of use are input by the vendor based on space type. For common area measures in multifamily buildings (labeled Attached Low Rise, High Rise, and Residential End Use), vendors reference the hours recommended in the Navigant Multifamily Impact Study[3] (see table below).

Savings are then calculated per the algorithm below.
$$\Delta kWh = ((QTY_{PRE} \times Watts_{PRE}) - (QTY_{EE} \times Watts_{EE}) \times Hours)/1000$$
$$\Delta kW = \Delta kWh \times kW/kWh$$

Where:
QTYPRE   = Quantity of pre-retrofit fixtures/bulbs
QTYEE   = Quantity of efficient fixtures/bulbs installed
WattsPRE = Rated watts of pre-retrofit fixtures/bulbs
WattsEE   = Rated watts of efficient fixtures/bulbs installed

Hours = Annual hours of operation for pre-retrofit case. Note that any reduction in hours of operation due to the addition of lighting controls are calculated separately; refer to the relevant TRM entry.

kW/kWh   = Average kW reduction per kWh reduction: 0.00025 kW/kWh[4]

Measure Name	Core Initiative	Δ Watts	Annual HOU	ΔKWh	ΔkW
LED Bulb, Common Area (Attached Low Rise) LED Fixture, Common Area (Attached Low Rise) LED Fixture, Common Area, Linear (Attached Low Rise) LED Fixture, Common Area, Exterior (Attached Low Rise) LED Bulb, Common Area (High Rise) LED Fixture, Indoor Common Area (High Rise) LED Fixture, Linear Indoor Common Area (High Rise) LED Fixture, Outdoor Common Area (High Rise)	RES_CD	Vendor Input	Varies by Space Type	Calculated	Calculated
LED Bulb, Common Area (Residential End Use) LED Fixture, Indoor Common Area (Residential End Use) LED Fixture, Linear Indoor Common Area (Residential End Use) LED Fixture, Outdoor Common Area (Residential End Use)	CI_RETRO	Vendor Input	Varies by Space Type	Calculated	Calculated
LED Bulb, Renters Moderate Income Qualified - LED Bulb	RES_Retail	38	949	36	0.01
LED Bulb, Specialty, Renters	RES_CD	29	949	27.5	0.01

Common Area Lighting HOU (Non-Income-Eligible)

Space Type	Annual HOU
Interior, Circulation	8,307
Interior, Other	4,115
Exterior	4,689
Parking Garage	8,760

Baseline Efficiency:

The baseline efficiency case for in-unit bulbs is a combination of an incandescent bulb and halogen bulb. The baseline efficiency case for all Common Area bulbs and fixtures is the existing site conditions, as identified by the vendor.

High Efficiency:

The high efficiency case is an LED.

Measure Life:

The table below includes the Expected Useful Life (amount of time the LED is physically expected to last) and Adjusted Measure Life (the amount of time that the PAs claim savings). EULs for bulbs are based on a rated lifetime of 15,000 hours, per ENERGY STAR specifications. EULs for Common Area Fixtures are based on the following rated lives: Indoor - 55,000 hours; Linear - 75,000 hours; Exterior - 50,000 hours.

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
LED Bulb, Common Area (Attached Low Rise) LED Bulb, Common Area (High Rise) LED Bulb, Common Area (Residential End Use)	RES_CD RES_CD CI_RETRO	All	3	n/a	n/a	1
LED Fixture, Common Area (Attached Low Rise); LED Fixture, Indoor Common Area (High Rise) LED Fixture, Indoor Common Area (Residential End Use)	RES_CD RES_CD CI_RETRO	All	6	n/a	n/a	6
LED Fixture, Common Area, Linear (Attached Low Rise); LED Fixture, Linear Indoor Common Area (High Rise) LED Fixture, Linear Indoor Common Area (Residential End Use)	RES_CD RES_CD CI_RETRO	All	8	n/a	n/a	8
LED Fixture, Common Area, Exterior (Attached Low Rise); LED Fixture, Outdoor Common Area (High Rise); LED Fixture, Outdoor Common Area (Residential End Use)	RES_CD RES_CD CI_RETRO	All	11	n/a	n/a	11
LED Bulb, Renters LED Bulb, Specialty, Renters Moderate Income Qualified - LED Bulb	RES_Retail	All	15	n/a	n/a	1

Moderate Income Qualified - LED Bulb, Specialty								

Other Resource Impacts:

There are no other resource impacts. Interactive effects for direct install lighting are assumed to be captured in the realization rates for insulation measures within the same program.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
LED Bulb, Common Area, (Attached Low Rise) LED Fixture, Common Area (Attached Low Rise) LED Fixture, Common Area, Linear (Attached Low Rise)	RES_CD	All	1.00	1.00	1.00	1.00	1.00	0.80	0.61
LED Bulb, Common Area (High Rise) LED Bulb, Common Area (Residential End Use) LED Fixture, Indoor Common Area (High Rise) LED Fixture, Linear Indoor Common Area (High Rise)	RES_CD CI_RETRO	All	1.00	1.00	1.00	1.00	1.00	0.80	0.61
LED Fixture, Common Area, Exterior (Attached Low Rise) LED Fixture, Outdoor Common Area (High Rise)	RES_CD	All	1.00	1.00	1.00	1.00	1.00	0.0	1.0
LED Bulb, Renters LED Bulb, Specialty, Renters Moderate Income Qualified - LED Bulb Moderate Income Qualified - LED Bulb, Specialty	RES_Retail	All	0.72	1.00	1.00	1.00	1.00	0.55	0.85

In-Service Rate:

Direct Install ISRs are 100%. The in-unit bulbs that were offered during 2023 were offered as leave-behind kits rather than direct install. Therefore, the In-service Rate from the Virtual Home Energy Assessment Study was used.[5]

Realization Rates:

Realization rates for in-unit lighting are 100% as PAs are using deemed savings. Realization rates for Common Area lighting are also 100% as vendors are using deemed HOU by space type.[6]

Coincidence Factors:

Summer and winter coincidence factors are estimated using the demand allocation methodology described in the Demand Impact Model which is developed based on the Residential Baseline Study.[7]

Impact Factors for Calculating Net Savings:

Net to gross factors for Residential Coordinated Delivery are from the "Massachusetts Residential Programs Net-to-Gross Research of RCD and Select Products Measures" evaluation.[8] Net to Gross for RCD in-unit lighting was negotiated by the PAs and EEAC Consultants.[9]

Measure Name	Core Initiative	PA	FR	SO$_P$	SO$_{NP}$	NTG
LED Bulb, Common Area (Attached Low Rise) LED Fixture, Common Area (Attached Low Rise) LED Fixture, Common Area, Linear (Attached Low Rise) LED Fixture, Common Area, Exterior (Attached Low Rise)	RES_CD	All	0.14			0.86
LED Bulb, Common Area (High Rise) LED Fixture, Indoor Common Area (High Rise) LED Fixture, Linear Indoor Common Area (High Rise) LED Fixture, Outdoor Common Area (High Rise)	RES_CD	All	0.14			0.86
LED Bulb, Common Area (Residential End Use) LED Fixture, Indoor Common Area (Residential End Use) LED Fixture, Linear Indoor Common Area (Residential End Use) LED Fixture, Outdoor Common Area (Residential End Use)	CI_RETRO	All	0.14			0.86
LED Bulb, Renters LED Bulb, Specialty, Renters	RES_RETAIL	All	0.55			0.45
Moderate Income Qualified - LED Bulb Moderate Income Qualified - LED Bulb, Specialty	RES_RETAIL	All	0.75			0.25

Non-Energy Impacts:

NEI values are rolled up, component values can be found in Appendix B.

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per KWh	Annual $ per Therm	One-time $ per Therm
LED Bulb, Common Area (Attached Low Rise)	RES_CD	All	$26/Unit. Values are applied per fixture in the BC model, and adjusted for the number of fixtures/unit.		$0.027			
LED Bulb, Common Area (High Rise) LED Bulb, Common Area (Residential End Use)	RES_CD CI_RETRO	All	$26/Unit. Values are applied per fixture in the BC model, and adjusted for the number of fixtures/unit.		$0.027			
LED Fixture, Common Area (Attached Low Rise)	RES_CD	All	$26/Unit. Values are applied per fixture in the BC model, and adjusted for the number of fixtures/unit.		$0.027			
LED Fixture, Common Area, Linear (Attached Low Rise)	RES_CD	All			$0.027			
LED Fixture, Common Area, Exterior (Attached Low Rise)	RES_CD	All			$0.027			
LED Fixture, Indoor Common Area (High Rise)	RES_CD	All	$26/Unit. Values are applied per fixture in the BC model, and adjusted for the number of fixtures/unit.		$0.027			
LED Fixture, Linear Indoor Common Area	RES_CD	All	$26/Unit. Values are applied per		$0.027			

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per KWh	Annual $ per Therm	One-time $ per Therm
(High Rise)			fixture in the BC model, and adjusted for the number of fixtures/unit.					
LED Fixture, Outdoor Common Area (High Rise)	RES_CD	All	$26/Unit. Values are applied per fixture in the BC model, and adjusted for the number of fixtures/unit.		$0.027			

Endnotes:

1 : NMR Group, Inc. (2022). RCD Lighting Memo. 2022_NMR_RCD_Lighting_Memo
2 : NMR Group, Inc. (2020). Residential Lighting Hours-of-Use Quick Hit Study (MA20R21-E). 2019_NMR_LightingHOU_Update
3 : Navigant Consulting (2018). Multi-Family Program Impact and Net-to-Gross Evaluation. 2018_Navigant_Multifamily_Program_Impact_Evaluation
4 : Guidehouse (2020). Residential Baseline Study Phase 4 2020_Guidehouse_Residential_Baseline_Phase_4
5 : Guidehouse, Inc. (2021). Residential Coordinated Delivery Virtual Home Energy Assessment Study. 2021_Guidehouse_RCD ISR 2020 Analysis_FINAL
6 : Navigant Consulting (2018). Multi-Family Program Impact and Net-to-Gross Evaluation. 2018_Navigant_Multifamily_Program_Impact_Evaluation
7 : Guidehouse (2020). Residential Baseline Study Phase 4. 2020_Guidehouse_Residential_Baseline_Phase_4
8 : Guidehouse (2021). Massachusetts Residential Programs Net-to-Gross Research of RCD and Select Products Measures. 2021_Guidehouse_MA_Res_NTG_Final_Report
9 : NMR Group, Inc. (2022). Lighting Purchase Behavior. 2022_NMR_Lighting_Purchase_Behavior_MA22R47

1.61 Motor - Heat Pump Pool Heater

Measure Code	RES-MAD-HPPH
Market	Residential
Program Type	Retrofit
Category	Motors and Drives

Measure Description:

The installation of a heat pump pool heater.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Heat Pump Pool Heater displacing electric	Residential Retail (RES_RETAIL)	EA2c387
Heat Pump Pool Heater displacing propane	Residential Retail (RES_RETAIL)	EA2c388

Algorithms for Calculating Primary Energy Impact:

The savings assumptions used for this are based on usage from the 2015 RECS using the Middle Atlantic and East North Central divisions (there were no pool heaters in the New England division data)

Propane

MMBTUs Required for Heating = 7.68[1]
MMBTUs required to heat pool = MMBTUs for Heating * Baseline Efficiency
MMBTUs required to heat pool = 8.03*83%= 6.37
Conversion to kWh = 6.37*293.07 = 1,868

Electric

MMBTUs Required for Heating = 7.68
Conversion to kWh = 7.68 * 293.07 = 2,250
kWh required to heat pool = kWh for Heating * Baseline Efficiency
kWh required to heat pool = 2,250 * 98% = 2,205

kWh required for heat pump = kWh required to heat pool / COP
kWh required for heat pump = 2,205/5.5 = 401 kWh
kWh Savings = kWh required for heating - kWh required for heat pump = 2,250 – 401 = 1,849 kWh

Demand savings are derived from the demand impact model which is developed as part of the Residential Baseline Study.[2]

Measure Name	ΔkWh	ΔkW	ΔMMBTU
Heat Pump Pool Heater displacing electric	1,849	1.95	
Heat Pump Pool Heater displacing propane	-340	-0.36	7.68

Baseline Efficiency:

The baseline efficiency case is 83% efficient propane pool heater or a 98% efficient electic pool heater.[3]

High Efficiency:

A heat pump pool heater with a COP 5.5.

Measure Life:

The measure life is 15 years.[4]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Heat Pump Pool Heater	RES_RETAIL	All	15	n/a	n/a	15

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR$_E$	RR$_{NE}$	RR$_{SP}$	RR$_{WP}$	CF$_{SP}$	CF$_{WP}$
Heat Pump Pool Heater displacing electric	RES_RETAIL	All	1.00	1.00	n/a	1.00	1.00	0.55	0.00
Heat Pump Pool Heater displacing propane	RES_RETAIL	All	1.00	1.00	n/a	1.00	1.00	0.55	0.00

In-Service Rates:
In-service rates are set to 100% based on the assumption that all purchased units are installed.

Realization Rates:
Realization rates are set to 100% as savings are deemed.

Coincidence Factor:

Summer and winter coincidence factors are estimated using the demand allocation methodology described in the Demand Impact Model which is developed based on the Residential Baseline Study.[5]

Impact Factors for Calculating Net Savings:

Measure Name	Core Initiative	PA	FR	SO$_P$	SO$_{NP}$	NTG
Heat Pump Pool Heater	RES_RETAIL	All	0.0	0.00	0.00	1.0

Non-Energy Impacts:

There are no non-energy impacts identified for this measure.

Endnotes:

1 : https://www.eia.gov/consumption/residential/data/2015/

2 : Guidehouse (2020). Residential Baseline Study Phase 4
2020_Guidehouse_Residential_Baseline_Phase_4

3 : Brookhaven National Laboratory (2009)

4 : NY and NH TRMs

5 : Guidehouse (2020). Residential Baseline Study Phase 4
2020_Guidehouse_Residential_Baseline_Phase_4

1.62 Motor - Pool Pump

Measure Code	RES-MAD-PP
Market	Residential
Program Type	Retrofit
Category	Motors and Drives

Measure Description:

The installation of an Energy Star rated pool pump.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Pool Pump (Energy Star)	Residential Retail (RES_RETAIL)	EA2c071

Algorithms for Calculating Primary Energy Impact:

Unit savings are deemed based on the following algorithms and assumptions[1] :
$\Delta kWh = UEC_{baseline} - UEC_{efficient}$
$UEC_{annual} = UEC_{day} * days$
$UEC_{day} = (hours_{low} * P_{low} + hours_{high} * P_{high})/1000$

Where:

$UEC_{baseline}$ = Unit Energy Consumption per year for the baseline condition (kWh)
$UEC_{efficient}$ = Unit Energy Consumption per year for the efficient condition (kWh)
UEC = Unit Energy Consumption per year (kWh)
days = Annual days of operation, 122 days
P_{high} = Input power at high speed (W)
$hours_{high}$ = Daily operating hours at high speed
P_{low} = Input power at high speed (W)
$hours_{low}$ = Daily operating hours at low speed
1,000 = 1,000 Watt-hours per kWh

Demand savings are derived from the demand impact model which is developed as part of the Residential Baseline Study.[2]

Measure Name	ΔkWh	ΔkW
Pool Pump	151	0.16

Baseline Efficiency:

The baseline efficiency case is pump that meets the July 2021 federal standard.[3]

High Efficiency:

The high efficiency case is an Energy Star rated pump.

Measure Life:

The measure life is 6 years.[4]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Pool pump	RES_RETAIL	All	6	n/a	n/a	6

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Pool Pump	RES_RETAIL	All	1.00	1.00	n/a	1.00	1.00	0.55	0.00

In-Service Rates:
In-service rates are set to 100% based on the assumption that all purchased units are installed.

Realization Rates:
Realization rates are set to 100% as savings are deemed.

Coincidence Factor:
Summer and winter coincidence factors are estimated using the demand allocation methodology described in the Demand Impact Model which is developed based on the Residential Baseline Study.[5]

Impact Factors for Calculating Net Savings:

Net-to-gross factors are based on evaluation study results.[6]

2022

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG

| Pool Pump | RES_RETAIL | All | 0.11 | 0.00 | 0.00 | 0.89 |

2023

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Pool Pump	RES_RETAIL	All	0.13	0.00	0.00	0.87

2024

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Pool Pump	RES_RETAIL	All	0.16	0.00	0.00	0.84

Non-Energy Impacts:

There are no non-energy impacts identified for this measure.

Endnotes:

1 : Guidehouse (2021). Pool Pump Savings Calculations. 2021_Guidehouse_Pool Pump Savings Estimate_July2021
2 : Guidehouse (2020). Residential Baseline Study Phase 4 2020_Guidehouse_Residential_Baseline_Phase_4
3 : DOE Direct Final Rule Technical Support Document https://www.regulations.gov/document/EERE-2015-BT-STD-0008-0105
4 : Guidehouse (2021). Comprehensive TRM Review. 2021_Guidehouse_TRM_Final_Report
5 : Guidehouse (2020). Residential Baseline Study Phase 4 2020_Guidehouse_Residential_Baseline_Phase_4
6 : NMR Group, Inc. (2021). Residential Products NTG Report. 2021_NMR_Res_Products_NTG_Report

1.63 Motor - Variable Frequency Drive

Measure Code	RES-MAD-VFD
Market	Residential
Program Type	Retrofit
Category	Motors and Drives

Measure Description:

This measure covers the installation of variable speed drives according to the terms and conditions stated on the statewide worksheet. The measure covers multiple end use types and building types. The installation of this measure saves energy since the power required to rotate a pump or fan at lower speeds requires less power than when rotated at full speed.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Custom - Motors & VFD	Residential Coordinated Delivery (RES_CD)	EA2a250

Algorithms for Calculating Primary Energy Impact:

$\Delta kWh = (HP)(kWh/HP)$
$\Delta kW = (HP)(kW/HP_{SP})$

Where:
HP = Rated horsepower for the impacted motor.
kWh / HP = Annual electric energy reduction based on building and equipment type. See table below.
kW / HPSP = Summer demand reduction based on building and equipment type. See table below.
kW / HPWP = Winter demand reduction based on building and equipment type. See table below.

Savings factors below already account for motor efficiency and consequently an adjustment is not required in the algorithm.

Savings Factors for VFDs[1] [2] (kWh/HP and kW/HP)

Savings Factor	Building Type	Building Exhaust Fan	Cooling Tower Fan	Chilled Water Pump	Boiler Feed Water Pump	Hot Water Circulating Pump	MAF - Make-up Air Fan	Return Fan	Supply Fan	WS Heat Pump Circulating Loop

Savings Factor	Building Type	Building Exhaust Fan	Cooling Tower Fan	Chilled Water Pump	Boiler Feed Water Pump	Hot Water Circulating Pump	MAF - Make-up Air Fan	Return Fan	Supply Fan	WS Heat Pump Circulating Loop
Annual Energy Savings Factors (kWh/HP)	Multi-Family	3202	889	1633	2340	1548	3082	1788	2033	2563
Summer Demand Savings Factors (kW/HP$_{SP}$)	Multi-Family	0.109	-0.023	0.183	0.457	0.096	0.109	0.302	0.288	0.229
Winter Demand Savings Factors (kW/HP$_{WP}$)	Multi-Family	0.109	-0.006	0.194	0.221	0.221	0.109	0.274	0.265	0.297

Baseline Efficiency:

The baseline efficiency case measure varies with equipment type. All baselines assume either a constant or 2-speed motor. Air or water volume/temperature is controlled using valves, dampers, and/or reheats.

High Efficiency:

In the high efficiency case, pump flow or fan air volume is directly controlled using downstream information. The pump or fan will automatically adjust its speed based on inputted set points and the downstream feedback it receives.

Measure Life:

The lifetime is 15 years.[3]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
VFDs (High Rise)	RES_CD	All	15	n/a	n/a	15

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR$_E$	RR$_{NE}$	RR$_{SP}$	RR$_{WP}$	CF$_{SP}$	CF$_{WP}$
VFDs (High Rise)	RES_CD	All	1.00	0.86	1.00	0.86	0.86	0.24	0.24

<u>**In-Service Rates:**</u>
All installations have 100% in service rate since all PAs programs include verification of equipment installations.

<u>**Realization Rates:**</u>
Realization rate is based on evaluation results.[4]

<u>**Coincidence Factors:**</u>
CFs for all PAs set to 1.0 since summer and winter demand savings are based on evaluation results.

Impact Factors for Calculating Net Savings:

Net to gross factors are based on evaluation results.[5]

Measure Name	Core Initiative	PA	FR	SO$_P$	SO$_{NP}$	NTG
VFDs (High Rise)	RES_CD	All	0.14	0.00	0.00	0.86

Non-Energy Impacts:

NEI values are rolled up, component values can be found in Appendix B.

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per KWh	Annual $ per Therm	One-time $ per Therm
VFD (High Rise)	RES_CD	All	$0.00	$0.00	$0.20	$0.00	$0.00	$0.00

Endnotes:

1 : For Chilled Water Pump, Hot Water Circ. Pump, Return Fan, Supply Fan, and WSHP Circ. Loop: kW and kWh /HP estimates derived from Cadmus (2012). Variable Speed Drive Loadshape Project. Prepared for the NEEP Regional Evaluation, Measurement & Verification Forum. Other drive type savings estimates based on Chan, Tumin (2010). Formulation of a Prescriptive Incentive for the VFD and Motors & VFD impact tables at NSTAR. Cadmus_2014_VSD_Loadshape_Project

2 : For Chilled Water Pump, Hot Water Circ. Pump, Return Fan, Supply Fan, and WSHP Circ. Loop: kW and kWh /HP estimates derived from Cadmus (2012). Variable Speed Drive Loadshape Project. Prepared for the NEEP Regional Evaluation, Measurement & Verification Forum. Other drive type savings estimates based on Chan, Tumin (2010). Formulation of a Prescriptive Incentive for the VFD and Motors & VFD impact tables at NSTAR.

Chan_2010_Formulation_of_a_Prescriptive_Incentive_for_the_VFD_and_Motors_and_VFD_Impact_Tables_at_NSTAR

3 : Energy & Resource Solutions (2005). Measure Life Study. ERS_2005_Measure_Life_Study

4 : Navigant Consulting (2018). Multi-Family Program Impact and Net-to-Gross Evaluation. 2018_Navigant_Multifamily_Program_Impact_Evaluation

5 : Guidehouse (2021). Residential Programs Net-to-Gross Research of RCD and Select Products. 2021_Guidehouse_MA_Res_NTG_Final_Report

1.64 Other - Codes and Standards Advocacy

Measure Code	RES-CM-CSA
Market	Residential
Program Type	Lost Opportunity, New Construction
Category	Other

Measure Description:

The MassSave Codes and Standards Advocacy program works with stakeholders to advocate for higher energy code and appliance standards. This Advocacy is on both the state and federal level.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Codes Development and Support	Residential New Homes & Renovations (RES_NH&R)	EA1a020
Standards Adoption	Residential Retail (RES_RETAIL)	EA2c343
Codes Development and Support	Residential New Homes & Renovations (RES_NH&R)	GA1a017
Standards Adoption	Residential Retail (RES_RETAIL)	GA2c079

Algorithms for Calculating Primary Energy Impact:

Savings for Program Administrator activity in the Codes and Standards Advocacy initiative will be reviewed on a case by case basis. Each activity will have its own unique level of effort and its own corresponding level of savings. 2024 savings are based on Program Administrator activity in advocating for the passage of appliance standards passed in the 2021 Climate Act. 2024 savings are based on study results and assumes a 20% attribution factor.[1] The 2022-2024 Plan Order allows the Program Administrators to use a placeholder attribution value of 10% while a study was conducted. The study was submitted to the DPU for review as part of the Program Administrator's 2022 Annual Report.[2] Savings are outlined in the tables below for the Electric and Gas Program Administrators.

Savings from Standards Adoption Efforts

PA	2024
	Savings (kWh)

PA	2024
CLC	228,514
Eversource	1,363,450
National Grid	1,513,443
Unitil	32,950
Savings (Therms)	
Berkshire Gas	3,633
Eversource Gas of Massachusetts	31,130
Eversource Gas	27,828
Liberty Utilities	5,754
National Grid	90,156
Unitil	1,499

Savings for the Codes Development and Support measure are outlined in the table below. There are no Electric PA residential savings for this measure. Savings are based on an evaluation study.[3] Savings were distributed among gas PAs based on residential customer counts.

Savings from Code Development Efforts

PA	2024 Savings (Therms)
Berkshire Gas	2,250
Eversource Gas of Massachusetts	19,054
Eversource Gas	16,960
Liberty Utilities	3,368
National Grid	54,662
Unitil	929

Baseline Efficiency:

The baseline level of efficiency will also be determined on a case-by-case basis. The baseline level of efficiency for each avenue of advocacy would correspond to the energy code or appliance standard that would have been in place without the intervention of the Program Administrators.

High Efficiency:

The high efficiency case would be the energy code or appliance standard that was advocated for by the Program Administrators.

Measure Life:

The measure life is assumed to be 20 years but could be adjusted on a case-by-case basis. Measure lives for Standards Adoption are based on evaluation results.[4]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Codes Development and Support	RES_NH&R	All	20	n/a	n/a	20
Standards Adoption, Electric	RES_RETAIL	All	6	n/a	n/a	6
Standards Adoption, Gas	RES_RETAIL	All	11	n/a	n/a	11

Other Resource Impacts:

There are no other resource impacts associated with this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RRe	RRne	RRsp	RRwp	CFsp	CFwp
Codes Development and Support	RES_NH&R	All	1.00	1.00	1.00	1.00	1.00	n/a	n/a
Standards Adoption	RES_RETAIL	All	1.00	1.00	1.00	1.00	1.00	n/a	n/a

In-Service Rates:
All PAs use 100% in service rate.

Realization Rates:
All PAs use 100% realization rates.

Coincidence Factors:
Per Statewide agreement, kW will not be claimed for this measure.

Impact Factors for Calculating Net Savings:

The net-to-gross value is assumed to be 100% but will be adjusted on a case by case basis. Each activity will have its own unique level of effort and its own corresponding net-to-gross value.

Measure Name	Core Initiative	PA	FR	SOp	SOnp	NTG
Codes Development and Support	RES_NH&R	All	0.00	0.00	0.00	1.00
Standards Adoption	RES_RETAIL	All	0.00	0.00	0.00	1.00

Non-Energy Impacts:

There are no non-energy impacts associated with this measure.

Endnotes:

1 : NMR (2023). Appliance Standards Gross Savings. 2023_NMR_MA23X12-B-ASGS_Appliance Standards Gross Savings Report_FINAL_2023
2 : NMR (2023). Standards Promulgation Attribution Report. 2023_NMR_MA22X01-B-SPA_Standards Promulgation Attribution Report FINAL_19may23
3 : NMR Group, Inc. (2020). Code Promulgation Attribution Study. 2020_NMR_Code_Promulgation_Attribution_Study
4 : NMR (2023). Appliance Standards Gross Savings. 2023_NMR_MA23X12-B-ASGS_Appliance Standards Gross Savings Report_FINAL_2023

1.65 Other - Small Equipment Electrification

Measure Code	RES-HVAC-ELEC
Market	Residential
Program Type	Lost Opportunity
Category	Other

Measure Description:

Rebates provided for the purchase of electric equipment instead of gas or propane equipment.

BCR Measure IDs:

Measure	Core Initiative	BCR Measure ID
Electric Lawnmower	Residential Retail (RES_RETAIL)	EA2c341
Electric Leaf blower	Residential Retail (RES_RETAIL)	EA2c349
Electric Trimmer	Residential Retail (RES_RETAIL)	EA2c350
Electric Chainsaw	Residential Retail (RES_RETAIL)	EA2c351

Algorithms for Calculating Primary Energy Impact:

Unit kWh savings are deemed.[1] Demand savings are derived from the demand impact model which is developed as part of the Residential Baseline Study.[2]

Measure Name	Core Initiative	ΔkWh	ΔkW
Electric Lawnmower	RES_RETAIL	-218	-0.23
Electric Leaf blower	RES_RETAIL	-28	-0.03
Electric Trimmer	RES_RETAIL	-25	-0.03
Electric Chainsaw	RES_RETAIL	-37	-0.04

Baseline Efficiency:

The baseline efficiency case for electric lawn equipment is gas powered versions of the equipment.

High Efficiency:

The high efficiency case is electric lawn equipment.

Measure Life:

The measure life is shown below.[3]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Electric Lawnmower	RES_RETAIL	All	7	n/a	n/a	7
Electric Leaf blower	RES_RETAIL	All	8	n/a	n/a	8
Electric Trimmer	RES_RETAIL	All	8	n/a	n/a	8
Electric Chainsaw	RES_RETAIL	All	8	n/a	n/a	8

Other Resource Impacts:

Measure Name	Core Initiative	PA	Gasoline (MMBTUs)[4]
Electric Lawnmower	RES_RETAIL	All	2.5
Electric Leaf blower	RES_RETAIL	All	1.4
Electric Trimmer	RES_RETAIL	All	1.4
Electric Chainsaw	RES_RETAIL	All	1.4

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Electric Lawnmower	RES_RETAIL	All	1.00	1.00	1.00	1.00	1.00	0.55	0.00
Electric Leaf blower	RES_RETAIL	All	1.00	1.00	1.00	1.00	1.00	0.55	0.00
Electric Trimmer	RES_RETAIL	All	1.00	1.00	1.00	1.00	1.00	0.55	0.00
Electric Chainsaw	RES_RETAIL	All	1.00	1.00	1.00	1.00	1.00	0.55	0.00

In-Service Rates:

The in-service rate is assumed to be 100% absent evaluation.

Realization Rates:

The realization rate is assumed to be 100% absent evaluation.

Coincidence Factors:

Summer and winter coincidence factors are estimated using the demand allocation methodology described in the Demand Impact Model which is developed based on the Residential Baseline Study.[5]

Impact Factors for Calculating Net Savings:

Measure Name	Core Initiative	PA	FR	SO$_P$	SO$_{NP}$	NTG
Electric Lawnmower	RES_RETAIL	All	0.00	0.00	0.00	1.00
Electric Leaf blower	RES_RETAIL	All	0.00	0.00	0.00	1.00
Electric Trimmer	RES_RETAIL	All	0.00	0.00	0.00	1.00
Electric Chainsaw	RES_RETAIL	All	0.00	0.00	0.00	1.00

Non-Energy Impacts:

There are no non-energy impacts for this measure.

Endnotes:

1 : Vermont Act 56 Tier III Technical Advisory Group 2020 Annual Report
2 : Guidehouse (2020). Residential Baseline Study Phase 4
2020_Guidehouse_Residential_Baseline_Phase_4
3 : Vermont Act 56 Tier III Technical Advisory Group 2020 Annual Report
4 : Vermont Act 56 Tier III Technical Advisory Group 2020 Annual Report
5 : Guidehouse (2020). Residential Baseline Study Phase 4
2020_Guidehouse_Residential_Baseline_Phase_4

1.66 Plug Load - Advanced Power Strip

Measure Code	RES-PL-APS
Market	Residential
Program Type	Retrofit
Category	Behavior

Measure Description:

Advanced power strips can automatically eliminate standby power loads of electronic peripheral devices that are not needed (DVD player, computer printer, scanner, etc.) either automatically or when an electronic control device (typically a television or personal computer) is in standby or off mode.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Smart Strip, Tier 1	Residential Coordinated Delivery (RES_CD)	EA2a008
Smart Strip, Tier 2	Residential Coordinated Delivery (RES_CD)	EA2a009
Smart Strip, Tier 1	Residential Retail (RES_RETAIL)	EA2c073
Smart Strip, Tier 2	Residential Retail (RES_RETAIL)	EA2c074
Smart Strip, Tier 1	Residential Coordinated Delivery (RES_CD)	GA2a116
Smart Strip, Tier 2	Residential Coordinated Delivery (RES_CD)	GA2a117

Algorithms for Calculating Primary Energy Impact:

Unit kWh savings are deemed based on study results.[1] Demand savings are derived from the demand impact model which is developed as part of the Residential Baseline Study.[2]

Savings for Smart Strips

Measure Name	Core Initiative	kWh	kW
Smart Strip, Tier 1	All	105	0.01
Smart Strip, Tier 2	All	207	0.02

Baseline Efficiency:

The baseline efficiency case is the customers' devices as they are currently operating.

High Efficiency:

The high efficiency case is the installation of an Advanced Power Strip.

Measure Life:

The measure life is assumed to be 5 years.

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Smart Strip	RES_CD, RES_RETAIL	All	5	n/a	n/a	5

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Smart Strip, Tier 1	RES_CD	All	0.73	0.92	n/a	0.92	0.92	1.00	1.00
Smart Strip, Tier 2	RES_CD	All	0.73	0.92	0.92	0.92	0.92	1.00	1.00
Smart Strip, Tier 1	RES_RETAIL	All	0.83	0.92	0.92	0.92	0.92	1.00	1.00
Smart Strip, Tier 2	RES_RETAIL	All	0.83	0.92	0.92	0.92	0.92	1.00	1.00

In-Service Rates:
For RCD In-Service Rates are blended and based on evaluation results.[3] [4] For Retail In-service rates are based on consumer surveys, as found in the referenced study.[5]

Realization Rates:
Realization rates account for the savings lost due to improper customer set-up/use of devices, as found in the referenced study.[6]

Coincidence Factors:
Summer and winter coincidence factors are from the referenced study.[7]

Impact Factors for Calculating Net Savings:

Net to gross factors are based on study results.[8] The study produced separate values for smart strips that were mailed as part of a VHEA and those that were left behind during an in-person HEA. The values in the table below are a weighted average where it was assumed that half would be mailed and half would be left behind in 2022-2024.

Measure	Core Initiative	PA	2022 NTG	2023 NTG	2024 NTG
Smart Strip, Tier 1	RES_CD	All	0.94	0.94	0.92

Smart Strip, Tier 2	RES_CD	All	0.94	0.94	0.92
Smart Strip, Tier 1	RES_RETAIL	All	0.91	0.90	0.88
Smart Strip, Tier 2	RES_RETAIL	All	0.91	0.90	0.88

Non-Energy Impacts:

There are no non-energy impacts identified for this measure.

Endnotes:

1 : NMR Group, Inc. (2019). Advanced Power Strip Metering Study.
2019_NMR_APSMeteringReport_Revised
2 : Guidehouse (2020). Residential Baseline Study Phase 4
2020_Guidehouse_Residential_Baseline_Phase_4
3 : Guidehouse (2021). Virtual Home Energy Assessment Study.
2021_Guidehouse_VHEA_Report_FINAL
4 : Guidehouse (2021). RCD ISR Analysis. 2021_Guidehouse_RCD ISR 2020 Analysis_FINAL
5 : NMR Group Inc. (2021). Residential Products In Service Rates Memo. 2021_NMR_Products_ISR
6 : NMR Group, Inc. (2019). Advanced Power Strip Metering Study.
2019_NMR_APSMeteringReport_Revised
7 : NMR Group, Inc. (2019). Advanced Power Strip Metering Study.
2018_NMR_APS_Metering_Report
8 : NMR Group, Inc. (2021). Residential Products NTG Report.
2021_NMR_Res_Products_NTG_Report

1.67 Refrigeration - Vending Miser

Measure Code	RES-R-VM
Market	Residential
Program Type	Retrofit
Category	Refrigeration

Measure Description:

Controls can significantly reduce the energy consumption of vending machine lighting and refrigeration systems. Qualifying controls must power down these systems during periods of inactivity but, in the case of refrigerated machines, must always maintain a cool product that meets customer expectations. This measure applies to refrigerated beverage vending machines, non-refrigerated snack vending machines, and glass front refrigerated coolers. This measure should not be applied to ENERGY STAR® qualified vending machines, as they already have built-in controls.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Vending Misers	Residential Coordinated Delivery (RES_CD)	EA2a249

Algorithms for Calculating Primary Energy Impact:

$\Delta kWh = (kWRATED)(Hours)(SAVE)$
$\Delta kW = \Delta kWh / Hours$

Where:
kWrated = Rated kW of connected equipment. See table below for default rated kW by connected equipment type.
Hours = Operating hours of the connected equipment: default of 8,760 hours
SAVE = Percent savings factor for the connected equipment. See table below for values.

Vending Machine and Cooler Controls Savings Factors[1]

Equipment Type	kWRATED	SAVE (%)	ΔkW	ΔkWh
Refrigerated Beverage Vending Machines	0.40	46	0.18	1612

Baseline Efficiency:

The baseline efficiency case is a standard efficiency refrigerated beverage vending machine without a control system capable of powering down lighting and refrigeration systems during periods of inactivity.

High Efficiency:

The high efficiency case is a standard efficiency refrigerated beverage vending machine with a control system capable of powering down lighting and refrigeration systems during periods of inactivity.

Measure Life:

The measure life is 5 years.[2]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Vending Misers	RES_CD	All	5	n/a	n/a	5

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Vending Misers	RES_CD	All	1.00	0.86	n/a	0.86	0.86	0.23	0.23

In-Service Rates:
All installations have 100% in service rate since all PAs' programs include verification of equipment installations.

Realization Rates:
Realization rates are based on evaluation study results.[3]

Coincidence Factors:
CFs based on staff estimates- assumed that savings occur during off peak hours.

Impact Factors for Calculating Net Savings:

Net to gross factors based on evaluation results.[4]

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Vending Misers	RES_CD	All	0.14	0.00	0.00	0.86

Non-Energy Impacts:

There are no non-energy impacts identified for this measure.

Endnotes:

1 : USA Technologies Energy Management Product Sheets (2006).
USA_Tech_2006_Energy_Management_Product_Sheets
2 : Energy & Resource Solutions (2005). Measure Life Study. ERS_2005_Measure_Life_Study
3 : Navigant Consulting (2018). Multi-Family Program Impact and Net-to-Gross Evaluation.
2018_Navigant_Multifamily_Program_Impact_Evaluation
4 : Guidehouse (2021). Residential Programs Net-to-Gross Research of RCD and Select Products.
2021_Guidehouse_MA_Res_NTG_Final_Report

1.68 Whole Building - Residential New Construction

Measure Code	RES-BE-RNC
Market	Residential
Program Type	New Construction
Category	Heating Ventilation and Air Conditioning, Water Heating

Measure Description:

The Residential New Construction (RNC) program and Renovations & Additions (R&A) program aim to capture lost opportunities and to drive the new homes market towards net-zero energy.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
RNC Heating (Low Rise)	Residential New Homes & Renovations (RES_NH&R)	EA1a001
RNC Cooling (Low Rise)	Residential New Homes & Renovations (RES_NH&R)	EA1a002
RNC Water Heating (Low Rise)	Residential New Homes & Renovations (RES_NH&R)	EA1a003
RNC Heating (High Rise)	Residential New Homes & Renovations (RES_NH&R)	EA1a008
RNC Cooling (High Rise)	Residential New Homes & Renovations (RES_NH&R)	EA1a009
RNC Water Heating (High Rise)	Residential New Homes & Renovations (RES_NH&R)	EA1a010
RNC Lighting (High Rise)	Residential New Homes & Renovations (RES_NH&R)	EA1a011
RNC Heating (Passive House)	Residential New Homes & Renovations (RES_NH&R)	EA1a013
RNC Cooling (Passive House)	Residential New Homes & Renovations (RES_NH&R)	EA1a014
RNC Water Heating (Passive House)	Residential New Homes & Renovations (RES_NH&R)	EA1a015

Measure Name	Core Initiative	BCR Measure ID
RNC Lighting (Passive House)	Residential New Homes & Renovations (RES_NH&R)	EA1a016
RNC Heating - All-Electric	Residential New Homes & Renovations (RES_NH&R)	EA1a018
RNC Water Heating - All-Electric	Residential New Homes & Renovations (RES_NH&R)	EA1a019
R&A Heating	Residential New Homes & Renovations (RES_NH&R)	EA1a005
R&A Cooling	Residential New Homes & Renovations (RES_NH&R)	EA1a006
R&A Water Heating	Residential New Homes & Renovations (RES_NH&R)	EA1a007
Heating (New Construction)	Residential New Homes & Renovations (RES_NH&R)	GA1a001
Cooling (New Construction)	Residential New Homes & Renovations (RES_NH&R)	GA1a002
Water Heating (New Construction)	Residential New Homes & Renovations (RES_NH&R)	GA1a003
Heating (Additions)	Residential New Homes & Renovations (RES_NH&R)	GA1a005
Cooling (Additions)	Residential New Homes & Renovations (RES_NH&R)	GA1a006
Water Heating (Additions)	Residential New Homes & Renovations (RES_NH&R)	GA1a007
Heating (High Rise)	Residential New Homes & Renovations (RES_NH&R)	GA1a008
Cooling (High Rise)	Residential New Homes & Renovations (RES_NH&R)	GA1a009
Water Heating (High Rise)	Residential New Homes & Renovations (RES_NH&R)	GA1a010
Lighting (High Rise)	Residential New Homes & Renovations (RES_NH&R)	GA1a011
Heating (Passive House)	Residential New Homes & Renovations	GA1a013

Measure Name	Core Initiative	BCR Measure ID
	(RES_NH&R)	
Cooling (Passive House)	Residential New Homes & Renovations (RES_NH&R)	GA1a014
Water Heating (Passive House)	Residential New Homes & Renovations (RES_NH&R)	GA1a015
Lighting (Passive House)	Residential New Homes & Renovations (RES_NH&R)	GA1a016

Algorithms for Calculating Primary Energy Impact:

Savings are derived from two modelling pathways within this initiative: the Low-Rise Performance Path, and the Multifamily High-Rise Performance Path.

The Program Administrators currently use vendor calculated energy savings for Low-Rise Performance Path projects.   These savings are calculated using a RESNET accredited Rating Software Tool (Ekotrope) where a user inputs a detailed set of technical data about a project, comparing as-built projected energy consumption to that of a baseline home, the User-Defined Reference Home (UDRH). This process is used to calculate electric and fossil fuel energy savings due to heating, cooling, and water heating for all homes, both single family and multifamily buildings (three stories and below).

For homes participating in the Multifamily High-Rise Path, the vendor models savings using a proprietary software. The software models the consumption of the as-built efficient building and compares that consumption to an architecturally similar building with baseline efficient equipment. The difference in consumption yields Heating, Cooling, Water Heating, and Lighting savings.

The deemed gross savings for the all-electric fuel-switch measures represent switching from an average home with baseline-efficiency propane heating and water heating consumption to a comparably-sized home with baseline-efficiency electric heating and water heating consumption.[1]   Space heating saves 60.6 MMBTU of propane with a 5,845 kWh electric penalty; water heating saves 13.5 MMBTU of propane with a 1,467 kWh electric penalty. Program attribution is adjusted using net-to-gross factors, detailed below.

Measure	kW-per-kWh
Heating	0.00073
Cooling	0.00143
Water Heating	0.00025
Lighting (High Rise)	0.00025

Baseline Efficiency:

The User-Defined Reference Home (UDRH) is used for low-rise projects. The single-family values were updated in early 2020[2] and adjustments were made for low-rise multifamily in starting in 2022.[3]

The Multifamily High-Rise baseline is evaluated separately.[4]

Starting in 2020, renovation project savings use an Industry Standard Practice (ISP) baseline, per the recommendation provided by NMR in the R&A Market Characterization Study.[5]

High Efficiency:

The high-efficiency case is represented by the specific energy characteristics of each "as-built" home completed through the program.

Measure Life:

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Heating	RES_NH&R	All	25	n/a	n/a	25
Cooling	RES_NH&R	All	25	n/a	n/a	25
Water Heating	RES_NH&R	All	15	n/a	n/a	15
Lighting (High Rise)	RES_NH&R	All	1	n/a	n/a	1

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Heating	RNH&R	All	1.00	1.00	1.00	1.00	1.00	0.00	0.43
Cooling	RNH&R	All	1.00	1.00	1.00	1.00	1.00	0.37	0.00
Water Heating	RNH&R	All	1.00	1.00	1.00	1.00	1.00	0.31	0.84
Lighting (High Rise)	RNH&R	All	1.00	1.00	1.00	1.00	1.00	0.55	0.85

In-Service Rates:
All installations have 100% in-service rate since all PA programs include verification of equipment installations.

Realization Rates:

Realization rates are 100% because energy and demand savings are custom-calculated based on project specific detail.

Coincidence Factors:

Summer and winter coincidence factors are estimated using the demand allocation methodology described in the Demand Impact Model which is developed based on the Residential Baseline Study.[6] National Grid uses custom calculated coincidence factors based on vendor-calculated project-specific detail.

Impact Factors for Calculating Net Savings:

Net to gross factors are based on evaluation results.[7] [8] [9]

The all-electric net-to-gross factors are based on the difference between the proportion of all-electric new homes built annually in Massachusetts prior to the deployment of the all-electric program offer and the proportion of all-electric new homes built annually in Massachusetts after the launch of the all-electric program offer.[10]

Measure Name	Core Initiative	PA	FR	SO$_P$	SO$_{NP}$	NTG
RNC Low Rise (2022)	RNH&R	All	0.83	0.00	0.32	0.49
RNC Low Rise (2023)	RNH&R	All	0.82	0.00	0.44	0.62
RNC Low Rise (2024)	RNH&R	All	0.82	0.00	0.38	0.56
RNC High Rise	RNH&R	All	--	--	--	0.83
RNC Passive House	RNH&R	All	--	--	--	0.90
Renovations & Additions	RNH&R	All	0.22	0.02	0.12	0.92
RNC All-Electric (2022)	RNH&R	All	--	--	--	0.20
RNC All-Electric (2023)	RNH&R	All	--	--	--	0.65
RNC All-Electric (2024)	RNH&R	All	--	--	--	0.80

Non-Energy Impacts:

NEI values are rolled up, component values can be found in Appendix B.[11] The heating values are applied based on the home's primary heating fuel.

Measure Name	Core Initiative	PA	Annual $/Unit	One-time $/Unit	Annual $/kWh	One-time $/KWh	Annual $/Therm	One-time $/Therm
Heating (New Construction)	RNH&R	All	$142.30					

Measure Name	Core Initiative	PA	Annual $/Unit	One-time $/Unit	Annual $/kWh	One-time $/KWh	Annual $/Therm	One-time $/Therm
Cooling (New Construction)	RNH&R	All						
Water Heating (New Construction)	RNH&R	All						
Heating (Renovations)	RNH&R	All	$142.30					
Cooling (Renovations)	RNH&R	All						
Water Heating (Renovations)	RNH&R	All						
Heating (High Rise)	RNH&R	All						
Cooling (High Rise)	RNH&R	All						
Water Heating (High Rise)	RNH&R	All						
Lighting (High Rise)	RNH&R	All						

Endnotes:

1 : NMR Group, Inc (2021). MA RNC UDRH Ad Hoc Memo on Standard Practice Fuel Choices for Heating and Water Heating. 2021_NMR_RNC_UDRH_Consumption_Memo
2 : NMR Group, Inc. (2019). 2019 Residential New Construction Baseline/Compliance Study. 2019_NMR_RNC-LowRise-UDRH_Baseline
3 : NMR Group Inc. (2022). Massachusetts Multifamily Low-Rise New Construction Baseline Study. 2022_NMR_RNC MF LowRise Baseline Study
4 : NMR Group Inc. (2017). Massachusetts Multifamily High Rise Baseline Study. NMR_2017_MA_MFHR_Baseline
5 : NMR Group, Inc. (2019). Renovations and Additions Market Characterization and Potential Savings Study. 2019_NMR_R&A-Market-Potential
6 : Guidehouse (2020). Residential Baseline Study Phase 4 2020_Guidehouse_Residential_Baseline_Phase_4
7 : NMR Group, Inc. (2021). Low-Rise Residential New Construction NTG Study 2021_NMR_Low_Rise_RNC_NTG
8 : NMR Group, Inc. (2021). Renovations and Additions Net-to-Gross Study 2021_NMR_Renovations_Additions_NTG
9 : NMR Group, Inc. (2021). Non Residential New Construction NTG Report. 2021_NMR_Non_Residential_New_Construction_NTG_Report
10 : NMR Group, Inc (2021). MA RNC UDRH Ad Hoc Memo on Standard Practice Fuel Choices for Heating and Water Heating. 2021_NMR_RNC_UDRH_Consumption_Memo

11 : NMR Group, Inc. (2021). Residential New Construction NEI Quick Hit Assessment. 2021_NMR_RNC_NEI_Quick Hit_Study

2 Income Eligible Efficiency Measures

2.1 Appliance - Dehumidifier

Measure Code	IE-PL-ERDH
Market	Income Eligible
Program Type	Retrofit
Category	Plug Load

Measure Description:

Rebate for the purchase of an Energy Star dehumidifier or early retirement of an existing dehumidifier.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Early Retirement Dehumidifier	Income Eligible Coordinated Delivery (IE_CD)	EB1a121

Algorithms for Calculating Primary Energy Impact:

Unit savings are deemed based on the following algorithms and assumptions:
$\Delta kWh = \text{Dehumidification Load} * ((1/EffRETIRE)-(1/EffEE))$

Where:
Dehumidification Load = Typical annual moisture removal, in Liters/year.   Average annual dehumidifictaion load is 1,520 Liters/year.[1]
EffRETIRE = Average efficiency of model being recycled, in Liters/kWh (1.6 Liters/kWh)
EffEE = Efficiency of ENERGY STAR® model, in Liters/kWh (3.3 Liters/kWh)

Demand savings are derived from the demand impact model which is developed as part of the Residential Baseline Study.[2]

Measure Name	**ΔkWh**	**ΔkW**
Early Retirement Dehumidifier	489	0.11

Baseline Efficiency:

The baseline efficiency is a unit that is approximately 8 years old, meeting the standard that was in place at the time.[3]

High Efficiency:

The high efficiency case is a new ENERGY STAR® unit.[4]

Measure Life:

The measure life is 12 years.[5]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Early Retirement Dehumidifier	IE_CD	All	12	n/a	n/a	12

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Early Retirement Dehumidifier	IE_CD	All	1.00	1.00	n/a	1.00	1.00	0.82	0.17

In-Service Rates:
In-service rates are 100% because recycled units are collected.

Realization Rates:
Realization rates are set to 100% as unit savings are deemed.

Coincidence Factors:
Summer and winter coincidence factors are estimated using the demand allocation methodology described in the Demand Impact Model which is developed based on the Residential Baseline Study.[6]

Impact Factors for Calculating Net Savings:

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Early Retirement Dehumidifier	IE_CD	All	0.00	0.00	0.00	1.00

Non-Energy Impacts:

There are no non-energy impacts identified for this measure.

Endnotes:

1 : Guidehouse (2021). Comprehensive TRM Review. 2021_Guidehouse_TRM_Final_Report

2 : Guidehouse (2020). Residential Baseline Study Phase 4
2020_Guidehouse_Residential_Baseline_Phase_4

3 : The Energy Policy Act of 2005, 42 USC §13201 et seq. Accessed at
https://www.gpo.gov/fdsys/pkg/BILLS-109hr6enr/pdf/BILLS-109hr6enr.pdf

4 : ENERGY STAR® Program Requirements Product Specification for Dehumidifiers, Version 4.0.
Accessed at
https://www.energystar.gov/sites/default/files/ENERGY%20STAR_Dehumidifiers_V4%200_Specificat
ion_Final.pdf

5 : Environmental Protection Agency (2018). Savings Calculator for ENERGY STAR Qualified
Appliances. Energy_Star_2018_Consumer_Appliance_Calc

6 : Guidehouse (2020). Residential Baseline Study Phase 4
2020_Guidehouse_Residential_Baseline_Phase_4

2.2 Appliance - Early Retirement Clothes Washer

Measure Code	IE-A-ERCW
Market	Income Eligible
Program Type	Retrofit
Category	Appliances

Measure Description:

The replacement and recycling of a working top-loading clothes washer with an agitator with an Energy Star rated washing machine.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Early Retirement CW Elec DHW & Elec Dryer	Income Eligible Coordinated Delivery (IE_CD)	EB1a123
Early Retirement CW Gas DHW & Elec Dryer	Income Eligible Coordinated Delivery (IE_CD)	EB1a124
Early Retirement CW Elec DHW & Gas Dryer	Income Eligible Coordinated Delivery (IE_CD)	EB1a125
Early Retirement CW Gas DHW & Gas Dryer	Income Eligible Coordinated Delivery (IE_CD)	EB1a127
Early Retirement CW Oil DHW & Elec Dryer	Income Eligible Coordinated Delivery (IE_CD)	EB1a126
Early Retirement CW Propane DHW & Elec Dryer	Income Eligible Coordinated Delivery (IE_CD)	EB1a128

Algorithms for Calculating Primary Energy Impact:

Unit savings are deemed based on the following algorithms and assumptions:

ΔkWh = [(Capacity x 1/IMEFbase x Ncycles) * (%CWkwhbase + %DHWkwhbase + %Dryerkwhbase)] - [(Capacity x 1/IMEFeff x Ncycles) x (%CWkwheff + %DHWkwheff + %Dryerkwheff)]
ΔMMBTUs = [(Capacity x 1/MEFbase x Ncycles) x ((%DHWffbase x r_eff) + %Dryerffbase] - [(Capacity x 1/MEFeff x Ncycles) x (%DHWffeff x r_eff) + %Dryergaseff]xMMBTU_convert

Where:

Capacity = washer volume in ft3. Existing top loading washer is 3.09 ft3, new standard efficiency top loading washer is 3.38 ft3, ENERGY STAR front loading is 3.90 ft

IMEF = Integrated Modified Energy Factor and is measured in ft3 /kWh/cycle

Ncycles = 283 loads per year[1]

%CWkwh = % of total kWh energy consumption for clothes washer operation (different for baseline and efficient unit). See table below

%DHWkwh = % of total kWh energy consumption used for water heating (different for baseline and efficient unit). See table below. If water is heated by gas or propane this is 0%

%DHWff = % of total kWh energy consumption for dryer operation (different for baseline and efficient unit). See table below. If the dryer is gas this is 0%

%Dryerkwh = % of total fossil fuel energy consumption used for water heating (different for baseline and efficient unit). See table below. If water is heated by electric this is 0%.

%Dryerff = % of total fossil fuel energy consumption for dryer operation (different for baseline and efficient unit). See table below. If the dryer is electric this is 0%.

r_eff = recovery energy factor used to account for the difference in recovery efficiencies of electric and gas/oil/propane hot water heaters. Electric water heaters are 100% efficient while other water heaters are 75% efficient. The ratio is 1.33 (100%/75%)

MMBTU_convert = Conversion factor from kWh to MMBTU is 0.003412

Efficiency Ratings and Percentage of Total Energy Consumption[2]

	% Energy used for:			IMEF	IWF	Volume
	Washer operation	**Water heating**	**Drying**	**ft3/kWh/cycle**	**gallons/cycle/ft3**	**ft3**
Existing-Top Loading CW	8%	34%	59%	0.84	9.92	3.09
New-Federal Standard Top Loading CW	5%	37%	58%	1.29	8.44	3.38
New-Energy Star Front Loading CW	8%	20%	72%	2.38	3.70	3.90

Savings from Early Retirement of Clothes Washers

Measure Name	ΔkWh	ΔkW[3]	ΔMMBtu
Early Retirement CW Elec DHW & Elec Dryer	600	0.18	0.00
Early Retirement CW Gas DHW & Elec Dryer	260.5	0.08	1.54
Early Retirement CW Elec DHW & Gas Dryer	375	0.11	0.76
Early Retirement CW Oil DHW & Elec Dryer	260.5	0.08	1.54

Early Retirement CW Gas DHW & Gas Dryer	35.7	0.01	2.31
Early Retirement CW Propane DHW & Elec Dryer	260.5	0.08	1.54

Baseline Efficiency:

It is assumed that the existing top loading clothes washer met the 2007 federal standard which was an MEF > 1.262 and WF < 9.53. This is equivalent to an IMEF of 0.84 and IWH of 9.92. A new standard efficiency clothes washer meets the federal standard for top loading washers effective 1/1/18 which requires an IMEF > 1.57 and an IWF < 6.5.

MEF is Modified Energy Factor and is measured in ft^3/kWh/cycle
WF is Water Factor and is measured in gallons/cycle/ft
IMEF is Integrated Modified Energy Factor and is measured in ft^3/kWh/cycle
IWF is Integrated Water Factor and is measured in gallons/cycle/ft^3

High Efficiency:

The new high efficiency washer is an Energy Star (Version 8.0) rated front loader washer with a minimum IMEF > 2.76 and IWF < 3.2.[4]

Measure Life:

The effective useful life of the new clothes washer is assumed to be 12 years.[5] It is assumed that without the program, Income Eligible customers would have purchased a used clothes washer meeting the 2007 federal standards, so the savings are counted for the full lifetime of the measure.

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Early Retirement CW	IE_CD	All	12	n/a	n/a	12

Other Resource Impacts:

Water savings are calculated using the following algorithm:
ΔWater (gallons) = (Capacity * (IWFbase - IWFeff)) * Ncycles
Total water savings are 4,777 gallons.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Early Retirement CW	IE_CD	All	1.00	1.00	n/a	1.00	1.00	0.42	0.56

In-Service Rates:

In-service rates are set to 100% based on the assumption that all purchased units are installed.

Realization Rates:

Realization rates are based on Massachusetts Common Assumptions.

Coincidence Factors:

Summer and winter coincidence factors are estimated using the demand allocation methodology described in the Demand Impact Model which is developed based on the Residential Baseline Study.[6]

Impact Factors for Calculating Net Savings:

Net-to-Gross values have not been studied. The default NTG is 1.00.

Measure Name	Core Initiative	PA	FR	SO$_P$	SO$_{NP}$	NTG
Early Retirement CW	IE_CD	All	0.00	0.00	0.00	1.00

Non-Energy Impacts:

NEI values are rolled up, component values can be found in Appendix B.

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per KWh	Annual $ per Therm	One-time $ per Therm
Early Retirement CW	IE_CD	All			Varies by PA	0.01		

Endnotes:

1 : DOE (2013). 10 CFR Parts 429 and 430 Energy Conservation Program: Test Procedures for Residential Clothes Dryers; Final Rule DOE_2013_Test_Procedures_for_Residential_Clothes_Dryers
2 : DOE (2012). Residential Clothes Washers Direct Final Rule Technical Support Document; Chapter 7. DOE_2012_Technical_Support_Document_Clothes_Washers
4 : New Energy Star standard as of 2/5/18
5 : Environmental Protection Agency (2018). Savings Calculator for ENERGY STAR Qualified Appliances. https://www.energystar.gov/sites/default/files/asset/document/appliance_calculator.xlsx Energy_Star_2018_Consumer_Appliance_Calc
6 : Guidehouse (2020). Residential Baseline Study Phase 4
2020_Guidehouse_Residential_Baseline_Phase_4

2.3 Appliance - Freezer Replacement

Measure Code	IE-A-FR
Market	Income Eligible
Program Type	Retrofit
Category	Appliances

Measure Description:

This measure covers the replacement of an existing inefficient freezer with a new energy efficient model

BCR Measure IDs:

Measure	Core Initiative	BCR Measure ID
Freezer Replacement (Single Family)	Income Eligible Coordinated Delivery (IE_CD)	EB1a037
Freezer Replacement (Multifamily)	Income Eligible Coordinated Delivery (IE_CD)	EB1a114

Algorithms for Calculating Primary Energy Impact:

Unit savings are deemed based on study results.[1] Demand savings are derived from the demand impact model which is developed as part of the Residential Baseline Study.[2]

Measure Name	Core Initiative	ΔkWh	ΔkW
Freezer Replacement (Single Family)	IE_CD	239	0.04
Freezer Replacement (Multifamily)	IE_CD	158	0.03

Baseline Efficiency:

The baseline efficiency case for both the replaced and baseline new freezer is represented by the existing freezer. It is assumed that low-income customers would replace their freezers with a used inefficient unit.

High Efficiency:

The high efficiency case is a new high efficiency freezer.

Measure Life:

The measure life is 12 years.[3]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Freezer Replacement (Single Family)	IE_CD	All	12	n/a	n/a	12
Freezer Replacement (Multifamily)	IE_CD	All	12	n/a	n/a	12

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Freezer Replacement (Single Family)	IE_CD	All	1.00	1.00	n/a	1.00	1.00	0.85	0.65
Freezer Replacement (Multifamily)	IE_CD	All	1.00	1.00	n/a	1.00	1.00	0.85	0.65

In-Service Rates:

All installations have 100% in service rate since all PAs programs include verification of equipment installations.

Realization Rates:
Realization rates are set to 100% since deemed savings are based on evaluation results.

Coincidence Factors:
Summer and winter coincidence factors are estimated using the demand allocation methodology described in the Demand Impact Model which is developed based on the Residential Baseline Study.[4]

Impact Factors for Calculating Net Savings:

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Freezer Replacement (Single Family)	IE_CD	All	0.00	0.00	0.00	1.00
Freezer Replacement (Multifamily)	IE_CD	All	0.00	0.00	0.00	1.00

Non-Energy Impacts:

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per kWh	Annual $ per Therm	One-time $ per Therm
Freezer Replacement (Single Family)	IE_CD	All	$1.40		Varies by PA	$0.01		
Freezer Replacement (Multifamily)	IE_CD	All	$20.29		Varies by PA	$0.01		

Endnotes:

1 : The Cadmus Group, Inc. (2012). Low Income Single Family Impact Evaluation.
CADMUS_2012_Single_Family_Low_Income_Impact_Eval
2 : Guidehouse (2020). Residential Baseline Study Phase 4
2020_Guidehouse_Residential_Baseline_Phase_4
3 : Environmental Protection Agency (2018). Savings Calculator for Energy Star Qualified Appliances.
Energy_Star_2018_Consumer_Appliance_Calc
4 : Guidehouse (2020). Residential Baseline Study Phase 4
2020_Guidehouse_Residential_Baseline_Phase_4

2.4 Appliance - Refrigerator Replacement - IE Multi-Family

Measure Code	IE-A-RR-MF
Market	Income Eligible
Program Type	Retrofit
Category	Appliances

Measure Description:

Removal of old inefficient refrigerator or freezer with the installation of new efficient refrigerator or freezer.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Refrigerator Replacement (Multifamily)	Income Eligible Coordinated Delivery (IE_CD)	EB1a115

Algorithms for Calculating Primary Energy Impact:

Unit savings are calculated using the following algorithms and assumptions:

$\Delta kWh = ((kWh_{pre} - kWh_{ES}) \times RUL/EUL) + ((kWh_{std} + kWh_{used}/2 - kWh_{ES}) \times EUL - RUL/EUL)) \times F_{occ}$

$\Delta kW = \Delta kWh \times kW/kWh$

Where:

kWh_{pre} = Annual kWh consumption of existing equipment. Value is based on metering or AHAM database. The default value is 874 kWh.

kWh_{ES} = Annual kWh consumption of new ENERGY STAR qualified refrigerator or freezer. This is from the nameplate on the new unit. The default value is 358 kWh.

STD = Average annual consumption of equipment meeting federal standard: Calculated by dividing the kWh_{ES} by 0.9 (i.e., the Energy Star units are assumed to be 10% more efficient than the kWh_{std} units). The default value is 398 kWh.

kWh_{used} = Average annual consumption of used equipment. Default value is 475 kWh.[1]

RUL = Remaining Useful life assumed to be 6 years

EUL = Estimated useful life for a new refrigerator is 12 years.[2]

F_{occ} = Occupant adjustment factor used to adjust the energy savings according to the number of occupants in the dwelling unit. See table below. Default is 2.3 occupants per tenant unit

$\Delta kWh = 330$, using the default assumptions

kW/kWh = Average kW reduction per kWh reduction: 0.00018 kW/kWh[3]

$\Delta kW = 0.06$, using the default assumptions

Occupant Adjustment Factor[4]

Number of Occupants	Focc
0 occupants	1.00
1 occupant	1.05
1.8 occupants	1.09
2 occupants	1.10
2.3 occupants	1.11
3 occupants	1.13
4 occupants	1.15
5 occupants	1.16

Baseline Efficiency:

The baseline efficiency case is an existing refrigerator for which the annual kWh may be looked up in a refrigerator database. If the manufacturer and model number are not found, the refrigerator is metered for 1.5 hours in order to determine the annual kWh.

High Efficiency:

The high efficiency case is a new more efficiency refrigerator. The manufacturer and model number is looked up in a refrigerator database to determine annual kWh.

Measure Life:

The measure life is 12 years.[5]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Refrigerator Replacement (Multifamily)	IE_CD	All	12	n/a	n/a	12

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Refrigerator Replacement (Multifamily)	IE_CD	All	1.00	1.00	n/a	1.00	1.00	0.85	0.65

In-Service Rates:

All installations have 100% in service rate since all PA programs include verification of equipment installations.

Realization Rates:

Realization rates are set to 100% since this measure has not been evaluated.

Coincidence Factors:

Summer and winter coincidence factors are estimated using the demand allocation methodology described in the Demand Impact Model which is developed based on the Residential Baseline Study.[6]

Impact Factors for Calculating Net Savings:

Measure Name	Core Initiative	PA	FR	SO$_P$	SO$_{NP}$	NTG
Refrigerator Replacement (Multifamily)	IE_CD	All	0.00	0.00	0.00	1.00

Non-Energy Impacts:

NEI values are rolled up, component values can be found in Appendix B.[7]

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per kWh	Annual $ per Therm	One-time $ per Therm
Refrigerator Replacement (Multifamily)	IE_CD	All	$20.29	$0.00	Varies by PA	$0.01	$0.00	$0.00

Endnotes:

1 : Association of Home Appliance Manufacturers (2014 Revised Feb. 2015), Technical Support Document: Early Replacement Program, (Value estimated based on Figure 9 on page 23)
2 : Environmental Protection Agency (2014). Savings Calculator for Energy Star Qualified Appliances. ENERGY_STAR_2015_Appliance_Calculator
3 : Guidehouse (2020). Residential Baseline Study Phase 4. 2020_Guidehouse_Residential_Baseline_Phase_4
4 : The Cadmus Group (2012). Massachusetts 2011 Residential Retrofit Multifamily Program Impact Analysis. CADMUS_2012_Multifamily_Impacts_Analysis_Report
5 : Environmental Protection Agency (2018). Savings Calculator for Energy Star Qualified Appliances. Energy_Star_2018_Consumer_Appliance_Calc
6 : Guidehouse (2020). Residential Baseline Study Phase 4 2020_Guidehouse_Residential_Baseline_Phase_4

7 : NMR Group, Inc., Tetra Tech (2011). Massachusetts Special and Cross-Sector Studies Area, Residential and Low-Income Non-Energy Impacts (NEI) Evaluation.
Tetra_Tech_and_NMR_2011_MA_Res_and_LI_NEI_Evaluation

2.5 Appliance - Refrigerator Replacement - IE Single Family

Measure Code	IE-A-RR-SF
Market	Income Eligible
Program Type	Retrofit
Category	Appliances

Measure Description:

Removal of old inefficient refrigerator or freezer with the installation of new efficient refrigerator or freezer.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Refrigerator Replacement (Single Family)	Income Eligible Coordinated Delivery (IE_CD)	EB1a038

Algorithms for Calculating Primary Energy Impact:

Unit savings are deemed based on study results.[1] Demand savings are derived from the demand impact model which is developed as part of the Residential Baseline Study.[2]

Measure	ΔkWh	ΔkW
Refrigerator Replacement (Single Family)	762	0.13

Baseline Efficiency:

The baseline efficiency case for both the replaced and baseline new refrigerator is an existing refrigerator. It is assumed that low-income customers would otherwise replace their refrigerators with a used inefficient unit.

High Efficiency:

The high efficiency case is a new Energy Star refrigerator.

Measure Life:

The measure life is 12 years.[3]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML

Refrigerator Replacement (Single Family)	IE_CD	All	12	n/a	n/a	12

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Refrigerator Replacement (Single Family)	IE_CD	All	1.00	1.00	n/a	1.00	1.00	0.85	0.65

In-Service Rates:
All installations have 100% in service rate since all PA programs include verification of equipment installations.

Realization Rates:
Realization rates are set to 100% since this measure has not been evaluated.

Coincidence Factors:
Summer and winter coincidence factors are estimated using the demand allocation methodology described in the Demand Impact Model which is developed based on the Residential Baseline Study.[4]

Impact Factors for Calculating Net Savings:

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Refrigerator Replacement (Single Family)	IE_CD	All	0.00	0.00	0.00	1.00

Non-Energy Impacts:

NEI values are rolled up, component values can be found in Appendix B.

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per kWh	Annual $ per Therm	One-time $ per Therm
Refrigerator Replacement (Single	IE_CD	All	$1.40	$0.00	Varies by PA	$0.01	$0.00	$0.00

Family)								

Endnotes:

1 : The Cadmus Group, Inc. (2012). Low Income Single Family Impact Evaluation.
CADMUS_2012_Single_Family_Low_Income_Impact_Eval
2 : Guidehouse (2020). Residential Baseline Study Phase 4
2020_Guidehouse_Residential_Baseline_Phase_4
3 : Environmental Protection Agency (2018). Savings Calculator for Energy Star Qualified Appliances.
Energy_Star_2018_Consumer_Appliance_Calc
4 : Guidehouse (2020). Residential Baseline Study Phase 4
2020_Guidehouse_Residential_Baseline_Phase_4

2.6 Appliance - Secondary Refrigerator/Freezer Removal

Measure Code	IE-A-AR
Market	Income Eligible
Program Type	Retrofit
Category	Appliances

Measure Description:

Removal of second working refrigerator or freezer.

BCR Measure IDs:

Measure	Core Initiative	BCR Measure ID
Appliance Removal (Single Family)	Income Eligible Coordinated Delivery (IE_CD)	EB1a039
Appliance Removal (Multifamily)	Income Eligible Coordinated Delivery (IE_CD)	EB1a113

Algorithms for Calculating Primary Energy Impact:

Unit savings are deemed based on study results.[1] Demand savings are derived from the demand impact model which is developed as part of the Residential Baseline Study.[2]

Measure Name	ΔkWh	ΔkW
Appliance Removal	874	0.15

Baseline Efficiency:

The baseline efficiency case is the old, inefficient secondary working refrigerator or freezer.

High Efficiency:

The high efficiency case assumes no replacement of secondary unit.

Measure Life:

The measure life is 5 years.[3]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Appliance Removal	IE_CD	All	5	n/a	n/a	5

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR$_E$	RR$_{NE}$	RR$_{SP}$	RR$_{WP}$	CF$_{SP}$	CF$_{WP}$
Appliance Removal	IE_CD	All	1.00	1.00	1.00	1.00	1.00	0.85	0.65

In-Service Rates:
All installations have 100% in service rate since all PAs programs include verification of equipment installations.

Realization Rates:
Realization rates are set to 100% since deemed savings are based on evaluation results.

Coincidence Factors:
Summer and winter coincidence factors are estimated using the demand allocation methodology described in the Demand Impact Model which is developed based on the Residential Baseline Study.[4]

Impact Factors for Calculating Net Savings:

Measure Name	Core Initiative	PA	FR	SO$_P$	SO$_{NP}$	NTG
Appliance Removal	IE_CD	All	0.00	0.00	0.00	1.00

Non-Energy Impacts:

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per kWh	Annual $ per Therm	One-time $ per Therm
Appliance Removal	IE_CD	All	$0.00	$0.00	Varies by PA	$0.01	$0.00	$0.00

Endnotes:

1 : The Cadmus Group, Inc. (2015). Massachusetts Low-Income Multifamily Initiative Impact Evaluation. CADMUS_2015_Low_Income_Multifamily_Impact_Evaluation
2 : Guidehouse (2020). Residential Baseline Study Phase 4
2020_Guidehouse_Residential_Baseline_Phase_4
3 : Massachusetts Common Assumption.
4 : Guidehouse (2020). Residential Baseline Study Phase 4
2020_Guidehouse_Residential_Baseline_Phase_4

2.7 Behavior - Basic Educational Measures

Measure Code	IE-A-BEM
Market	Income Eligible
Program Type	Retrofit
Category	Appliances

Measure Description:

Installation of basic educational measures during an audit to help customers become more aware of energy efficiency.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Participants (Single Family)	Income Eligible Coordinated Delivery (IE_CD)	EB1a001
TLC Kit (Single Family)	Income Eligible Coordinated Delivery (IE_CD)	EB1a278
Participants (Multifamily)	Income Eligible Coordinated Delivery (IE_CD)	EB1a277
TLC Kit (Multifamily)	Income Eligible Coordinated Delivery (IE_CD)	EB1a052
Participant, Gas	Income Eligible Coordinated Delivery (IE_CD)	GB1a001

Algorithms for Calculating Primary Energy Impact:

Unit savings are deemed based on study results.[1] Demand savings are derived from the demand impact model which is developed as part of the Residential Baseline Study.[2]

Measure Name	ΔkWh	ΔkW
TLC Kit (Single Family)	69	0.01
TLC Kit (Multifamily)	69	0.01

Baseline Efficiency:

The baseline efficiency case assumes no measures installed.

High Efficiency:

The high efficiency case includes basic educational measures such as LED nightlights, refrigerator thermostats, hot water thermostats, refrigerator coil brush, wall plate stoppers.

Measure Life:

The measure life is 5 years.[3]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
All Measures	IE_CD	All	5	n/a	n/a	5

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
TLC Kit (Single Family)	IE_CD	All	1.00	1.00	n/a	1.00	1.00	0.65	0.80
TLC Kit (Multifamily)	IE_CD	All	1.00	1.00	n/a	1.00	1.00	0.65	0.80

<u>**In-Service Rates:**</u>

All installations have 100% in service rate since all PAs programs include verification of equipment installations.

<u>**Realization Rates:**</u>

Realization rates are set to 100% since deemed savings are based on evaluation results.

<u>**Coincidence Factors:**</u>

Summer and winter coincidence factors are estimated using the demand allocation methodology described in the Demand Impact Model which is developed based on the Residential Baseline Study.[4]

Impact Factors for Calculating Net Savings:

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
TLC Kit (Single Family)	IE_CD	All	0.00	0.00	0.00	1.00
TLC Kit (Multifamily)	IE_CD	All	0.00	0.00	0.00	1.00

Non-Energy Impacts:

NEI values are rolled up, component values can be found in Appendix B.

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per kWh	Annual $ per Therm	One-time $ per Therm
TLC Kit (Single Family)	IE_CD	All	$0.00	$0.00	Varies by PA	$0.01	$0.00	$0.00
TLC Kit (Multifamily)	IE_CD	All	$0.00	$0.00	Varies by PA	$0.01	$0.00	$0.00
Participant/TLC Kit, Gas	IE_CD	All	$7.70	$0.00	$0.00	$0.00	$0.00	$0.00
Participants (Single Family)	IE_CD	All	$10.37	$0.00	$0.00	$0.00	$0.00	$0.00
Participants (Multifamily)	IE_CD	All	$7.70	$0.00	$0.00	$0.00	$0.00	$0.00

Endnotes:

1 : The Cadmus Group, Inc. (2012). Low Income Single Family Impact Evaluation
CADMUS_2012_Single_Family_Low_Income_Impact_Eval
2 : Guidehouse (2020). Residential Baseline Study Phase 4
2020_Guidehouse_Residential_Baseline_Phase_4
3 : Massachusetts Common Assumption.
4 : Guidehouse (2020). Residential Baseline Study Phase 4
2020_Guidehouse_Residential_Baseline_Phase_4

2.8 Building Shell - Air Sealing - IE Multi-Family

Measure Code	IE-BS-AS-MF
Market	Income Eligible
Program Type	Retrofit
Category	Building Shell

Measure Description:

Air sealing will decrease the infiltration of outside air through cracks and leaks in the building.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Air Sealing, Electric (Multifamily)	Income Eligible Coordinated Delivery (IE_CD)	EB1a056
Air Sealing, Oil (Multifamily)	Income Eligible Coordinated Delivery (IE_CD)	EB1a057
Air Sealing, Other (Multifamily)	Income Eligible Coordinated Delivery (IE_CD)	EB1a058
Air Sealing, Gas (Multifamily)	Income Eligible Coordinated Delivery (IE_CD)	GB1a018

Algorithms for Calculating Primary Energy Impact:

Eversource, EGMA and Liberty:

The program delivery agency uses vendor calculated energy savings for all allowed measures. These savings values are calculated with custom building simulation model software where the user inputs a set of technical data about the house and the software calculates building heating and cooling loads and other key parameters. The building model is based on thermal transfer, building gains, and a variable-based heating/cooling degree day/hour climate model. This provides an initial estimate of energy use that may be compared with actual billing data to adjust as needed for existing conditions. Then, specific recommendations for improvements are added and savings are calculated using measure-specific heat transfer algorithms.

Rather than using a fixed degree day approach, the building model estimates both heating degree days and cooling degree hours based on the actual characteristics and location of the house to determine the heating and cooling balance point temperatures. Savings from shell measures use standard U-value, area, and degree day algorithms, (see attached for details). Infiltration savings use site-specific seasonal factors to convert measured leakage to seasonal energy impacts. HVAC savings are estimated based on changes in system and/or distribution efficiency improvements, using ASHRAE 152 and BPI

recommendations as their basis. Interactivity between architectural and mechanical measures is always included, to avoid overestimating savings due to "adding" individual measure results.

All PAs except Eversource, EGMA and Liberty:

Unit savings are calculated using the following algorithms and assumptions:

$$MMBtu = (Vol \times \Delta ACH \times 0.018 \times HDD60 \times 24) / (1,000,000 * \eta heating)$$
$$kWh = MMBtu * 293.1$$
$$kW = kWh \times kW/kWh$$

Where:
Vol = [ft3]   This is the air volume of the treated space, calculated from the dimensions of the space, which could include the number of floors, the floor area per floor, and the floor-toceiling height, or the dwelling floor area and number of dwellings. The treated space can be the entire building including the common areas, or just the individual dwelling units. (Auditor Input)

ΔACH = [ºF-day]   Infiltration reduction in Air Changes per Hour, natural infiltration basis. This will typically be a default value, but the source of the assumption should be transparent and traceable, or it could come from a blower door test. (Stipulated Value or Blower Door Test)

HDD60 = Heating degree-days, base 60 from TMYx weather data. See table below.

$\eta heating$ = [AFUE, COP, thermal efficiency(%)]   Efficiency of the heating system, as determined on site (Auditor Input)

24 = Conversion factor: 24 hours per day

0.018 = [Btu/ft3- ºF]   Air heat capacity: The specific heat of air (0.24 Btu/ºF.lb) times the density of air (0.075 lb/ft3)

1,000,000 = Conversion factor: 1,000,000 Btu per MMBtu

293.1 = Conversion factor: 293.1 kWh/MMBtu

kW/kWh = Average kW reduction per kWh reduction: 0.00073 kW/kWh[1]

Hours:
Heating hours are characterized by the heating degree days for the facility. The heating degree days and cooling degree hours are looked up based on the nearest weather station to the customer, as selected by the program vendor.

TMYx - City/Station	HDD	CDH
Barnstable Muni Boa	4,241	2,159
Beverly Muni	4,736	3,799
Boston Logan Int'l Arpt	4,156	5,937
Chicopee Falls Westo	5,078	6,642
Lawrence Muni	4,607	5,009
Marthas Vineyard	4,335	2,234
Nantucket Memorial AP	3,900	448

TMYx - City/Station	HDD	CDH
New Bedford Rgnl	4,319	5,082
North Adams	5,420	3,507
Norwood Memorial	4,509	7,230
Otis ANGBb	4,440	2,420
Plymouth Municipal	4,589	4,189
Provincetown (AWOS)	4,103	1,785
Westfield Barnes Muni AP	4,916	4,796
Worchester Regional Arpt	5,082	3,207

These values have been derived from TMYx data downloaded from the Massachusetts Typical Weather - Research and Dataset Development Evaluation.[2]   The HDD values were calculated by taking the minimum and maximum temperatures for each day, and calculating a daily average.

Baseline Efficiency:

The baseline efficiency case is the existing building before the air sealing measure is implemented. The baseline building is characterized by the existing air changes per hour (ACHPRE) for multi-family facilities, which is measured prior to the implementation of the air sealing measure. This will typically be a default value of a baseline/pre-retrofit ACH =0.5.

High Efficiency:

The high efficiency case is the existing building after the air sealing measure is implemented. The high efficiency building is characterized by the new air changes per hour (ACHPOST) for multi-family facilities, which is measured after the air sealing measure is implemented. This will typically be a default value of a baseline/pre-retrofit ACH =0.4.

Measure Life:

The measure life is 15 years.[3]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Air Sealing	IE_CD	All	15	n/a	n/a	15

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Realization rates are based on study results.[4]

Measure Name	Core Initiative	PA	ISR	RR$_E$	RR$_{NE}$	RR$_{SP}$	RR$_{WP}$	CF$_{SP}$	CF$_{WP}$
Air Sealing, Electric (Multifamily)	IE_CD	All	1.00	1.00	n/a	1.00	1.00	0.00	0.43
Air Sealing, Gas (Multifamily)	IE_CD	Berkshire	1.00	n/a	0.80	n/a	n/a	n/a	n/a
Air Sealing, Gas (Multifamily)	IE_CD	Columbia	1.00	n/a	0.96	n/a	n/a	n/a	n/a
Air Sealing, Gas (Multifamily)	IE_CD	Eversource	1.00	n/a	1.05	n/a	n/a	n/a	n/a
Air Sealing, Gas (Multifamily)	IE_CD	Liberty	1.00	n/a	0.96	n/a	n/a	n/a	n/a
Air Sealing, Gas (Multifamily)	IE_CD	National Grid	1.00	n/a	0.75	n/a	n/a	n/a	n/a
Air Sealing, Gas (Multifamily)	IE_CD	Unitil	1.00	n/a	0.96	n/a	n/a	n/a	n/a
Air Sealing, Oil (Multifamily)	IE_CD	All	1.00	n/a	1.00	n/a	n/a	n/a	n/a
Air Sealing, Other (Multifamily)	IE_CD	All	1.00	n/a	1.00	n/a	n/a	n/a	n/a

In-Service Rates:
All installations have 100% in service rate since all PA programs include verification of equipment installations.

Realization Rates:
Realization rates are based on evaluation results.[5]

Coincidence Factors:
Summer and winter coincidence factors are estimated using the demand allocation methodology described in the Demand Impact Model which is developed based on the Residential Baseline Study.[6]

Impact Factors for Calculating Net Savings:

Measure Name	Core Initiative	PA	FR	SO$_P$	SO$_{NP}$	NTG
Air Sealing (Multifamily)	IE_CD	All	0.00	0.00	0.00	1.00

Non-Energy Impacts:

NEI values are rolled up, component values can be found in Appendix B.[7]

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per KWh	Annual $ per Therm	One-time $ per Therm
Air Sealing, Electric (Multifamily)	IE_CD	All	$389.29	$0.00	Varies by PA	$0.01	$0.00	$0.00
Air Sealing, Gas (Multifamily)	IE_CD	All	$389.29	$0.00	$0.00	$0.00	Varies by PA	$0.08
Air Sealing, Oil (Multifamily)	IE_CD	All	$389.29	$0.00	$0.00	$0.00	$0.00	$0.00
Air Sealing, Other (Multifamily)	IE_CD	All	$389.29	$0.00	$0.00	$0.00	$0.00	$0.00

Endnotes:

1 : Guidehouse (2020). Residential Baseline Study Phase 4
2020_Guidehouse_Residential_Baseline_Phase_4
2 : DNV (2023). Massachusetts Typical Weather – Research and Dataset Development Study.
2023_DNV_MA_TMYx-Final_Report
3 : GDS Associates, Inc. (2007). Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures.
GDS_2007_Measure_Life_Report_Residential_and_CI_Lighting_and_HVAC_Measures
4 : The Cadmus Group (2015). Massachusetts Low-Income Multifamily Initiative Impact Evaluation.
CADMUS_2015_Low_Income_Multifamily_Impact_Evaluation
5 : The Cadmus Group (2015). Massachusetts Low-Income Multifamily Initiative Impact Evaluation.
CADMUS_2015_Low_Income_Multifamily_Impact_Evaluation
6 : Guidehouse (2020). Residential Baseline Study Phase 4
2020_Guidehouse_Residential_Baseline_Phase_4
7 : NMR Group, Inc. (2021). Low Income Multifamily Non-Energy Impact Study
2021_NMR_LIMF_NEI_Study_TXC50

2.9 Building Shell - IE Window

Measure Code	IE-BS-WIN
Market	Income Eligible
Program Type	Early Replacement
Category	Building Shell

Measure Description:

Early replacement of a single pane window without a storm with a triple pane window.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Window - Electric Resistance	Income Eligible Coordinated Delivery (IE_CD)	EB1a288
Window - Heat Pump	Income Eligible Coordinated Delivery (IE_CD)	EB1a289
Window - Gas	Income Eligible Coordinated Delivery (IE_CD)	GB1a056
Window - Oil	Income Eligible Coordinated Delivery (IE_CD)	EB1a290
Window - Propane	Income Eligible Coordinated Delivery (IE_CD)	EB1a291

Algorithms for Calculating Primary Energy Impact:

Savings are calculated using the installed area of the replacement window and usage factors develop using RESFEN[1] to model different window types and heating fuels. The results of this analysis are shown in the 'Annual Energy Usage' table below, which provides the annual usage based by window type. The savings are deemed by heating fuel type per window based on the following table.

Heating Fuel Type	Gross Annual kWh Saved	Maximum Load Reduction (kW)	Savings (MMBtu / Year)
Window - Electric Resistance Heating	254	0.13	-
Window - Heat Pump*	127	0.09	-
Window - Gas Heating	7	0.01	1.3
Window - Oil/Propane Heating	7	0.01	1.3

* Heat pump savings are assumed to be half of the electric resistance savings.

Electric resistance heating savings are calculated using the following: (AEHb-AEHes3)*SqFt = 254 kWh

Fossil fuel heating savings are calculated using the following: (AGUb-AGUes3)*SqFt = 1.3 MMBtu where:

AEHb=25.35 (see Annual Energy Usage table)
AEHes3=3.64 (see Annual Energy Usage table)
AGUb=0.126 (see Annual Energy Usage table)
AGUes3=0.018 (see Annual Energy Usage table)
SqFt= Assumed 11.7 square feet of area per window based on an average window size of 31.5"x53.5"

The cooling savings are weighted assuming that 34% of homes have central cooling and 53% of homes have window ACs.[2]   The window AC savings are assumed to be 28.3% of the central cooling savings[3] calculated as follows:

Cooling early replacement savings are calculated using the following: (AECb-AECes3)*SqFt = 14.74 kWh

AECb=2.57 (see Annual Energy Usage table)
AECes3=1.35 (see Annual Energy Usage table)
SqFt= Assumed 11.7 square feet of area per window based on an average window size of 31.5"x53.5"

Annual Energy Usage

Window /Sliding Glass Door Type	U-Value	Annual Electric Heating Usage AEH (kWh/ft^2)	Annual Electric Cooling Usage AEC (kWh/ft^2)	Annual Fossil Fuel Usage AGU (MMBtu/ft^2)
Single-Pane (average of tight and leaky)	1.16	25.35	2.57	0.126
ENERGY STAR - Triple Pane	0.17	3.64	1.35	0.018

Baseline Efficiency:

The baseline efficiency case is a single pane window with or without a storm.

High Efficiency:

The high efficiency case is an ENERGY STAR® qualified triple pane window.

Measure Life:

The measure life is 25 years.[4]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Window	IE_CD	All	25	n/a	n/a	25

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Window - Electric Resistance Heating	IE_CD	All	1.00	1.00	n/a	1.00	1.00	0.33	0.43
Window - Heat Pump	IE_CD	All	1.00	1.00	n/a	1.00	1.00	0.37	0.24
Window - Gas Heating	IE_CD	All	1.00	1.00	n/a	1.00	1.00	0.37	0.00
Window - Oil/Propane Heating	IE_CD	All	1.00	1.00	n/a	1.00	1.00	0.37	0.00

In-Service Rates:

The in-service rate is assumed to be 100%.

Realization Rates:

Realization rates are based on Massachusetts Common Assumptions.

Coincidence Factors:

Summer and winter coincidence factors are estimated using demand allocation methodology described in the Demand Impact Model.[5]

Impact Factors for Calculating Net Savings:

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Window	IE_CD	All	0.00	0.00	0.00	1.00

Non-Energy Impacts:

NEI values are rolled up, component values can be found in Appendix B.[6]

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per KWh	Annual $ per Therm	One-time $ per Therm
Window	IE_CD	All	$0.19		Varies by PA	$0.01	Varies by PA	

Endnotes:

1 : Lawrence Berkeley National Laboratory, RESFEN 5.0 computer software, May 12, 2005. http://windows.lbl.gov/software.

2 : Guidehouse (2020). Residential Baseline Study Phase 4.
2020_Guidehouse_Residential_Baseline_Phase_4

3 : Nexant Market Research Inc. (2007). Market Assessment for ENERGY STAR Room Air Conditioners in Connecticut.

2 : Guidehouse (2020). Residential Baseline Study Phase 4.
2020_Guidehouse_Residential_Baseline_Phase_4

2 : Guidehouse (2020). Residential Baseline Study Phase 4.
2020_Guidehouse_Residential_Baseline_Phase_4

2 : Guidehouse (2020). Residential Baseline Study Phase 4.
2020_Guidehouse_Residential_Baseline_Phase_4

4 : GDS Associates (2007). Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures.
GDS_2007_Measure_Life_Report_Residential_and_CI_Lighting_and_HVAC_Measures

5 : Guidehouse (2020). Residential Baseline Study Phase 4
2020_Guidehouse_Residential_Baseline_Phase_4

6 : NMR Group, Inc., Tetra Tech (2011). Massachusetts Special and Cross-Sector Studies Area, Residential and Low-Income Non-Energy Impacts (NEI) Evaluation.
Tetra_Tech_and_NMR_2011_MA_Res_and_LI_NEI_Evaluation

2.10 Building Shell - Insulation - IE Multi-Family

Measure Code	IE-BS-I
Market	Income Eligible
Program Type	Retrofit
Category	Building Shell

Measure Description:

Shell insulation installed through the Home Energy Services (MassSAVE) program.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Insulation, Electric (Multifamily)	Income Eligible Coordinated Delivery (IE_CD)	EB1a059
Insulation, Oil (Multifamily)	Income Eligible Coordinated Delivery (IE_CD)	EB1a060
Insulation, Other (Multifamily)	Income Eligible Coordinated Delivery (IE_CD)	EB1a061
Insulation, Gas (Multifamily)	Income Eligible Coordinated Delivery (IE_CD)	GB1a019

Algorithms for Calculating Primary Energy Impact:

Eversource, EGMA and Liberty:

The program delivery agency uses vendor calculated energy savings for all allowed measures. These savings values are calculated with custom building simulation model software where the user inputs a set of technical data about the house and the software calculates building heating and cooling loads and other key parameters. The building model is based on thermal transfer, building gains, and a variable-based heating/cooling degree day/hour climate model. This provides an initial estimate of energy use that may be compared with actual billing data to adjust as needed for existing conditions. Then, specific recommendations for improvements are added and savings are calculated using measure-specific heat transfer algorithms.

Rather than using a fixed degree day approach, the building model estimates both heating degree days and cooling degree hours based on the actual characteristics and location of the house to determine the heating and cooling balance point temperatures. Savings from shell measures use standard U-value, area,

and degree day algorithms, (see attached for details). Infiltration savings use site-specific seasonal factors to convert measured leakage to seasonal energy impacts. HVAC savings are estimated based on changes in system and/or distribution efficiency improvements, using ASHRAE 152 and BPI recommendations as their basis. Interactivity between architectural and mechanical measures is always included, to avoid overestimating savings due to "adding" individual measure results.

kW Factors for HES Vendor Measures[1] :

Measure	kW/kWh Factor
Insulation (Electric)	0.00073
Insulation (Gas, Oil, Other FF)	0.00076

All PAs except Eversource, EGMA and Liberty:

$MMBtu = ((1/R_{exist} - 1/R_{new})*HDD * 24 * Area) / (1000000 * \eta_{heat})$
$kWh = MMBtu * 293.1$
$kW = kWh * kW/kWh_{heat}$

Where:
R_{exist} = Existing effective R-value (R-ExistingInsulation + R-Assembly),ft2-°F/Btuh
R_{new} = New total effective R-value (R-ProposedMeasure + R-ExistingInsulation+ R-Assembly), ft2-°F/Btuh
Area = Square footage of insulated area
 η_{heat} = Efficiency of the heating system (AFUE or COP)
293.1 = Conversion constant (1MMBtu = 293.1 kWh)
24   = Conversion for hours per day
HDD = Heating Degree Days; dependent on location, see table below
1,000,000 = Conversion from Btu to MMBtu
kW/kWh_{heat} = Average annual kW reduction per kWh reduction: 0.00073 kW/kWh

 If Facility has central cooling then also calculate air conditioning savings:

$kWh_{cool} = ((1/R_{exist} - 1/R_{new}) * CDH * DUA * Area) / (1000 Btu/kBtu * \eta cool)$
$kW = kWh * kW/kWh_{cool}$

Where:
R_{exist} = Existing effective R-value (R-ExistingInsulation + R-Assembly),ft2-°F/Btuh
R_{new} = New total effective R-value (R-ProposedMeasure + R-ExistingInsulation+ R-Assembly), ft2-°F/Btuh
DUA = Discretionary Use Adjustment to account for the fact that people do not always operate their air conditioning system when the outside temperature is greater than 75°F = 0.75[2]
Area = Square footage of insulated area
 $\eta cool$ = Efficiency of air conditioning equipment (SEER or EER)
CDH = Cooling Degree Hours; dependent on location, see table below

1,000,000 = Conversion from Btu to MMBtu

kW/kWh$_{cool}$ = Average annual kW reduction per kWh reduction: 0.00073 kW/kWh

Hours:

Heating hours are characterized by the heating degree days for the facility. The heating degree days and cooling degree hours are looked up based on the nearest weather station to the customer, as selected by the program vendor.

TMYx - City/Station	HDD	CDH
Barnstable Muni Boa	4,241	2,159
Beverly Muni	4,736	3,799
Boston Logan Int'l Arpt	4,156	5,937
Chicopee Falls Westo	5,078	6,642
Lawrence Muni	4,607	5,009
Marthas Vineyard	4,335	2,234
Nantucket Memorial AP	3,900	448
New Bedford Rgnl	4,319	5,082
North Adams	5,420	3,507
Norwood Memorial	4,509	7,230
Otis ANGBb	4,440	2,420
Plymouth Municipal	4,589	4,189
Provincetown (AWOS)	4,103	1,785
Westfield Barnes Muni AP	4,916	4,796
Worchester Regional Arpt	5,082	3,207

These values have been derived from TMYx data downloaded from the Massachusetts Typical Weather - Research and Dataset Development Evaluation.[3] The HDD values were calculated by taking the minimum and maximum temperatures for each day, and calculating a daily average.

Baseline Efficiency:

The baseline efficiency case is the existing conditions of the participating household.

For high tise the baseline efficiency case is characterized by the total R-value of the existing attic, basement or sidewall (Rexisit). This is calculated as the R-value of the existing insulation, estimated by

the program contractor, plus the R-value of the ceiling, floor, or wall (for all projects: RCEILING = 3.36; RFLOOR = 6.16; RWALL = 6.65).[4]

High Efficiency:

The high efficiency case is characterized by the total R-value of the attic after the installation of additional attic, basement or sidewall insulation. This is calculated as the sum of the existing R-value (Rexisit) plus the R-value of the added insulation.

Measure Life:

The measure life is 25 years[5]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Insulation	IE_CD	All	25	n/a	n/a	25

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Insulation, Electric (Multifamily)	IE_CD	All	1.00	1.00	n/a	1.00	1.00	0.00	0.43
Insulation, Gas (Multifamily)	IE_CD	Berkshire	1.00	1.00	0.80	1.00	1.00	0.35	0.00
Insulation, Gas (Multifamily)	IE_CD	Columbia	1.00	1.00	0.96	1.00	1.00	0.35	0.00
Insulation, Gas (Multifamily)	IE_CD	Eversource	1.00	1.00	1.05	1.00	1.00	0.35	0.00
Insulation, Gas (Multifamily)	IE_CD	Liberty	1.00	1.00	0.96	1.00	1.00	0.35	0.00
Insulation, Gas (Multifamily)	IE_CD	National Grid	1.00	1.00	0.75	1.00	1.00	0.35	0.00
Insulation, Gas (Multifamily)	IE_CD	Unitil	1.00	1.00	0.96	1.00	1.00	0.35	0.00
Insulation, Oil	IE_CD	All	1.00	1.00	1.00	1.00	1.00	0.35	0.00

(Multifamily)									
Insulation, Other (Multifamily)	IE_CD	All	1.00	1.00	1.00	1.00	1.00	0.35	0.00

In-Service Rates:
All installations have 100% in service rate since all PA programs include verification of installations.

Realization Rates:
Realization rates are based on evaluation results. [6]

Coincidence Factor:
Summer and winter coincidence factors are estimated using the demand allocation methodology described in the Demand Impact Model which is developed based on the Residential Baseline Study.[7]

Impact Factors for Calculating Net Savings:

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Insulation (Multifamily)	IE_CD	All	0.00	0.00	0.00	1.00

Non-Energy Impacts:

NEI values are rolled up, component values can be found in Appendix B.[8]

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per KWh	Annual $ per Therm	One-time $ per Therm
Insulation, Electric (Multifamily)	IE_CD	All	$391.20	$0.00	Varies by PA	$0.01	$0.00	$0.00
Insulation, Gas (Multifamily)	IE_CD	All	$391.20	$0.00	$0.00	$0.00	Varies by PA	$0.08
Insulation, Oil (Multifamily)	IE_CD	All	$391.20	$0.00	$0.00	$0.00	$0.00	$0.00
Insulation, Other (Multifamily)	IE_CD	All	$391.20	$0.00	$0.00	$0.00	$0.00	$0.00

Endnotes:

1 : Guidehouse (2020). Residential Baseline Study Phase 4
2020_Guidehouse_Residential_Baseline_Phase_4
2 : The Cadmus Group (2012). Massachusetts 2011 Residential Retrofit Multifamily Program Impact Analysis. CADMUS_2012_Multifamily_Impacts_Analysis_Report
3 : DNV (2023). Massachusetts Typical Weather – Research and Dataset Development Study. 2023_DNV_MA_TMYx-Final_Report
4 : Assumptions from National Grid program vendor.
5 : GDS Associates, Inc. (2007). Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures.
GDS_2007_Measure_Life_Report_Residential_and_CI_Lighting_and_HVAC_Measures
6 : The Cadmus Group (2015). Massachusetts Low-Income Multifamily Initiative Impact Evaluation. CADMUS_2015_Low_Income_Multifamily_Impact_Evaluation
7 : Guidehouse (2020). Residential Baseline Study Phase 4
2020_Guidehouse_Residential_Baseline_Phase_4
8 : NMR Group, Inc. (2021). Low Income Multifamily Non-Energy Impact Study
2021_NMR_LIMF_NEI_Study_TXC50

2.11 Building Shell - Weatherization

Measure Code	IE-BS-W
Market	Income Eligible
Program Type	Retrofit
Category	Building Shell

Measure Description:

Installation of weatherization measures such as air sealing and insulation

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Weatherization, Electric (Single Family)	Income Eligible Coordinated Delivery (IE_CD)	EB1a002
Weatherization, Oil (Single Family)	Income Eligible Coordinated Delivery (IE_CD)	EB1a003
Weatherization, Other (Single Family)	Income Eligible Coordinated Delivery (IE_CD)	EB1a004
Air Sealing, Electric (Single Family)	Income Eligible Coordinated Delivery (IE_CD)	EB1a005
Air Sealing, Oil (Single Family)	Income Eligible Coordinated Delivery (IE_CD)	EB1a006
Air Sealing, Other (Single Family)	Income Eligible Coordinated Delivery (IE_CD)	EB1a007
Insulation, Electric (Single Family)	Income Eligible Coordinated Delivery (IE_CD)	EB1a008
Insulation, Oil (Single Family)	Income Eligible Coordinated Delivery (IE_CD)	EB1a009
Insulation, Other (Single Family)	Income Eligible Coordinated Delivery (IE_CD)	EB1a010
Weatherization, Electric (Multifamily)	Income Eligible Coordinated Delivery (IE_CD)	EB1a053
Weatherization, Oil (Multifamily)	Income Eligible Coordinated Delivery (IE_CD)	EB1a054
Weatherization, Other (Multifamily)	Income Eligible Coordinated Delivery (IE_CD)	EB1a055
Weatherization (Single Family)	Income Eligible Coordinated Delivery (IE_CD)	GB1a002
Air Sealing, Gas (Single Family)	Income Eligible Coordinated Delivery (IE_CD)	GB1a003
Insulation, Gas (Single Family)	Income Eligible Coordinated Delivery (IE_CD)	GB1a004

Algorithms for Calculating Primary Energy Impact:

Unit savings are per home and deemed based on study results.[1] Demand savings are derived from the demand impact model which is developed as part of the Residential Baseline Study.[2] All other assumptions are consistent with the Multi Family Offering.

Measure Name	PA	Energy Type	ΔkWh	ΔkW	ΔMMBtu
Weatherization, Electric (Single Family)	All	Electric	1,616	1.18	
Weatherization, Oil (Single Family)	All	Oil	377	0.60	28.1
Weatherization, Other (Single Family)	All	Propane	344	0.55	26.3
Weatherization, Gas (Single Family)	All	Gas	344	0.55	26.3
Air Sealing, Electric (Single Family)	All	Electric	501	0.37	
Air Sealing, Oil (Single Family)	All	Oil			9.9
Air Sealing, Other (Single Family)	All	Propane			10.5
Air Sealing, Gas (Single Family)	All	Gas			10.5
Insulation, Electric (Single Family)	All	Electric	1,115	0.37	
Insulation, Oil (Single Family)	All	Oil	377	0.60	18.2
Insulation, Other (Single Family)	All	Propane	344	0.55	15.8
Insulation, Gas (Single Family)	All	Gas	344	0.55	15.8

Baseline Efficiency:

The baseline efficiency case is any existing home shell measures.

High Efficiency:

The high efficiency case includes the installation of weatherization measures (air sealing & insulation).

Measure Life:

For the combined weatherization measure the measure life is 20 years.[3] For insulation the measure life is 25 years and for air sealing the measure life is 15 years.

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Air Sealing	IE_CD	All	15	n/a	n/a	15
Insulation	IE_CD	All	25	n/a	n/a	25
Weatherization	IE_CD	All	20	n/a	n/a	20

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Weatherization, Electric (Single Family)	IE_CD	All	1.00	1.00	n/a	1.00	1.00	0.00	0.43
Weatherization, Oil (Single Family)	IE_CD	All	1.00	1.00	1.00	1.00	1.00	0.35	0.00
Weatherization, Other (Single Family)	IE_CD	All	1.00	1.00	1.00	1.00	1.00	0.35	0.00
Weatherization, Gas (Single Family)	IE_CD	All	1.00	1.00	1.00	1.00	1.00	0.35	0.00
Air Sealing, Electric (Single Family)	IE_CD	All	1.00	1.00	n/a	1.00	1.00	0.00	0.43
Air Sealing, Oil (Single Family)	IE_CD	All	1.00	n/a	1.00	n/a	n/a	n/a	n/a
Air Sealing, Other (Single Family)	IE_CD	All	1.00	n/a	1.00	n/a	n/a	n/a	n/a
Air Sealing, Gas (Single Family)	IE_CD	All	1.00	n/a	1.00	n/a	n/a	n/a	n/a
Insulation, Electric (Single Family)	IE_CD	All	1.00	1.00	n/a	1.00	1.00	0.00	0.43
Insulation, Oil (Single Family)	IE_CD	All	1.00	1.00	1.00	1.00	1.00	0.35	0.00

Insulation, Other (Single Family)	IE_CD	All	1.00	1.00	1.00	1.00	1.00	0.35	0.00
Insulation, Gas (Single Family)	IE_CD	All	1.00	1.00	1.00	1.00	1.00	0.35	0.00
Weatherization, Electric (Multi Family)	IE_CD	CLC	1.00	1.00	n/a	1.00	1.00	0.00	0.43
Weatherization, Oil (Multi Family)	IE_CD	CLC	1.00	1.00	1.00	1.00	1.00	0.35	0.00
Weatherization, Propane (Multi Family)	IE_CD	CLC	1.00	1.00	1.00	1.00	1.00	0.35	0.00

In-Service Rates:

All installations have 100% in service rate since all PAs programs include verification of equipment installations.

Realization Rates:

Realization rates are set to 100% since deemed savings are based on evaluation results.

Coincidence Factors:

Summer and winter coincidence factors are estimated using the demand allocation methodology described in the Demand Impact Model which is developed based on the Residential Baseline Study.[4]

Impact Factors for Calculating Net Savings:

Measure Name	Core Initiative	PA	FR	SO$_P$	SO$_{NP}$	NTG
Weatherization, Electric (Single Family)	IE_CD	All	0.00	0.00	0.00	1.00
Weatherization, Oil (Single Family)	IE_CD	All	0.00	0.00	0.00	1.00
Weatherization, Other (Single Family)	IE_CD	All	0.00	0.00	0.00	1.00
Weatherization, Gas (Single Family)	IE_CD	All	0.00	0.00	0.00	1.00
Air Sealing, Electric (Single Family)	IE_CD	All	0.00	0.00	0.00	1.00
Air Sealing, Oil (Single Family)	IE_CD	All	0.00	0.00	0.00	1.00
Air Sealing, Other (Single Family)	IE_CD	All	0.00	0.00	0.00	1.00
Air Sealing, Gas (Single Family)	IE_CD	All	0.00	0.00	0.00	1.00

Insulation, Electric (Single Family)	IE_CD	All	0.00	0.00	0.00	1.00
Insulation, Oil (Single Family)	IE_CD	All	0.00	0.00	0.00	1.00
Insulation, Other (Single Family)	IE_CD	All	0.00	0.00	0.00	1.00
Insulation, Gas (Single Family)	IE_CD	All	0.00	0.00	0.00	1.00
Weatherization, Electric (Multi Family)	IE_CD	CLC	0.00	0.00	0.00	1.00
Weatherization, Oil (Multi Family)	IE_CD	CLC	0.00	0.00	0.00	1.00
Weatherization, Propane (Multi Family)	IE_CD	CLC	0.00	0.00	0.00	1.00

Non-Energy Impacts:

NEI values are rolled up, component values can be found in Appendix B.[5]

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per kWh	Annual $ per Therm	One-time $ per Therm
Weatherization, Electric (Single Family)	IE_CD	All	$558.21		Varies by PA	$0.01		
Weatherization, Oil (Single Family)	IE_CD	All	$558.21		Varies by PA	$0.01		
Weatherization, Other (Single Family)	IE_CD	All	$558.21		Varies by PA	$0.01		
Weatherization, Gas (Single Family)	IE_CD	All	$558.21				Varies by PA	$0.08
Air Sealing, Electric (Single Family)	IE_CD	All	$295.21		Varies by PA	$0.01		
Air Sealing, Oil (Single Family)	IE_CD	All	$295.21		Varies by PA	$0.01		
Air Sealing, Other (Single Family)	IE_CD	All	$295.21		Varies by PA	$0.01		
Air Sealing, Gas (Single Family)	IE_CD	All	$295.21				Varies by PA	$0.08
Insulation, Electric (Single Family)	IE_CD	All	$263.00		Varies by PA	$0.01		

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per kWh	Annual $ per Therm	One-time $ per Therm
Insulation, Oil (Single Family)	IE_CD	All	$263.00		Varies by PA	$0.01		
Insulation, Other (Single Family)	IE_CD	All	$263.00		Varies by PA	$0.01		
Insulation, Gas (Single Family)	IE_CD	All	$263.00				Varies by PA	$0.08
Weatherization, Electric (Multi Family)	IE_CD	CLC	$771.73		Varies by PA	$0.01		
Weatherization, Oil (Multi Family)	IE_CD	CLC	$771.73		Varies by PA	$0.01		
Weatherization, Other (Multi Family)	IE_CD	CLC	$771.73		Varies by PA	$0.01		

Endnotes:

1 : The Cadmus Group, Inc (2012). Low Income Single Family Program Impact Evaluation.
CADMUS_2012_Single_Family_Low_Income_Impact_Eval
2 : Guidehouse (2020). Residential Baseline Study Phase 4
2020_Guidehouse_Residential_Baseline_Phase_4
3 : Massachusetts Common Assumption.
4 : Guidehouse (2020). Residential Baseline Study Phase 4
2020_Guidehouse_Residential_Baseline_Phase_4
5 : NMR Group, Inc., Tetra Tech (2011). Residential and Low-Income Non-Energy Impacts (NEI)
Evaluation. Tetra_Tech_and_NMR_2011_MA_Res_and_LI_NEI_Evaluation

2.12 Custom - Income Eligible

Measure Code	IE-CM-CMIE
Market	Income Eligible
Program Type	Retrofit
Category	Custom

Measure Description:

Vendors install a variety of electric and gas measures at IE multifamily facilities. The measures covered in this entry are associated with commercial gas and electric meters. Measures include HVAC, process, and domestic hot water equipment measures.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Heating System Retrofit, Heat Pump (Single Family)	Income Eligible Coordinated Delivery (IE_CD)	EB1a015
Custom - HVAC (Multifamily)	Income Eligible Coordinated Delivery (IE_CD)	EB1a119
Custom - Hot Water (Multifamily)	Income Eligible Coordinated Delivery (IE_CD)	EB1a130
Custom - Process (Multifamily)	Income Eligible Coordinated Delivery (IE_CD)	EB1a131
Custom - Other (Multifamily)	Income Eligible Coordinated Delivery (IE_CD)	EB1a132
Boiler Reset Control, Gas (Multifamily)	Income Eligible Coordinated Delivery (IE_CD)	GB1a038
Demand Circulator (Multifamily)	Income Eligible Coordinated Delivery (IE_CD)	GB1a039
Custom - HVAC (Multifamily)	Income Eligible Coordinated Delivery (IE_CD)	GB1a066
Custom - Hot Water (Multifamily)	Income Eligible Coordinated Delivery (IE_CD)	GB1a067
Custom - Process (Multifamily)	Income Eligible Coordinated Delivery	GB1a068

	(IE_CD)	
Custom - Other (Multifamily)	Income Eligible Coordinated Delivery (IE_CD)	GB1a069

Algorithms for Calculating Primary Energy Impact:

Gross energy and demand savings estimates for custom IE Multifamily projects are calculated by approved vendors with project-specific details. Energy and demand savings calculations are based on projected or measured changes in equipment efficiencies and operating characteristics and are determined on a case-by-case basis.

Baseline Efficiency:

For retrofit projects, the baseline efficiency case is the same as the existing, or pre-retrofit, case for the facility.

High Efficiency:

The high efficiency scenario is specific to the facility and may include one or more energy efficiency measures.

Measure Life:

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Demand Circulator (Multifamily)	IE_CD	All	15	n/a	n/a	15
Boiler Reset Control, Gas (Multifamily)	IE_CD	All	15[1]	n/a	n/a	15
Custom HVAC (Multifamily)	IE_CD	All	custom	n/a	n/a	custom
Custom Hot Water (Multifamily)	IE_CD	All	custom	n/a	n/a	custom
Custom Process (Multifamily)	IE_CD	All	custom	n/a	n/a	custom
Custom Other (Multifamily)	IE_CD	All	custom	n/a	n/a	custom
Heating System Retrofit, Heat Pump (Single Family)	IE_CD	All	15	n/a	n/a	15

Other Resource Impacts:

Other resource impacts are determined on a case-by-case basis.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Gas Measures	IE_CD	Berkshire	1	n/a	0.80	n/a	n/a	n/a	n/a
Gas Measures	IE_CD	Columbia	1	n/a	0.96	n/a	n/a	n/a	n/a
Gas Measures	IE_CD	Eversource	1	n/a	1.05	n/a	n/a	n/a	n/a
Gas Measures	IE_CD	Liberty	1	n/a	0.96	n/a	n/a	n/a	n/a
Gas Measures	IE_CD	National Grid	1	n/a	0.75	n/a	n/a	n/a	n/a
Gas Measures	IE_CD	Unitil	1	n/a	0.96	n/a	n/a	n/a	n/a
Custom HVAC (Multifamily)	IE_CD	All	1.00	1.00	n/a	1.00	1.00	custom	custom
Custom Hot Water (Multifamily)	IE_CD	All	1.00	1.00	n/a	1.00	1.00	custom	custom
Custom Process (Multifamily)	IE_CD	All	1.00	1.00	n/a	1.00	1.00	custom	custom
Custom Other (Multifamily)	IE_CD	All	1.00	1.00	n/a	1.00	1.00	custom	custom
Heating System Retrofit, Heat Pump (Single Family)	IE_CD	All	1.00	1.00	n/a	1.00	1.00	0.38	0.05

<u>In-Service Rates:</u>
All installations have 100% in-service rates since all PA programs include verification of equipment installations.

<u>Realization Rates:</u>
Realization rates are based on an evaluation study.[2]

<u>Coincidence Factors:</u>
For all PAs, gross summer and winter peak coincidence factors are custom-calculated for each custom project based on project-specific information. The actual or measured coincidence factors are included in the summer and winter demand realization rates.

Impact Factors for Calculating Net Savings:

Measure Name	Core Initiative	PA	FR	SO$_P$	SO$_{NP}$	NTG
All Measures	IE_CD	All	0.00	0.00	0.00	1.00

Non-Energy Impacts:

NEI values are rolled up, component values can be found in Appendix B.[3]Custom - HVAC NEI values for Multifamily are based on 2021 results.[4]

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per kWh	Annual $ per Therm	One-time $ per Therm
Gas Measures	IE_CD	All					Varies by PA	$0.08
Electric Measures	IE_CD	All			Varies by PA	$0.01		
Heating System Retrofit, Heat Pump (Single Family)	IE_CD	All	$310.82					
Custom - HVAC	IE_CD	All	$836.39					

Endnotes:

1 : ACEEE (2006). Emerging Technologies Report: Advanced Boiler Controls. Prepared for ACEEE. ACEEE_2006_Emerging_Technologies_Report_Advanced_Boiler_Controls
2 : The Cadmus Group (2015). Massachusetts Low-Income Multifamily Initiative Impact Evaluation. CADMUS_2015_Low_Income_Multifamily_Impact_Evaluation
3 : NMR Group, Inc., Tetra Tech (2011). Residential and Low-Income Non-Energy Impacts (NEI) Evaluation. Tetra_Tech_and_NMR_2011_MA_Res_and_LI_NEI_Evaluation
4 : NMR Group, Inc. (2021). Low Income Multifamily Non-Energy Impact Study 2021_NMR_LIMF_NEI_Study_TXC50

2.13 Demand - Active Demand Reduction

Measure Code	IE-DR-ADR
Market	Income Eligible
Program Type	Active Demand Response
Category	Custom

Measure Description:

The core model for the Direct Load Control offering is focused on reducing demand during summer peak load. The design is a bring-your-own-device model, starting first with communicating thermostats controlling central air conditioning units and cooling loads. Additional eligible connected devices may include water heaters, pool pumps, and other devices. Program Administrators, through the demand response management platform, send a signal to the device during an event that causes the controller to reduce the demand of the connected device. Events are called in the summer (June - September) during afternoon and evening hours. Customers can opt-out of events; however, they may be removed from the program if they regularly do not participate. Program Administrators will seek to enroll both customers with devices already installed and customers installing devices through the energy efficiency delivery pathways during the 2022-2024 plan period.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Direct Load Control	Income Eligible Active Demand Reduction (IE_ADR)	EB1b001

Algorithms for Calculating Primary Energy Impact:

For Direct Load Control, Initial savings are based on vendor estimates, which are then adjusted by hourly load adjustment factors described below in the Impact Factors for Calculating Adjusted Gross Savings section.

Baseline Efficiency:

For Direct Load Control, evaluators determined baseline conditions using an experimental design methodology (randomly assigned treatment and control groups), or a within-subject methodology or savings adjustment factor for demand reduction events where experimental design was not possible.[1]

Summer kW savings supplied by vendors is the average of the top hour of each day in July and August on which events were called.

High Efficiency:

N/A, Active Demand Reduction does not directly increase efficiency. Direct load control does reduce energy consumption by curtailing use, but does not increase efficiency per se. Storage increases energy consumption due to round trip efficiency losses.

Measure Life:

Because Active Demand Reduction is based on Program Administrators calling demand reduction events each year, the measure life is one year.

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
All Active Demand Reduction measures	IE_ADR	All	1	n/a	n/a	1

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

For the Direct Load Control (DLC) offer, realization rates are set to 100% because hourly load adjustment factors, based on evaluation results, are used instead. Evaluators determined hourly load adjustment factors to adjust vendor-reported demand reduction based on evaluated results. The hourly load adjustment factor is 0.72 during the pre-cooling period and 0.68 during the recovery period. During the event, the hourly load adjustment factor is a function of temperature, equal to -3.06 + (0.05 x Average Temperature °F). This calculation applies under the following conditions: when the ISO-NE or PJM baseline is used, the event duration is three hours, the assumed air conditioning nameplate capacity continues to be 3.5 kW, and the average outdoor temperature is 75 degrees F or higher.[2] Benefits are calculated based on adjusted demand reduction during the peak hour of each of the 62 days in July and August. This generates an average curtailment amount and a limited scaling factor that are used to calculate demand reduction benefits.

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Direct Load Control	IE_ADR	All	1.00	1.00	1.00	1.00	1.00	1.00	0.00

Impact Factors for Calculating Net Savings:

Statewide Active Demand Reduction offerings are new in 2019 and have not yet been evaluated. Net-to-gross ratios are assumed to be 1.0 until the statewide program is evaluated.

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
All Active Demand Reduction measures	IE_ADR	All	0.00	0.00	0.00	1.00

Non-Energy Impacts:

There are no non-energy impacts identified for this measure.

Endnotes:

1 : Guidehouse (2020). 2019 Residential Wi-Fi Thermostat Direct Load Control Offering Evaluation
2019 _Guidehouse_Residential_Wi-Fi_Thermostat_DLC
2 : Guidehouse (2020). 2019 Residential Wi-Fi Thermostat Direct Load Control Offering Evaluation
2019 _Guidehouse_Residential_Wi-Fi_Thermostat_DLC

2.14 HVAC - Boiler Reset Control

Measure Code	IE-HVAC-BSC
Market	Income Eligible
Program Type	Retrofit
Category	Heating Ventilation and Air Conditioning

Measure Description:

Boiler Reset Controls are devices that automatically control boiler water temperature based on outdoor or return water temperature using a software program.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Boiler Reset Controls, Oil (Single Family)	Income Eligible Coordinated Delivery (IE_CD)	EB1a016
Boiler Reset Control, Gas (Single Family)	Income Eligible Coordinated Delivery (IE_CD)	GB1a016

Algorithms for Calculating Primary Energy Impact:

Unit savings are deemed based on study results.[1]

Measure Name	Core Initiative	ΔMMBtu/Unit
Boiler Reset Control, Oil (Single Family)	IE_CD	4.4
Boiler Reset Control, Gas (Single Family)	IE_CD	4.5

Baseline Efficiency:

The baseline efficiency case is a boiler without reset controls.

High Efficiency:

The high efficiency case is a boiler with reset controls.

Measure Life:

The measure life is 15 years.[2]

Measure Name	Core	PA	EUL	OYF	RUL	AML

	Initiative					
Boiler Reset Control, Oil (Single Family)	IE_CD	All	15	n/a	n/a	15
Boiler Reset Control, Gas (Single Family)	IE_CD	All	15	n/a	n/a	15

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR$_E$	RR$_{NE}$	RR$_{SP}$	RR$_{WP}$	CF$_{SP}$	CF$_{WP}$
Boiler Reset Control, Oil (Single Family)	IE_CD	All	1.00	n/a	1.00	n/a	n/a	n/a	n/a
Boiler Reset Control, Gas (Single Family)	IE_CD	All	1.00	n/a	1.00	n/a	n/a	n/a	n/a

In-Service Rates:

All installations have 100% in service rate since programs include verification of equipment installations.

Realization Rates:

All PAs use 100% energy realization rate. The summer and winter peak realization rates are not applicable for this measure since there are no electric savings claimed.

Coincidence Factors:

Not applicable for this measure since no electric savings are claimed.

Impact Factors for Calculating Net Savings:

Measure Name	Core Initiative	PA	FR	SO$_P$	SO$_{NP}$	NTG
Boiler Reset Control, Oil (Single Family)	IE_CD	All	0.00	0.00	0.00	1.00
Boiler Reset Control, Gas (Single Family)	IE_CD	All	0.00	0.00	0.00	1.00

Non-Energy Impacts:

NEI values are rolled up, component values can be found in Appendix B.[3]

Measure Name	Core Initiative	PA	Annual $ per	One-time $	Annual $ per	One-time $	Annual $ per	One-time $

			Unit	per Unit	kWh	per kWh	Therm	per Therm
Boiler Reset Control, Oil (Single Family)	IE_CD	All						
Boiler Reset Control, Gas (Single Family)	IE_CD	All					Varies by PA	$0.08

Endnotes:

1 : The Cadmus Group, Inc. (2012). Low Income Single Family Impact Evaluation.
CADMUS_2012_Single_Family_Low_Income_Impact_Eval
2 : ACEEE (2006). Emerging Technologies Report: Advanced Boiler Controls. Prepared for ACEEE.
ACEEE_2006_Emerging_Technologies_Report_Advanced_Boiler_Controls
3 : NMR Group, Inc., Tetra Tech (2011). Massachusetts Special and Cross-Sector Studies Area, Residential and Low-Income Non-Energy Impacts (NEI) Evaluation.
Tetra_Tech_and_NMR_2011_MA_Res_and_LI_NEI_Evaluation

2.15 HVAC - Boiler Retrofit

Measure Code	IE-HVAC-BR
Market	Income Eligible
Program Type	Retrofit
Category	Heating Ventilation and Air Conditioning

Measure Description:

Replacement of an old inefficient space heating boiler with a new boiler.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Heating System Retrofit, Boiler, Oil (Single Family)	Income Eligible Coordinated Delivery (IE_CD)	EB1a011
Heating System Retrofit, Boiler, Other (Single Family)	Income Eligible Coordinated Delivery (IE_CD)	EB1a012
Heating System Retrofit, Boiler, Gas (Single Family)	Income Eligible Coordinated Delivery (IE_CD)	GB1a005

Algorithms for Calculating Primary Energy Impact:

Unit savings are deemed based on study results.[1]

Measure Name	Energy Type	ΔMMBtu
Heating System Retrofit, Boiler, Oil (Single Family)	Oil	20.4
Heating System Retrofit, Boiler, Other (Single Family)	Propane	19.4
Heating System Retrofit, Boiler, Gas (Single Family)	Gas	19.4

Baseline Efficiency:

The baseline efficiency case is the existing inefficient boiler.

High Efficiency:

The high efficiency case is the new efficient boiler.

Measure Life:

The measure life is 23 years.[2]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Heating System Retrofit, Boiler (Single Family)	IE_CD	All	23	n/a	n/a	23

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Heating System Retrofit, Boiler (Single Family)	IE_CD	All	1.00	n/a	1.00	n/a	n/a	n/a	n/a

In-Service Rates:

All installations have 100% in service rate since all PAs programs include verification of equipment installations.

Realization Rates:

Realization rates are set to 100% since deemed savings are based on evaluation results.

Coincidence Factors:

Not applicable for this measure since no electric savings are claimed.

Impact Factors for Calculating Net Savings:

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Heating System Retrofit, Boiler (Single Family)	IE_CD	All	0.00	0.00	0.00	1.00

Non-Energy Impacts:

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per kWh	Annual $ per Therm	One-time $ per Therm
Heating System Retrofit, Boiler,	IE_CD	All	$310.82		Varies	$0.01		

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per kWh	Annual $ per Therm	One-time $ per Therm
Oil (Single Family)					by PA			
Heating System Retrofit, Boiler, Other (Single Family)	IE_CD	All	$310.82		Varies by PA	$0.01		
Heating System Retrofit, Boiler, Gas (Single Family)	IE_CD	All	$310.82				Varies by PA	$0.08

Endnotes:

1 : The Cadmus Group, Inc. (2012). Low Income Single Family Impact Evaluation.
CADMUS_2012_Single_Family_Low_Income_Impact_Eval
2 : Guidehouse (2021). Comprehensive TRM Review. 2021_Guidehouse_TRM_Final_Report

2.16 HVAC - CVEO Battery Storage Dispatch

Measure Code	IE-HVAC-CVEO-BAT
Market	Income Eligible
Program Type	Active Demand Response
Category	Heating Ventilation and Air Conditioning

BCR Measure IDs:

Measure	Core Initiative	BCR Measure ID
CVEO Storage Daily Dispatch, discharge (savings) Summer	Income Eligible Active Demand Reduction (IE_ADR)	CVEO13
CVEO Storage Daily Dispatch, charge (consumption) Summer	Income Eligible Active Demand Reduction (IE_ADR)	CVEO14
CVEO Storage Targeted Dispatch, discharge (savings) Winter	Income Eligible Active Demand Reduction (IE_ADR)	CVEO15
CVEO Storage Targeted Dispatch, charge (consumption) Winter	Income Eligible Active Demand Reduction (IE_ADR)	CVEO16

Under the Residential Storage Performance Offering, customers are incentivized to decrease demand through the discharge of energy from storage in response to a signal.

The measures in the CVEO initiative planned by CLC are consistent with the Statewide Residential Active Demand Core Initiative. CLC has not yet evaluated Battery Storage and plans to in the near future.

Algorithms for Calculating Primary Energy Impact:

For Summer Storage Daily Dispatch, unit savings are deemed based on study results.[1]
For Winter Storage Daily Dispatch, unit savings are deemed based on study results.[2]

PA	kW Savings per Battery*
National Grid - Summer	5.5
National Grid - Winter	6.9
Unitil - Summer	1.3
Unitil - Winter	8.3

---

* Savings per battery represent the average demand savings (which is equivalent to the battery discharge) during events for batteries that successfully participated.

Baseline Efficiency:

For Storage Daily Dispatch, demand and energy impacts of the energy storage are measures assuming the whole-home and solar PV data as the baseline.[3] [4]

High Efficiency:

N/A, Active Demand Reduction does not directly increase efficiency. Storage increases energy consumption due to round trip efficiency losses.

Measure Life:

Because Active Demand Reduction is based on Program Administrators calling demand reduction events each year, the measure life is one year.

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
CVEO Battery Storage	IE_ADR	CLC	1	n/a	n/a	1

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

For Storage Daily Dispatch, realization rates are set to 100% since deemed savings are based on evaluation results.[5] [6]

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Storage Daily Dispatch, discharge (savings) Summer	IE_ADR	CLC	1.00	1.00	1.00	1.00	1.00	1.00	0.00
Storage Daily Dispatch, discharge (consumption) Summer	IE_ADR	CLC	1.00	1.00	1.00	1.00	1.00	1.00	0.00
Storage Daily Dispatch, discharge (savings) Winter	IE_ADR	CLC	1.00	1.00	1.00	1.00	1.00	0.00	1.00
Storage Daily Dispatch, discharge (consumption) Winter	IE_ADR	CLC	1.00	1.00	1.00	1.00	1.00	0.00	1.00

Impact Factors for Calculating Net Savings:

Net-to-gross ratios are assumed to be 1.0 for Income Eligible measures.

Measure Name	Core Initiative	PA	FR	SO$_P$	SO$_{NP}$	NTG
CVEO Battery Storage	IE_ADR	CLC	0.00	0.00	0.00	1.00

Non-Energy Impacts:

There are no non-energy impacts identified for this measure.

Endnotes:

1 : 2020_Guidehouse_Residential_Energy_Storage_Demand_Response_Summer
2 : 2020_Guidehouse_Residential_Energy_Storage_Demand_Response_Winter_Season
3 : 2020_Guidehouse_Residential_Energy_Storage_Demand_Response_Summer
4 : 2020_Guidehouse_Residential_Energy_Storage_Demand_Response_Winter_Season
5 : 2020_Guidehouse_Residential_Energy_Storage_Demand_Response_Summer
6 : 2020_Guidehouse_Residential_Energy_Storage_Demand_Response_Winter_Season

2.17 HVAC - CVEO Solar PV

Measure Code	IE-HVAC-CVEO-SOLPV
Market	Income Eligible
Program Type	Early Replacement
Category	Heating Ventilation and Air Conditioning

BCR Measure IDs:

Measure	Core Initiative	BCR Measure ID
CVEO Solar PV	Income Eligible Coordinated Delivery (IE_CD)	CVEO12

Algorithms for Calculating Primary Energy Impact:

The annual energy (in kWh and kW) produced by the installed solar PV system, accounting for location, system size, system orientation, and capacity factor.

The kWh for a particular system can be estimated using the National Renewable Energy Laboratory ("NREL") PVWatts Calculator, available at: https://pvwatts.nrel.gov/

Baseline Efficiency:

No Solar PV

High Efficiency:

Installation of Solar

Measure Life:

The measure life for a new solar PV system is assumed to be 25 years, consistent with net metering credit availability in Massachusetts. See: https://www.mass.gov/guides/net-metering-guide,

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
CVEO Solar PV	IE_CD	CLC	25	n/a	n/a	n/a

Other Resource Impacts:

There are no other resource impacts for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}

| CVEO Solar PV | IE_CD | CLC | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 0.80 | 0.00 |

Impact Factors for Calculating Net Savings:

Net-to-Gross values are set to 100% until an evaluation occurs.

Measure Name	Core Initiative	PA	FR	SO$_P$	SO$_{NP}$	NTG
CVEO Solar PV	IE_CD	CLC	0.00	0.00	0.00	1.00

Non-Energy Impacts:

NEI values are rolled up, component values can be found in Appendix B.[1]

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per KWh	Annual $ per Therm	One-time $ per Therm
CVEO Solar PV	IE_CD	CLC	$0.00	$0.00	Varies by PA	$0.01	$0.00	$0.00

Endnotes:

1 : Tetra Tech and NMR Group, Inc. (2011). Massachusetts Special and Cross Sector Studies Area, Residential and Low-Income Non-Energy Impacts (NEI) Evaluation.
Tetra_Tech_and_NMR_2011_MA_Res_and_LI_NEI_Evaluation

2.18 HVAC - Communicating Thermostat

Measure Code	IE-HVAC-WT
Market	Income Eligible
Program Type	Retrofit
Category	Heating Ventilation and Air Conditioning

Measure Description:

A communicating thermostat which allows remote set point adjustment and control via remote application. System requires an outdoor air temperature algorithm in the control logic to operate heating and cooling systems.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Wi-Fi Thermostat, AC Only (Single Family)	Income Eligible Coordinated Delivery (IE_CD)	EB1a044
Wi-Fi Thermostat, Gas (Single Family)	Income Eligible Coordinated Delivery (IE_CD)	EB1a045
Wi-Fi Thermostat, Oil (Single Family)	Income Eligible Coordinated Delivery (IE_CD)	EB1a047
Wi-Fi Thermostat, Other (Single Family)	Income Eligible Coordinated Delivery (IE_CD)	EB1a049
Wi-Fi Thermostat, AC Only (Multifamily)	Income Eligible Coordinated Delivery (IE_CD)	EB1a095
Wi-Fi Thermostat, Oil (Multifamily)	Income Eligible Coordinated Delivery (IE_CD)	EB1a096
Wi-Fi Thermostat, Other (Multifamily)	Income Eligible Coordinated Delivery (IE_CD)	EB1a097
Wi-Fi Thermostat, Gas (Single Family)	Income Eligible Coordinated Delivery (IE_CD)	GB1a014
Wi-Fi Thermostat, Gas (Multifamily)	Income Eligible Coordinated Delivery (IE_CD)	GB1a036

Algorithms for Calculating Primary Energy Impact:

Unit savings are deemed based on study results.[1] [2] Demand savings are derived from the demand impact model which is developed as part of the Residential Baseline Study.[3] The total cooling savings of 64 kWh were adjusted to reflect the percent of homes that have cooling which based on the Residential Baseline study is 28 percent.

Measure Name	ΔkWh	ΔkW	Δ MMBtu
Wi-Fi Thermostat, Electric (AC Only) (Single Family)	64	0.09	
Wi-Fi Thermostat, Gas (Single Family)	18	0.03	2.79
Wi-Fi Thermostat, Oil (Single Family)	18	0.03	2.78
Wi-Fi Thermostat, Other (Single Family)	18	0.03	2.78
Wi-Fi Thermostat, Electric (AC Only) (Multifamily)	64	0.09	
Wi-Fi Thermostat, Gas (Multifamily)	18	0.03	2.79
Wi-Fi Thermostat, Oil (Multifamily)	18	0.03	2.78
Wi-Fi Thermostat, Other (Multifamily)	18	0.03	2.78

Baseline Efficiency:

The baseline efficiency case is an HVAC system with either a manual or a programmable thermostat.

High Efficiency:

The high efficiency case is an HVAC system that has a Wi-Fi thermostat installed.

Measure Life:

The measure life is 15 years.[4]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Wi-Fi Thermostat	IE_CD	All	15	n/a	n/a	15

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Wi-Fi Thermostat,	IE_CD	All	1.00	1.00	1.00	1.00	1.00	0.37	0.00

Measure Name	Core Initiative	PA	ISR	RR$_E$	RR$_{NE}$	RR$_{SP}$	RR$_{WP}$	CF$_{SP}$	CF$_{WP}$
Electric (AC Only) (Single Family)									
Wi-Fi Thermostat, Gas (Single Family)	IE_CD	All	1.00	1.00	1.00	1.00	1.00	0.37	0.00
Wi-Fi Thermostat, Oil (Single Family)	IE_CD	All	1.00	1.00	1.00	1.00	1.00	0.37	0.00
Wi-Fi Thermostat, Other (Single Family)	IE_CD	All	1.00	1.00	1.00	1.00	1.00	0.37	0.00
Wi-Fi Thermostat, Electric (AC Only) (Multifamily)	IE_CD	All	1.00	1.00	1.00	1.00	1.00	0.37	0.00
Wi-Fi Thermostat, Gas (Multifamily)	IE_CD	All	1.00	1.00	1.00	1.00	1.00	0.37	0.00
Wi-Fi Thermostat, Oil (Multifamily)	IE_CD	All	1.00	1.00	1.00	1.00	1.00	0.37	0.00
Wi-Fi Thermostat, Other (Multifamily)	IE_CD	All	1.00	1.00	1.00	1.00	1.00	0.37	0.00

In-Service Rates:
All PAs assume 100% in service rate.

Realization Rates:
Realization rates are set to 100% for deemed measures.

Coincidence Factors:
Summer and winter coincidence factors are estimated using the demand allocation methodology described in the Demand Impact Model which is developed based on the Residential Baseline Study.[5]

Impact Factors for Calculating Net Savings:

Measure Name	Core Initiative	PA	FR	SO$_P$	SO$_{NP}$	NTG
Wi-Fi Thermostat	IE_CD	All	0.00	0.00	0.00	1.00

Non-Energy Impacts:

NEI values are rolled up, component values can be found in Appendix B. The thermostat NEI values are per household and the PAs adjust the total value by the average number of thermostats per account depending on the initiative. In the case of income eligible, we assume one thermostat per household.

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per KWh	Annual $ per Therm	One-time $ per Therm
Wi-Fi Thermostat, Electric (AC Only) (Single Family)	IE_CD	All	$44.53		Varies by PA	$0.01		
Wi-Fi Thermostat, Gas (Single Family)	IE_CD	All	$44.53				Varies by PA	$0.08
Wi-Fi Thermostat, Oil (Single Family)	IE_CD	All	$44.53					
Wi-Fi Thermostat, Other (Single Family)	IE_CD	All	$44.53					
Wi-Fi Thermostat, Electric (AC Only) (Multifamily)	IE_CD	All	$16.02		Varies by PA	$0.01		
Wi-Fi Thermostat, Gas (Multifamily)	IE_CD	All	$16.02				Varies by PA	$0.08
Wi-Fi Thermostat, Oil (Multifamily)	IE_CD	All	$16.02					
Wi-Fi Thermostat, Other (Multifamily)	IE_CD	All	$16.02					

Endnotes:

1 : Navigant Consulting (2018). Wi-Fi Thermostat Impact Evaluation--Secondary Research Study Memo. 2018_Navigant_Wi-Fi_Thermostat_Impact_Evaluation_Secondary_Literature_Study
2 : Guidehouse (2021). Residential Wi-Fi and Programmable Thermostat Impacts.
2021_Guidehouse_Thermostat_Impact_Study
3 : Guidehouse (2020). Residential Baseline Study Phase 4
2020_Guidehouse_Residential_Baseline_Phase_4
4 : Assumed to have the same lifetime as a regular programmable thermostat. Environmental Protection Agency (2010). Life Cycle Cost Estimate for ENERGY STAR Programmable Thermostat.
EPA_2010_Lifecycle_Cost_Estimate_for_ENERGY_STAR_Programmable_Thermostats
5 : Guidehouse (2020). Residential Baseline Study Phase 4
2020_Guidehouse_Residential_Baseline_Phase_4

2.19 HVAC - Duct Insulation

Measure Code	IE-HVAC-DI
Market	Income Eligible
Program Type	Retrofit
Category	Heating Ventilation and Air Conditioning

Measure Description:

For existing ductwork in non-conditioned spaces, insulate ductwork.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Duct Insulation, Electric (Single Family)	Income Eligible Coordinated Delivery (IE_CD)	EB1a135
Duct Insulation, Oil (Single Family)	Income Eligible Coordinated Delivery (IE_CD)	EB1a018
Duct Insulation, Other (Single Family)	Income Eligible Coordinated Delivery (IE_CD)	EB1a019
Duct Insulation, Gas (Single Family)	Income Eligible Coordinated Delivery (IE_CD)	GB1a008

Algorithms for Calculating Primary Energy Impact:

Unit savings are deemed based on study results[1]:

Measure Name	ΔkWh	ΔkW[2]	Δ MMBtu
Duct Insulation, Electric (Single Family)	726	0.51	
Duct Insulation, Oil (Single Family)			4.3
Duct Insulation, Other (Single Family)			5.5
Duct Insulation, Gas (Single Family)			5.5

Baseline Efficiency:

The baseline efficiency case is existing, un-insulated ductwork in unconditioned spaces (e.g. attic or basement) .

High Efficiency:

The high efficiency condition is insulated ductwork in unconditioned spaces.

Measure Life:

The measure life is 20 years.[3]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Duct Insulation	IE_CD	All	20	n/a	n/a	20

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR$_E$	RR$_{NE}$	RR$_{SP}$	RR$_{WP}$	CF$_{SP}$	CF$_{WP}$
Duct Insulation, Electric (Single Family)	IE_CD	All	1.00	1.00	1.00	1.00	1.00	0.37	0.22
Duct Insulation, Oil (Single Family)	IE_CD	All	1.00	n/a	1.00	n/a	n/a	n/a	n/a
Duct Insulation, Other (Single Family)	IE_CD	All	1.00	n/a	1.00	n/a	n/a	n/a	n/a
Duct Insulation, Gas (Single Family)	IE_CD	All	1.00	n/a	1.00	n/a	n/a	n/a	n/a

In-Service Rates:
All installations have 100% in-service rates since programs include verification of equipment installations.

Realization Rates:
Realization rates are set to 100% since savings are deemed.

Coincidence Factors:
Summer and winter coincidence factors are estimated using the demand allocation methodology described in the Demand Impact Model which is developed based on the Residential Baseline Study.[4]

Impact Factors for Calculating Net Savings:

Measure Name	Core Initiative	PA	FR	SO$_P$	SO$_{NP}$	NTG
Duct Insulation, Electric (Single Family)	IE_CD	All	0.00	0.00	0.00	1.00
Duct Insulation, Oil (Single Family)	IE_CD	All	0.00	0.00	0.00	1.00
Duct Insulation, Other (Single Family)	IE_CD	All	0.00	0.00	0.00	1.00
Duct Insulation, Gas (Single Family)	IE_CD	All	0.00	0.00	0.00	1.00

Non-Energy Impacts:

NEI values are rolled up, component values can be found in Appendix B.

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per KWh	Annual $ per Therm	One-time $ per Therm
Duct Insulation, Electric (Single Family)	IE_CD	All			Varies by PA	$0.01		
Duct Insulation, Oil (Single Family)	IE_CD	All						
Duct Insulation, Other (Single Family)	IE_CD	All						
Duct Insulation, Gas (Single Family)	IE_CD	All					Varies by PA	$0.08

Endnotes:

1 : Cadmus Group (2012). Massachusetts Low Income Single Family Program Impact Evaluation.
CADMUS_2012_Single_Family_Low_Income_Impact_Eval
2 : Guidehouse (2020). Residential Baseline Study Phase 4
2020_Guidehouse_Residential_Baseline_Phase_4
3 : GDS Associates, Inc. (2007). Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures.
GDS_2007_Measure_Life_Report_Residential_and_CI_Lighting_and_HVAC_Measures
4 : Guidehouse (2020). Residential Baseline Study Phase 4
2020_Guidehouse_Residential_Baseline_Phase_4

2.20 HVAC - Duct Insulation - IE Multi-Family

Measure Code	IE-HVAC-DI-MF
Market	Income Eligible
Program Type	Retrofit
Category	Heating Ventilation and Air Conditioning

Measure Description:

For existing ductwork in non-conditioned spaces, insulate ductwork.

BCR Measure IDs:

Core Initiative	Measure Name	BCR Measure ID
Duct Insulation, Electric (Multifamily)	Income Eligible Coordinated Delivery (IE_CD)	EB1a064
Duct Insulation, Oil (Multifamily)	Income Eligible Coordinated Delivery (IE_CD)	EB1a065
Duct Insulation, Other (Multifamily)	Income Eligible Coordinated Delivery (IE_CD)	EB1a066
Duct Insulation, Gas (Multifamily)	Income Eligible Coordinated Delivery (IE_CD)	GB1a024

Algorithms for Calculating Primary Energy Impact:

Eversource and CMA:

The program delivery agency uses vendor calculated energy savings for all allowed measures. These savings values are calculated with custom building simulation model software where the user inputs a set of technical data about the house and the software calculates building heating and cooling loads and other key parameters. The building model is based on thermal transfer, building gains, and a variable-based heating/cooling degree day/hour climate model. This provides an initial estimate of energy use that may be compared with actual billing data to adjust as needed for existing conditions. Then, specific recommendations for improvements are added and savings are calculated using measure-specific heat transfer algorithms.

Rather than using a fixed degree day approach, the building model estimates both heating degree days and cooling degree hours based on the actual characteristics and location of the house to determine the heating and cooling balance point temperatures. Savings from shell measures use standard U-value, area, and degree day algorithms, (see attached for details). Infiltration savings use site-specific seasonal

factors to convert measured leakage to seasonal energy impacts. HVAC savings are estimated based on changes in system and/or distribution efficiency improvements, using ASHRAE 152 and BPI recommendations as their basis. Interactivity between architectural and mechanical measures is always included, to avoid overestimating savings due to "adding" individual measure results.

All PAs except Eversource and CMA:

Unit savings are deemed based on study results:
ΔMMBtu = MMBtu x Units

Where:
Unit = Number of square feet of ductwork treated
MMBtu = Average annual MMBtu savings per unit: 0.035[1]

Baseline Efficiency:

The baseline efficiency case is existing, un-insulated ductwork in unconditioned spaces (e.g. attic or basement).

High Efficiency:

The high efficiency condition is insulated ductwork in unconditioned spaces.

Measure Life:

The measure life is 20 years.[2]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Duct Insulation (Multifamily)	IE_CD	All	20	n/a	n/a	20

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Duct Insulation, Electric (Multifamily)	IE_CD	All	1.00	1.00	n/a	1.00	1.00	0.37	0.22
Duct Insulation, Gas	IE_CD	Berkshire	1.00	n/a	0.80	n/a	n/a	n/a	n/a

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
(Multifamily)									
Duct Insulation, Gas (Multifamily)	IE_CD	Columbia	1.00	n/a	0.96	n/a	n/a	n/a	n/a
Duct Insulation, Gas (Multifamily)	IE_CD	Eversource	1.00	n/a	1.05	n/a	n/a	n/a	n/a
Duct Insulation, Gas (Multifamily)	IE_CD	Liberty	1.00	n/a	0.96	n/a	n/a	n/a	n/a
Duct Insulation, Gas (Multifamily)	IE_CD	National Grid	1.00	n/a	0.75	n/a	n/a	n/a	n/a
Duct Insulation, Gas (Multifamily)	IE_CD	Unitil	1.00	n/a	0.96	n/a	n/a	n/a	n/a
Duct Insulation, Oil (Multifamily)	IE_CD	All	1.00	n/a	1.00	n/a	n/a	n/a	n/a
Duct Insulation, Other (Multifamily)	IE_CD	All	1.00	n/a	1.00	n/a	n/a	n/a	n/a

In-Service Rates:

All installations have 100% in service rate since programs include verification of equipment installations.

Realization Rates:

Realization rates are based on evaluation results.[3]

Coincidence Factors:

Summer and winter coincidence factors are estimated using the demand allocation methodology described in the Demand Impact Model which is developed based on the Residential Baseline Study.[4]

Impact Factors for Calculating Net Savings:

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Duct Insulation (Multifamily)	IE_CD	All	0.00	0.00	0.00	1.00

Non-Energy Impacts:

NEI values are rolled up, component values can be found in Appendix B.

Measure Name	Core	PA	Annual	One-	Annual	One-	Annual	One-

	Initiative		$ per Unit	time $ per Unit	$ per kWh	time $ per KWh	$ per Therm	time $ per Therm
Duct Insulation, Electric (Multifamily)	IE_CD	All			Varies by PA	$0.01		
Duct Insulation, Gas (Multifamily)	IE_CD	All					Varies by PA	$0.08
Duct Insulation, Oil (Multifamily)	IE_CD	All						
Duct Insulation, Other (Multifamily)	IE_CD	All						

Endnotes:

1 : National Grid Staff Estimate (2010) MA SBS-DI Duct Sealing and Insulation Scenario and Deemed Savings. NGrid_MA_SBS-DI_Duct_Sealing_and_Insulation_Scenario_and_Deemed_Savings_6-22-10
2 : GDS Associates, Inc. (2007). Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures.
GDS_2007_Measure_Life_Report_Residential_and_CI_Lighting_and_HVAC_Measures
3 : The Cadmus Group (2015). Massachusetts Low-Income Multifamily Initiative Impact Evaluation.
CADMUS_2015_Low_Income_Multifamily_Impact_Evaluation
4 : Guidehouse (2020). Residential Baseline Study Phase 4
2020_Guidehouse_Residential_Baseline_Phase_4

2.21 HVAC - Duct Sealing - IE Multi-Family

Measure Code	IE-HVAC-DSAF-MF
Market	Income Eligible
Program Type	Retrofit
Category	Heating Ventilation and Air Conditioning

Measure Description:

For existing ductwork in non-conditioned spaces, seal ductwork. This could include sealing leaky fixed ductwork with mastic or aerosol.

BCR Measure IDs:

Measure	Core Initiative	BCR Measure ID
Duct Sealing, Electric (Multifamily)	Income Eligible Coordinated Delivery (IE_CD)	EB1a067
Duct Sealing, Oil (Multifamily)	Income Eligible Coordinated Delivery (IE_CD)	EB1a068
Duct Sealing, Other (Multifamily)	Income Eligible Coordinated Delivery (IE_CD)	EB1a069
Duct Sealing, Gas (Multifamily)	Income Eligible Coordinated Delivery (IE_CD)	GB1a023

Algorithms for Calculating Primary Energy Impact:

Eversource and CMA:

The program delivery agency uses vendor calculated energy savings for all allowed measures. These savings values are calculated with custom building simulation model software where the user inputs a set of technical data about the house and the software calculates building heating and cooling loads and other key parameters. The building model is based on thermal transfer, building gains, and a variable-based heating/cooling degree day/hour climate model. This provides an initial estimate of energy use that may be compared with actual billing data to adjust as needed for existing conditions. Then, specific recommendations for improvements are added and savings are calculated using measure-specific heat transfer algorithms.

Rather than using a fixed degree day approach, the building model estimates both heating degree days and cooling degree hours based on the actual characteristics and location of the house to determine the heating and cooling balance point temperatures. Savings from shell measures use standard U-value, area, and degree day algorithms, (see attached for details). Infiltration savings use site-specific seasonal factors to convert measured leakage to seasonal energy impacts. HVAC savings are estimated based on changes in system and/or distribution efficiency improvements, using ASHRAE 152 and BPI

recommendations as their basis. Interactivity between architectural and mechanical measures is always included, to avoid overestimating savings due to "adding" individual measure results.

All PAs except Eversource and CMA:

MMBtu = Annual Heating Consumption x % SAVE x 1/1,000,000

Where:
AnnualHeatingConsumption = The total annual heating consumption for the facility (Btu)
%SAVE = Average reduction in energy consumption.
1/1,000,000 = Conversion from Btu to MMBtu.

Savings Factors for Multifamily Duct Sealing:

Measure Name	%SAVE[1]
Surface Area < 50 SQFT	7%
Surface Area > 50 SQFT and < 200 SQFT	3%
Surface Area > 200 SQFT	1%

Baseline Efficiency:

The baseline efficiency case is existing, non-sealed (leaky) ductwork in unconditioned spaces (e.g. attic or basement).

High Efficiency:

The high efficiency condition is air sealed ductwork in unconditioned spaces.

Measure Life:

The measure life is 20 years.[2]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Duct Sealing	IE_CD	All	20	n/a	n/a	20

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR$_E$	RR$_{NE}$	RR$_{SP}$	RR$_{WP}$	CF$_{SP}$	CF$_{WP}$
Duct Sealing, Electric	IE_CD	All	1.00	1.00	n/a	1.00	1.00	0.37	0.22

Measure Name	Core Initiative	PA	ISR	RR$_E$	RR$_{NE}$	RR$_{SP}$	RR$_{WP}$	CF$_{SP}$	CF$_{WP}$
(Multifamily)									
Duct Sealing, Gas (Multifamily)	IE_CD	Berkshire	1.00	n/a	0.80	n/a	n/a	n/a	n/a
Duct Sealing, Gas (Multifamily)	IE_CD	Columbia	1.00	n/a	0.96	n/a	n/a	n/a	n/a
Duct Sealing, Gas (Multifamily)	IE_CD	Eversource	1.00	n/a	1.05	n/a	n/a	n/a	n/a
Duct Sealing, Gas (Multifamily)	IE_CD	Liberty	1.00	n/a	0.96	n/a	n/a	n/a	n/a
Duct Sealing, Gas (Multifamily)	IE_CD	National Grid	1.00	n/a	0.75	n/a	n/a	n/a	n/a
Duct Sealing, Gas (Multifamily)	IE_CD	Unitil	1.00	n/a	0.96	n/a	n/a	n/a	n/a
Duct Sealing, Oil (Multifamily)	IE_CD	All	1.00	n/a	1.00	n/a	n/a	n/a	n/a
Duct Sealing, Other (Multifamily)	IE_CD	All	1.00	n/a	1.00	n/a	n/a	n/a	n/a

In-Service Rates:
All installations have 100% in service rate since programs include verification of equipment installations.

Realization Rates:
Realization rates are based on evaluation results.[3]

Coincidence Factors:
Summer and winter coincidence factors are estimated using the demand allocation methodology described in the Demand Impact Model which is developed based on the Residential Baseline Study.[4]

Impact Factors for Calculating Net Savings:

Measure Name	Core Initiative	PA	FR	SO$_P$	SO$_{NP}$	NTG
Duct Sealing, Electric (Multifamily)	IE_CD	All	0.00	0.00	0.00	1.00

Non-Energy Impacts:

NEI values are rolled up, component values can be found in Appendix B.

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per kWh	Annual $ per Therm	One-time $ per Therm
Duct Sealing, Electric	IE_CD	All	$1.04		Varies by PA	$0.01		
Duct Sealing, Gas	IE_CD	All	$1.04				Varies by PA	$0.08
Duct Sealing, Oil/Other	IE_CD	All	$1.04					

Endnotes:

1 : Savings assumptions from National Grid program vendor.
2 : GDS Associates, Inc. (2007). Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures.
GDS_2007_Measure_Life_Report_Residential_and_CI_Lighting_and_HVAC_Measures
3 : The Cadmus Group (2015). Massachusetts Low-Income Multifamily Initiative Impact Evaluation.
CADMUS_2015_Low_Income_Multifamily_Impact_Evaluation
4 : Guidehouse (2020). Residential Baseline Study Phase 4
2020_Guidehouse_Residential_Baseline_Phase_4

2.22 HVAC - Duct Sealing - IE Single Family

Measure Code	IE-HVAC-DSAF
Market	Income Eligible
Program Type	Retrofit
Category	Heating Ventilation and Air Conditioning

Measure Description:

For existing ductwork in non-conditioned spaces, seal ductwork. This could include sealing leaky fixed ductwork with mastic or aerosol.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Duct Sealing, Oil (Single Family)	Income Eligible Coordinated Delivery (IE_CD)	E19B1a020
Duct Sealing, Other (Single Family)	Income Eligible Coordinated Delivery (IE_CD)	E19B1a021
Duct Sealing, Electric (Single Family)	Income Eligible Coordinated Delivery (IE_CD)	E19B1a136
Duct Sealing, Gas (Single Family)	Income Eligible Coordinated Delivery (IE_CD)	G19B1a007

Algorithms for Calculating Primary Energy Impact:

1Unit savings are deemed based on study results.[1] [2]

Measure Name	ΔkWh	ΔkW[3]	Δ MMBtu
Duct Sealing, Electric (Single Family)	442	0.31	
Duct Sealing, Oil (Single Family)			3.3
Duct Sealing, Other (Single Family)			3.3
Duct Sealing, Gas (Single Family)			3.3

Baseline Efficiency:

The baseline efficiency case is existing, non-sealed (leaky) ductwork in unconditioned spaces (e.g. attic or basement).

High Efficiency:

The high efficiency condition is air sealed ductwork in unconditioned spaces.

Measure Life:

The measure life is 20 years.[4]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Duct Sealing	IE_CD	All	20	n/a	n/a	20

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Duct Sealing, Electric (Single Family)	IE_CD	All	1.00	1.00	n/a	1.00	1.00	0.37	0.22
Duct Sealing, Gas (Single Family)	IE_CD	All	1.00	n/a	1.00	n/a	n/a	n/a	n/a
Duct Sealing, Oil (Single Family)	IE_CD	All	1.00	n/a	1.00	n/a	n/a	n/a	n/a
Duct Sealing, Other (Single Family)	IE_CD	All	1.00	n/a	1.00	n/a	n/a	n/a	n/a

In-Service Rates:
All installations have 100% in service rate since programs include verification of equipment installations.

Realization Rates:
Realization rates are set to 100% since deemed savings are based on evaluated results.

Coincidence Factors:
Summer and winter coincidence factors are estimated using the demand allocation methodology described in the Demand Impact Model which is developed based on the Residential Baseline Study.[5]

Impact Factors for Calculating Net Savings:

Net-to-Gross values are based on evaluation results.

Measure Name	Core Initiative	PA	FR	SO$_P$	SO$_{NP}$	NTG
Duct Sealing	IE_CD	All	0.00	0.00	0.00	1.00

Non-Energy Impacts:

NEI values are rolled up, component values can be found in Appendix B.

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per kWh	Annual $ per Therm	One-time $ per Therm
Duct Sealing, Electric	IE_CD	All	$6.21		Varies by PA	$0.01		
Duct Sealing, Gas	IE_CD	All	$6.21				Varies by PA	$0.08
Duct Sealing, Oil/Other	IE_CD	All	$6.21					

Endnotes:

1 : The Cadmus Group, Inc. (2012). Low Income Single Family Impact Evaluation.
CADMUS_2012_Single_Family_Low_Income_Impact_Eval
2 : For Electric : Navigant Consulting (2018). Home Energy Services (HES) Impact Evaluation.
2018_Navigant_HES_Impact_Evaluation
3 : Guidehouse (2020). Residential Baseline Study Phase 4
2020_Guidehouse_Residential_Baseline_Phase_4
4 : GDS Associates, Inc. (2007). Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures.
GDS_2007_Measure_Life_Report_Residential_and_CI_Lighting_and_HVAC_Measures
5 : Guidehouse (2020). Residential Baseline Study Phase 4
2020_Guidehouse_Residential_Baseline_Phase_4

2.23 HVAC - Furnace Retrofit

Measure Code	IE-HVAC-FR
Market	Income Eligible
Program Type	Retrofit
Category	Heating Ventilation and Air Conditioning

Measure Description:

Replacement of an old inefficient space heating furnace with a new furnace.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Heating System Retrofit, Furnace, Oil (Single Family)	Income Eligible Coordinated Delivery (IE_CD)	EB1a013
Heating System Retrofit, Furnace, Other (Single Family)	Income Eligible Coordinated Delivery (IE_CD)	EB1a014
Heating System Retrofit, Furnace, Gas (Single Family)	Income Eligible Coordinated Delivery (IE_CD)	GB1a006

Algorithms for Calculating Primary Energy Impact:

Unit savings are deemed based on study results.[1] Electric savings can be attributed to reduced fan run time.

Measure Name	Energy Type	MMBtu/unit	kWh/Unit	kW/Unit[2]
Heating System Retrofit, Furnace, Oil (Single Family)	Oil	14.3	132	0.10
Heating System Retrofit, Furnace, Other (Single Family)	Propane	20.7	172	0.13
Heating System Retrofit, Furnace, Gas (Single Family)	Gas	20.7	172	0.13

Baseline Efficiency:

The baseline efficiency case is the existing inefficient furnace.

High Efficiency:

The high efficiency case is the new efficient furnace.

Measure Life:

The measure life is 17 years.[3]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Heating System Retrofit, Furnace (Single Family)	IE_CD	All	17	n/a	n/a	17

Other Resource Impacts:

There are no other resource impacts for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Heating System Retrofit, Furnace (Single Family)	IE_CD	All	1.00	1.00	1.00	1.00	1.00	0.00	0.43

In-Service Rates:
All installations have 100% in service rate since all PAs programs include verification of equipment installations.

Realization Rates:
Realization rates are set to 100% since deemed savings are based on evaluation results.

Coincidence Factors:
Summer and winter coincidence factors are estimated using the demand allocation methodology described in the Demand Impact Model which is developed based on the Residential Baseline Study.[4]

Impact Factors for Calculating Net Savings:

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Heating System Retrofit, Furnace (Single Family)	IE_CD	All	0.00	0.00	0.00	1.00

Non-Energy Impacts:

NEI values are rolled up, component values can be found in Appendix B.

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per kWh	Annual $ per Therm	One-time $ per Therm
Heating System Retrofit, Furnace, Oil/Other	IE_CD	All	$310.82		Varies by PA	$0.01		
Heating System Retrofit, Furnace, Gas	IE_CD	All	$310.82				Varies by PA	$0.08

Endnotes:

1 : The Cadmus Group, Inc. (2012). Low Income Single Family Impact Evaluation.
CADMUS_2012_Single_Family_Low_Income_Impact_Eval
2 : Guidehouse (2020). Residential Baseline Study Phase 4
2020_Guidehouse_Residential_Baseline_Phase_4
3 : Guidehouse (2021). Comprehensive TRM Review. 2021_Guidehouse_TRM_Final_Report
4 : Guidehouse (2020). Residential Baseline Study Phase 4
2020_Guidehouse_Residential_Baseline_Phase_4

2.24 HVAC - Heat Pump - IE - Custom

Measure Code	IE-HVAC-HP-C
Market	Income Eligible
Program Type	Retrofit
Category	Heating Ventilation and Air Conditioning

Measure Description:

Installation of a heat pump to displace electric, oil, or propane heat.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Custom - Heat Pumps displacing Electric Heat (Multifamily)	Income Eligible Coordinated Delivery (IE_CD)	EB1a274
Custom - Heat Pumps displacing Oil (Multifamily)	Income Eligible Coordinated Delivery (IE_CD)	EB1a275
Custom - Heat Pumps displacing Propane (Multifamily)	Income Eligible Coordinated Delivery (IE_CD)	EB1a276
Custom - Heat Pumps displacing Gas (Multifamily)	Income Eligible Coordinated Delivery (IE_CD)	GB1a061

Algorithms for Calculating Primary Energy Impact:

For custom, heat pump savings will be calculated by the vendor based on existing site conditions.

Baseline Efficiency:

For custom, the baseline efficiency case is existing site conditions.

High Efficiency:

For custom, the high efficiency case varies depending on the equipment installed.

Measure Life:

The measure life will vary depending on the actual equipment installed.

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR$_E$	RR$_{NE}$	RR$_{SP}$	RR$_{WP}$	CF$_{SP}$	CF$_{WP}$
Custom Heat Pumps, Displacing Electric Heat (Multifamily)	IE_CD	All	1.00	1.00	1.00	1.00	1.00	0.00	0.43
Custom Heat Pumps, Displacing Oil (Multifamily)	IE_CD	All	1.00	1.00	1.00	1.00	1.00	Custom	Custom
Custom Heat Pumps, Displacing Propane (Multifamily)	IE_CD	All	1.00	1.00	1.00	1.00	1.00	Custom	Custom
Custom Heat Pumps, Displacing Gas (Multifamily)	IE_CD	All	1.00	1.00	1.00	1.00	1.00	Custom	Custom

In-Service Rates:
All installations have 100% in-service rates since all PAs programs include verification of equipment installations.

Realization Rates:
Realization rates are set to 100% because the measure is new and has not been evaluated.

Coincidence Factors:
For replacing electric baseboard summer and winter coincidence factors are estimated using the demand allocation methodology described in the Demand Impact Model which is developed based on the Residential Baseline Study.[1]   Coincidence factors for fuel switching will be custom calculated based on site conditions.

Impact Factors for Calculating Net Savings:

NTG rates are set to 100% because the measure is new and has not been evaluated.

Measure Name	Core Initiative	PA	FR	SO$_P$	SO$_{NP}$	NTG
Custom Heat Pumps, Displacing Electric Heat (Multifamily)	IE_CD	All	0.00	0.00	0.00	1.00
Custom Heat Pumps, Displacing Oil (Multifamily)	IE_CD	All	0.00	0.00	0.00	1.00
Custom Heat Pumps, Displacing	IE_CD	All	0.00	0.00	0.00	1.00

Propane (Multifamily)							
Custom Heat Pumps, Displacing Gas (Multifamily)	IE_CD	All	0.00	0.00	0.00	1.00	

Non-Energy Impacts:

NEI values are rolled up, component values can be found in Appendix B.[2]

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per KWh	Annual $ per Therm	One-time $ per Therm
Custom Heat Pumps, Displacing Electric Heat (Multifamily)	IE_CD	All	$836.39		$0.05	$0.01		
Custom Heat Pumps, Displacing Oil (Multifamily)	IE_CD	All	$836.39		$0.05	$0.01		
Custom Heat Pumps, Displacing Propane (Multifamily)	IE_CD	All	$836.39		$0.05	$0.01		
Custom Heat Pumps, Displacing Gas (Multifamily)	IE_CD	All	$836.39				Varies	$0.076

Endnotes:

1 : Guidehouse (2020). Residential Baseline Study Phase 4
2020_Guidehouse_Residential_Baseline_Phase_4
2 : NMR Group, Inc. (2021). Low Income Multifamily Non-Energy Impact Study
2021_NMR_LIMF_NEI_Study_TXC50

2.25 HVAC - Heat Pump Displacing Existing Electric Resistance Heat

Measure Code	IE-HVAC-FS-DMSDEH
Market	Income Eligible
Program Type	Retrofit
Category	Heating Ventilation and Air Conditioning

Measure Description:

The displacement of electric resistance heating with a more efficient ductless mini-split heat pump (DMSHP) system.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
MSHP displacing Electric Heat (Single Family)	Income Eligible Coordinated Delivery (IE_CD)	EB1a266
MSHP displacing Electric Heat (Multifamily)	Income Eligible Coordinated Delivery (IE_CD)	EB1a292
CVEO MSHP displacing Electric Heat (Single Family)	Income Eligible Coordinated Delivery (IE_CD)	CVEO9

Algorithms for Calculating Primary Energy Impact:

Unit savings are deemed based on a per ton savings. Cooling savings are based on survey responses and include central air conditioning, room air conditioning and no AC. These different types of AC are weighted to supply the overall AC savings.[1]   Savings were calculated via simulation model runs assuming a full displacement of the areas of the home being displaced by the heat pump.[2]

All savings and other impact factors are the same for Single Family, Multifamily and CVEO Single family. CVEO is a CLC specific measure offering.

Measure Name	Saved MMBtu Oil/Propane/Gas Per Ton	ΔkW Per Ton	ΔkWh Per Ton
MSHP displacing Electric Heat	N/A	2.57	2316

Baseline Efficiency:

For displacement of electric heat, the equivalent HSPF for electric resistance heat is assumed to be 3.41 COP.[3]

High Efficiency:

For the minimum program qualifications, the high efficiency case is a SEER 16, HSPF 9.5

Measure Life:

The measure life is based on evaluation results.[4]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
MSHP displacing Electric Heat	IE_CD	All	18	N/A	N/A	18

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

CF_{Sp} = kW system On Peak (Summer) / kW Max peak (winter)
CF_{wp} = kW system On Peak (Winter) / kW Max Peak (winter)

Measure	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
MSHP displacing Electric Heat	IE_CD	All	1.00	1.00	1.00	1.00	1.00	-0.02	0.31

In-Service Rates:
All installations have 100% in service rate since all PAs programs include verification of equipment installations.

Realization Rates:
Realization rates are set to 100% since deemed savings are based on evaluation results.

Coincidence Factors:
Summer and winter coincidence factors are estimated using the demand allocation methodology described in the Demand Impact Model which is developed based on the Residential Baseline Study.[5]

Impact Factors for Calculating Net Savings:

Measure Name	Core Initiative	PA	FR	SO$_P$	SO$_{NP}$	NTG
MSHP displacing Electric Heat	IE_CD	All	0.0%	0.0%	0.0%	100.0%

Non-Energy Impacts:

Annual $ per Unit NEIs listed in the table below come from the following evaluation study [6]. NEI values are based on a per ton similiar to energy savings values. NEI values are rolled up, component values can be found in Appendix B.

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per kWh	Annual $ per Therm	One-time $ per Therm
MSHP displacing Electric Heat	IE_CD	All	196.46	0.00	Varies by PA	0.005	N/A	N/A

Endnotes:

1 : Savings were derived from energy simulation models that came from the following study:
2021_Guidehouse_Fuel Displacement Report_HP
2 : For more information on savings results, please refer to the following study: 2021_Guidehouse_Fuel Displacement Report_HP
3 : The Cadmus Group, Inc. (2016). Ductless Mini Split Heat Pump Impact Evaluation
Cadmus_2016_DMSHP_Impact_Evaluation
4 : GDS Associates, Inc. (2007). Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures.
GDS_2007_Measure_Life_Report_Residential_and_CI_Lighting_and_HVAC_Measures
5 : Guidehouse (2020). Residential Baseline Study Phase 4
2020_Guidehouse_Residential_Baseline_Phase_4
6 : The following study supplied the NEIs for market rate customers but recommends these NEIs be applied to the similar income eligible measure offering. 2022_NMR_MA21X21-E-RHPNEI_Residential Heat Pump NEIs Study Final Report_2023

2.26 HVAC - Heat Pump Fully Displacing Existing Boiler

Measure Code	IE-HVAC-FS-DMSHP
Market	Income Eligible
Program Type	Retrofit
Category	Heating Ventilation and Air Conditioning

Measure Description:

Full displacement of a boiler with a high efficiency ductless minisplit heat pump for heating.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
MSHP Fully Displacing Oil Heat (Single Family)	Income Eligible	EB1a286
MSHP Fully Displacing Propane Heat (Single Family)	Income Eligible	EB1a287
MSHP fully displacing Gas Heat (Single Family)	Income Eligible	GB1a060
MSHP Fully Displacing Oil Heat (Multifamily)	Income Eligible	EB1a299
MSHP Fully Displacing Propane Heat (Multifamily)	Income Eligible	EB1a300
MSHP fully displacing Gas Heat (Multifamily)	Income Eligible	GB1a065
CVEO MSHP fully displacing Oil Heat (Single Family)	Income Eligible	CVEO34
CVEO MSHP fully displacing Propane Heat (Single Family)	Income Eligible	CVEO35

Algorithms for Calculating Primary Energy Impact:

Unit savings are deemed based on a per ton savings. Cooling savings are based on survey responses and include central air conditioning, room air conditioning and no AC. These different types of AC are weighted to supply the overall AC savings.[1]   Savings were calculated via simulation model runs assuming the existing heating system will be fully displaced.[2]

Savings for gas to MSHP is set equal to savings from oil to MSHP.
Savings on a per tonnage basis are the same for Single Family, Multifamily and CVEO Single family.
CVEO single family is a CLC specific measure.

Measure Name	Saved MMBtu Oil/Propane/Gas Per Ton	ΔkW Per Ton	ΔkWh Per Ton
MSHP Fully Displacing Oil Heat	17.8	-0.56	-1508
MSHP Fully Displacing Propane Heat	17.8	-0.56	-1508
MSHP fully displacing Gas Heat	17.8	-0.56	-1508

Baseline Efficiency:

For propane the baseline is an existing inefficient boiler at 77.4% AFUE when the customer survey responses stated that the existing unit was functioning properly and a 83.7% AFUE efficiency when the customer survey responses stated the customer would have installed a new boiler without program intervention. For oil the baseline is an existing inefficient boiler at 79.4% AFUE furnace when the customer survey responses stated that the existing unit was functioning properly and a 86% AFUE efficiency when the customer survey responses stated the customer would have installed a new boiler without program intervention.

The cooling baseline is a weighted average of the existing inefficient Central AC at 12 SSEER, 11.4 EER Room AC and a load building no AC situation when the customer survey responses stated that the existing unit was functioning properly and a weighted average 14 SEER Central AC, 11 EER Room AC and a load building no AC situation when the customer survey responses stated the customer would have installed a new AC unit without program intervention.

High Efficiency:

For the minimum program qualifications, the high efficiency case is a new 16 SEER/9.5 HSPF ductless mini split heat pumps.

Measure Life:

Measure Name	Core Initiative	PA	EUL[3]	OYF	RUL	AML
MSHP Fully Displacing Any Fuel Heating	IE_CD	All	18	n/a	n/a	18

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

CF_{Sp} = kW system On Peak (Summer) / kW Max peak (winter)
CF_{wp} = kW system On Peak (Winter) / kW Max Peak (winter)

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
MSHP Fully Displacing Any Fuel Heating	IE_CD	All	1.00	1.00	1.00	1.00	1.00	0.08	0.67

In-Service Rates:

All installations have 100% in-service rates since all PAs programs include verification of equipment installations.

Realization Rates:

Realization rates are set to 100% since deemed savings are based on evaluation results.

Coincidence Factors:

Coincidence factors are custom calculated.

Impact Factors for Calculating Net Savings:

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG[4]
MSHP Fully Displacing Any Fuel Heating	IE_CD	All	0.00	0.00	0.00	1.00

Non-Energy Impacts:

For the annual $ per Unit NEI values, details can be found in the following study [3]. NEI values are rolled up, component values can be found in Appendix B.

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per kWh	Annual $ per Therm	One-time $ per Therm
MSHP Fully Displacing Oil Heat	IE_CD	All	94.14	0	Varies by PA	0.005		
MSHP Fully Displacing Propane Heat	IE_CD	All	94.14	0	Varies by PA	0.005		
MSHP fully displacing Gas Heat	IE_CD	All	94.14	0			Varies by PA	0.076

Endnotes:

1 : Savings were derived from energy simulation models that came from 2020 MA20R24 Heat Pump Fuel Displacement Study. The results can be found in the attached excel file. Fuel Displacement Eval Measure Impacts - 2021-09-10

2 : For more information on the weighting, please refer to the evaluation study. 2021_Guidehouse_Fuel Displacement Report_HP

3 : Measure life Air source heat Pump GDS Associates, Inc. (2007). Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures. GDS_2007_Measure_Life_Report_Residential_and_CI_Lighting_and_HVAC_Measures

4 : The income eligible sector assumes a 100% NTG value.

3 : Study recommended that the NEIs used for market rate heat pumps would also be applicable for the similiar measures in the income eligible and moderate income program offerings. 2022_NMR_MA21X21-E-RHPNEI_Residential Heat Pump NEIs Study Final Report_2023

2.27 HVAC - Heat Pump Fully Displacing Existing Furnace

Measure Code	IE-HVAC-FSHP
Market	Income Eligible
Program Type	Retrofit
Category	Heating Ventilation and Air Conditioning

Measure Description:

Full displacement of an existing inefficient propane or oil furnace with a high efficiency central ducted heat pump.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Central Heat Pump fully displacing Oil Heat (Single Family)	Income Eligible Coordinated Delivery (IE_CD)	EB1a273
Central Heat Pump fully displacing Propane Heat (Single Family)	Income Eligible Coordinated Delivery (IE_CD)	EB1a272
Central Heat Pump fully displacing Gas Heat (Single Family)	Income Eligible Coordinated Delivery (IE_CD)	GB1a059
Central Heat Pump fully displacing Oil Heat (Multifamily)	Income Eligible Coordinated Delivery (IE_CD)	EB1a297
Central Heat Pump fully displacing Propane Heat (Multifamily)	Income Eligible Coordinated Delivery (IE_CD)	EB1a298
Central Heat Pump fully displacing Gas Heat (Multifamily)	Income Eligible Coordinated Delivery (IE_CD)	GB1a064

Algorithms for Calculating Primary Energy Impact:

Unit savings are deemed based on a per ton savings. Cooling savings are based on survey responses and include central air conditioning, room air conditioning and no AC. These different types of AC are weighted to supply the overall AC savings.[1]   Savings were calculated via simulation model runs assuming the existing heating system will be fully displaced. [2]

Savings for gas to CHP is set equal to savings from oil to CHP.
Savings and other impact factors are the same for Single Family and Multifamily.

Measure Name	Saved MMBtu Oil/Propane/Gas Per Ton	ΔkW Per Ton	ΔkWh Per Ton
Central Heat Pump fully displacing Oil Heat	17.9	-0.75	-1795
Central Heat Pump fully displacing Propane Heat	17.9	-0.75	-1795
Central Heat Pump fully displacing Gas Heat	17.9	-0.75	-1795

Baseline Efficiency:

For propane the baseline is an existing inefficient furnace at 81% AFUE when the customer survey responses stated that the existing unit was functioning properly and a 90.1% AFUE efficiency when the customer survey responses stated the customer would have installed a new furnace without program intervention. For oil the baseline is an existing inefficient furnace at 77.7% AFUE when the customer survey responses stated that the existing unit was functioning properly and a 83% AFUE efficiency when the customer survey responses stated the customer would have installed a new furnace without program intervention.

The cooling baseline is a weighted average of the existing inefficient Central AC at 12 SSEER, 11.4 EER Room AC and a load building no AC situation when the customer survey responses stated that the existing unit was functioning properly and a weighted average 14 SEER Central AC, 11 EER Room AC and a load building no AC situation when the customer survey responses stated the customer would have installed a new AC unit without program intervention. [3]

High Efficiency:

For the minimum program qualifications, the high efficiency case is a new 16 SEER/9.5 HSPF ducted central heat pump.

Measure Life:

The measure life is 17 years.

Measure Name	Core Initiative	PA	EUL[4]	OYF	RUL	AML
Central Heat Pump Fully Displacing Any Fuel Heating	IE_CD	All	17	n/a	n/a	17

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR$_E$	RR$_{NE}$	RR$_{SP}$	RR$_{WP}$	CF$_{SP}$	CF$_{WP}$
Central Heat Pump fully displacing Oil Heat	RES_RETAIL	All	1.00	1.00	1.00	1.00	1.00	-0.02	0.65
Central Heat Pump fully displacing Propane Heat	RES_RETAIL	All	1.00	1.00	1.00	1.00	1.00	-0.02	0.65
Central Heat Pump fully displacing Gas Heat	RES_RETAIL	All	1.00	1.00	1.00	1.00	1.00	-0.02	0.65

In-Service Rates:
All installations have 100% in-service rates since all PAs programs include verification of equipment installations.

Realization Rates:
Realization rates are set to 100% since deemed savings are based on evaluation results.

Coincidence Factors:
Coincidence factors are calculated to reflect blend of heating and cooling.

Impact Factors for Calculating Net Savings:

Measure Name	Core Initiative	PA	FR	SO$_P$	SO$_{NP}$	NTG
Central Heat Pump Fully Displacing Any Fuel Heating	IE_CD	All	0.00	0.00	0.00	1.00

Non-Energy Impacts:

Annual $ per Unit NEIs listed in the table below come from the following evaluation study [5]. NEI values are based on a per ton similar to energy savings values. NEI values are rolled up, component values can be found in Appendix B.

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per kWh	Annual $ per Therm	One-time $ per Therm
Central Heat Pump fully displacing Oil Heat	IE_CD	All	64.24	0	Varies by PA	0.005		
Central Heat Pump fully displacing Propane Heat	IE_CD	All	64.24	0	Varies by PA	0.005		
Central Heat Pump fully displacing Gas Heat	IE_CD	All	67.24	0			Varies by PA	0.076

Endnotes:

1 : Savings were derived from energy simulation models that came from the following study: [2021_Guidehouse_Fuel Displacement Report_HP](#)

2 : Further information on the methodology used to calculate the overall savings can be found here: [2021_Guidehouse_Fuel Displacement Report_HP](#)

3 : Further information on the methodology used to calculate the overall savings can be found here: [2021_Guidehouse_Fuel Displacement Report_HP](#)

4 : GDS Associates, Inc. (2007). Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures. Measure life Air source heat Pump [GDS_2007_Measure_Life_Report_Residential_and_CI_Lighting_and_HVAC_Measures](#)

5 : The following study supplied the NEIs for market rate customers but recommends these NEIs be applied to the similar income eligible measure offering. [2022_NMR_MA21X21-E-RHPNEI_Residential Heat Pump NEIs Study Final Report_2023](#)

2.28 HVAC - Heat Pump Partially Displacing Existing Boiler

Measure Code	IE-HVAC-FS-DMSHP-P
Market	Income Eligible
Program Type	Retrofit
Category	Heating Ventilation and Air Conditioning

Measure Description:

Partial displacement of a boiler with a high efficiency ductless minisplit heat pump for heating.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
MSHP partially displacing Oil Heat (Single Family)	Income Eligible Coordinated Delivery (IE_CD)	EB1a271
MSHP partially displacing Propane Heat (Single Family)	Income Eligible Coordinated Delivery (IE_CD)	EB1a270
MSHP partially displacing Gas Heat (Single Family)	Income Eligible Coordinated Delivery (IE_CD)	GB1a058
MSHP partially displacing Oil Heat (Multifamily)	Income Eligible Coordinated Delivery (IE_CD)	EB1a295
MSHP partially displacing Propane Heat (Multifamily)	Income Eligible Coordinated Delivery (IE_CD)	EB1a296
MSHP partially displacing Gas Heat (Multifamily)	Income Eligible Coordinated Delivery (IE_CD)	GB1a063

Algorithms for Calculating Primary Energy Impact:

Unit savings are deemed based on a per ton savings. Cooling savings are based on survey responses and include central air conditioning, room air conditioning and no AC. These different types of AC are weighted to supply the overall AC savings. Savings were calculated via simulation model runs assuming using a weighted average of survey responses for the most accurate switch over temperature between the MSHP and the secondary heating source. Due to expected program changes, the weighting were updated for each year of the three year plan showing better control strategies for propane throughout the three year plan. [12]

Savings for gas to MSHP is set equal to savings from oil to MSHP.

Savings and all other impact factors are set the same for Single Family and Multifamily.

Measure Name	Saved MMBtu Oil/Propane/Gas Per Ton	ΔkW Per Ton	ΔkWh Per Ton
MSHP partially displacing Oil Heat	15.8	-0.32	-994
MSHP partially displacing Propane Heat	19	-0.43	-1264
MSHP partially displacing Gas Heat	15.8	-0.32	-994

Baseline Efficiency:

For propane the baseline is an existing inefficient boiler at 77.4% AFUE when the customer survey responses stated that the existing unit was functioning properly and a 83.7% AFUE efficiency when the customer servey responses stated the customer would have installed a new boiler without program intervention. For oil the baseline is an existing inefficient furnace at 79.4% AFUE boiler when the customer survey responses stated that the existing unit was functioning properly and a 86% AFUE efficiency when the customer survey responses stated the customer would have installed a new boiler without program intervention.

The cooling baseline is a weighted average of the existing inefficient Central AC at 12 SSEER, 11.4 EER Room AC and a load building no AC situation when the customer survey responses stated that the existing unit was functioning properly and a weighted average 14 SEER Central AC, 11 EER Room AC and a load building no AC situation when the customer survey responses stated the customer would have installed a new AC unit without program intervention.

High Efficiency:

For the minimum program qualifications, the high efficiency case is a new 16 SEER/9.5 HSPF ductless mini split heat pumps.

Measure Life:

Measure Name	Core Initiative	PA	EUL[3]	OYF	RUL	AML
MSHP partially displacing Any Fuel Heat	IE_CD	All	18	n/a	n/a	18

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
MSHP partially displacing Oil Heat	Income Eligible	All	1.00	1.00	1.00	1.00	1.00	0.15	0.72
MSHP partially displacing Propane Heat	Income Eligible	All	1.00	1.00	1.00	1.00	1.00	0.13	0.71
MSHP partially displacing Gas Heat	Income Eligible	All	1.00	1.00	1.00	1.00	1.00	0.15	0.72

In-Service Rates:

All installations have 100% in-service rates since all PAs programs include verification of equipment installations.

Realization Rates:

Realization rates are set to 100% since deemed savings are based on evaluation results.

Coincidence Factors:

Coincidence factors are custom calculated.

Impact Factors for Calculating Net Savings:

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
MSHP partially displacing Any Fuel Heat	IE_CD	All	0.00	0.00	0.00	1.00

Non-Energy Impacts:

Annual $ per Unit NEIs listed in the table below come from the following evaluation study [4] . NEI values are based on a per ton similar to energy savings values. NEI values are rolled up, component values can be found in Appendix B.

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per kWh	Annual $ per Therm	One-time $ per Therm
MSHP partially displacing Oil Heat	IE_CD	All	104.35	0	Varies by PA	0.005		
MSHP partially displacing	IE_CD	All	104.35	0	Varies	0.005		

Propane Heat					by PA			
MSHP partially displacing Gas Heat	IE_CD	All	104.35				Varies by PA	0.076

Endnotes:

1 : Savings were derived from energy simulation models that came from the following study: 2021_Guidehouse_Fuel Displacement Report_HP

2 : For more information on the weighting and savings calculations please refer to the evaluation report: 2021_Guidehouse_Fuel Displacement Report_HP

3 : Measure life Air source heat Pump GDS Associates, Inc. (2007). Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures. GDS_2007_Measure_Life_Report_Residential_and_CI_Lighting_and_HVAC_Measures

4 : The following study supplied the NEIs for market rate customers but recommends these NEIs be applied to the similar income eligible measure offering. 2022_NMR_MA21X21-E-RHPNEI_Residential Heat Pump NEIs Study Final Report_2023

2.29 HVAC - Heat Pump Partially Displacing Existing Furnace

Measure Code	IE-HVAC-FSHP-P
Market	Income Eligible
Program Type	Retrofit
Category	Heating Ventilation and Air Conditioning

Measure Description:

Partial displacement of an existing propane or oil furnace with a high efficiency central ducted heat pump.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Central Heat Pump Partially Displacing Oil Heat (Single Family)	Income Eligible Coordinated Delivery (IE_CD)	EB1a269
Central Heat Pump Partially Displacing Propane Heat (Single Family)	Income Eligible Coordinated Delivery (IE_CD)	EB1a268
Central Heat Pump partially displacing Gas Heat (Single Family)	Income Eligible Coordinated Delivery (IE_CD)	GB1a057
Central Heat Pump Partially Displacing Oil Heat (Multifamily)	Income Eligible Coordinated Delivery (IE_CD)	EB1a293
Central Heat Pump Partially Displacing Propane Heat (Multifamily)	Income Eligible Coordinated Delivery (IE_CD)	EB1a294
Central Heat Pump partially displacing Gas Heat (Multifamily)	Income Eligible Coordinated Delivery (IE_CD)	GB1a062

Algorithms for Calculating Primary Energy Impact:

Unit savings are deemed based on a per ton savings. These different types of AC are weighted to supply the overall AC savings. Energy Savings were calculated via energy simulation models. The crossover temp was modeled at several different crossover temps via customer survey responses and the results were weighted by the distribution of responses.[1] [2]

Savings for gas to CHP is set equal to savings from oil to CHP.

Savings and other impact factors are the same for Single Family and Multifamily.

Measure Name	Saved MMBtu Oil/Propane/Gas Per Ton	ΔkW/ Ton	ΔkWh/ Ton
Central Heat Pump Partially Displacing Oil Heat	12.7	-0.36	-899
Central Heat Pump Partially Displacing Propane Heat	17.9	-0.57	-1390
Central Heat Pump partially displacing Gas Heat	12.7	-0.36	-899

Baseline Efficiency:

For propane the baseline is an existing inefficient furnace at 81% AFUE when the customer survey responses stated that the existing unit was functioning properly and a 90.1% AFUE efficiency when the customer survey responses stated the customer would have installed a new furnace without program intervention. For oil the baseline is an existing inefficient furnace at 77.7% AFUE when the customer survey responses stated that the existing unit was functioning properly and a 83% AFUE efficiency when the customer survey responses stated the customer would have installed a new furnace without program intervention.
The cooling baseline is a weighted average of the existing inefficient Central AC at 12 SEER, 11.4 EER Room AC and a load building no AC situation when the customer survey responses stated that the existing unit was functioning properly and a weighted average 14 SEER Central AC, 11 EER Room AC and a load building no AC situation when the customer survey responses stated the customer would have installed a new AC unit without program intervention. [3]

High Efficiency:

For the minimum program qualifications, the high efficiency case is a new efficient 16 SEER/9.5 HSPF ducted central heat pump.

Measure Life:

Measure Name	Core Initiative	PA	EUL[4]	OYF	RUL	AML
Central Ducted Heat Pump Partially Displacing Any Fuel Heating	IE_CD	All	17	n/a	n/a	17

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR$_E$	RR$_{NE}$	RR$_{SP}$	RR$_{WP}$	CF$_{SP}$	CF$_{WP}$
Central Heat Pump Partially Displacing Oil Heat	IE_CD	All	1.00	1.00	1.00	1.00	1.00	-0.04	0.69
Central Heat Pump Partially Displacing Propane Heat	IE_CD	All	1.00	1.00	1.00	1.00	1.00	-0.04	0.68
Central Heat Pump partially displacing Gas Heat	IE_CD	All	1.00	1.00	1.00	1.00	1.00	-0.04	0.69

In-Service Rates:

All installations have 100% in-service rates since all PAs programs include verification of equipment installations.

Realization Rates:

Realization rates are set to 100% since deemed savings are based on evaluation results.

Coincidence Factors:

Coincidence factors are calculated to reflect blend of heating and cooling.

Impact Factors for Calculating Net Savings:

Measure Name	Core Initiative	PA	FR	SO$_P$	SO$_{NP}$	NTG
Central Ducted Heat Pump Partially Displacing Any Fuel Heating	IE_CD	All	0.00	0.00	0.00	1.00

Non-Energy Impacts:

Annual $ per Unit NEIs listed in the table below come from the following evaluation study [5]. NEI values are based on a per ton similar to energy savings values. NEI values are rolled up, component values can be found in Appendix B.

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per kWh	Annual $ per Therm	One-time $ per Therm
Central Heat Pump Partially Displacing Oil Heat	IE_CD	All	56.18	0	Varies by PA	0.005		
Central Heat Pump Partially Displacing	IE_CD	All	56.18	0	Varies by PA	0.005		

Propane Heat								
Central Heat Pump partially displacing Gas Heat	IE_CD	All	56.18	0			Varies by PA	0.076

Endnotes:

1 : Savings were derived from energy simulation models that came in the following study: 2021_Guidehouse_Fuel Displacement Report_HP

2 : Further information can be found on the methodology used to calculate savings in the following report: 2021_Guidehouse_Fuel Displacement Report_HP

3 : Further information on the baseline and the associated baseline weights can be found in the following report: 2021_Guidehouse_Fuel Displacement Report_HP

4 : GDS Associates, Inc. (2007). Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures. GDS_2007_Measure_Life_Report_Residential_and_CI_Lighting_and_HVAC_Measures

5 : The following study supplied the NEIs for market rate customers but recommends these NEIs be applied to the similar income eligible measure offering. 2022_NMR_MA21X21-E-RHPNEI_Residential Heat Pump NEIs Study Final Report_2023

2.30 HVAC - Heating System

Measure Code	IE-HVAC-HS
Market	Income Eligible
Program Type	Retrofit
Category	Heating Ventilation and Air Conditioning

Measure Description:

Installation of high efficiency heating equipment to replace the existing inefficient furnace, hydronic boiler or steam boiler.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Heating System Retrofit, Boiler, Gas (Multifamily)	Income Eligible Coordinated Delivery (IE_CD)	GB1a020
Heating System Retrofit, Furnace, Gas (Multifamily)	Income Eligible Coordinated Delivery (IE_CD)	GB1a021
Heating System, Commercial Boiler (Multifamily)	Income Eligible Coordinated Delivery (IE_CD)	GB1a022

Algorithms for Calculating Primary Energy Impact:

Eversource and CMA:

The program delivery agency uses vendor calculated energy savings for all allowed measures. These savings values are calculated with custom building simulation model software where the user inputs a set of technical data about the house and the software calculates building heating and cooling loads and other key parameters. The building model is based on thermal transfer, building gains, and a variable-based heating/cooling degree day/hour climate model. This provides an initial estimate of energy use that may be compared with actual billing data to adjust as needed for existing conditions. Then, specific recommendations for improvements are added and savings are calculated using measure-specific heat transfer algorithms.

Rather than using a fixed degree day approach, the building model estimates both heating degree days and cooling degree hours based on the actual characteristics and location of the house to determine the heating and cooling balance point temperatures. Savings from shell measures use standard U-value, area, and degree day algorithms, (see attached for details). Infiltration savings use site-specific seasonal factors to convert measured leakage to seasonal energy impacts. HVAC savings are estimated based on

changes in system and/or distribution efficiency improvements, using ASHRAE 152 and BPI recommendations as their basis. Interactivity between architectural and mechanical measures is always included, to avoid overestimating savings due to "adding" individual measure results.

All PAs except Eversource and CMA:

$$\Delta MMBtu = Btu/hr \times (1/AFUE_{BASE} - 1/AFUE_{EE}) \times EFLH_{heat} \times (1/1000000)$$

Where:
Btu/hr = Nominal heating capacity of the installed equipment (Btu/hr)
$AFUE_{BASE}$ = Average fuel utilization efficiency of the existing equipment (%)
$AFUE_{EE}$ = Average fuel utilization efficiency of the efficient equipment (%)
$EFLH_{Heat}$ = Equivalent full load heating hours for the facility (Hr)
1/1,000,000 = Conversion from Btu to MMBtu

Baseline Efficiency:

The baseline efficiency case is the existing inefficient heating system.

High Efficiency:

The high efficiency case is characterized by the rated efficiency ($AFUE_{EE}$) of the new high efficiency furnace or boiler.

Measure Life:

The measure lives for the boiler and furnace are 23 years and 17, respectively.[1]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Heating System Retrofit, Boiler	IE_CD	All	23	n/a	n/a	23
Heating System Retrofit, Furnace	IE_CD	All	17	n/a	n/a	17
Heating System Retrofit, Commercial Boiler	IE_CD	All	custom	n/a	n/a	custom

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Program	PA	ISR	RR$_E$	RR$_{NE}$	RR$_{SP}$	RR$_{WP}$	CF$_{SP}$	CF$_{WP}$
Heating System,	IE_CD	Berkshire	1.00	n/a	0.80	n/a	n/a	n/a	n/a

Measure Name	Program	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Gas (Multifamily)									
Heating System, Gas (Multifamily)	IE_CD	Columbia	1.00	n/a	0.96	n/a	n/a	n/a	n/a
Heating System, Gas (Multifamily)	IE_CD	Eversource	1.00	n/a	1.05	n/a	n/a	n/a	n/a
Heating System, Gas (Multifamily)	IE_CD	Liberty	1.00	n/a	0.96	n/a	n/a	n/a	n/a
Heating System, Gas (Multifamily)	IE_CD	National Grid	1.00	n/a	0.75	n/a	n/a	n/a	n/a
Heating System, Gas (Multifamily)	IE_CD	Unitil	1.00	n/a	0.96	n/a	n/a	n/a	n/a

In-Service Rates:

All installations have 100% in service rate since all PA programs include verification of equipment installations.

Realization Rates:

The realization rate is based on evaluation results.[2]

Coincidence Factors:

There are no electric savings for this measure.

Impact Factors for Calculating Net Savings:

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Heating System Retrofit, Boiler	IE_CD	All	0.00	0.00	0.00	1.00
Heating System Retrofit, Furnace	IE_CD	All	0.00	0.00	0.00	1.00
Heating System Retrofit, Commercial Boiler	IE_CD	All	0.00	0.00	0.00	1.00

Non-Energy Impacts:

NEI values are rolled up, component values can be found in Appendix B.

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per kWh	Annual $ per Therm	One-time $ per Therm
Heating System Retrofit, Boiler	IE_CD	All	$836.39				Varies by PA	$0.08
Heating System Retrofit, Furnace	IE_CD	All	$836.39				Varies by PA	$0.08
Heating System Retrofit, Commercial Boiler	IE_CD	All	$836.39				Varies by PA	$0.08

Endnotes:

1 : Guidehouse (2021). Comprehensive TRM Review. 2021_Guidehouse_TRM_Final_Report
2 : The Cadmus Group, Inc. (2015). Massachusetts Low-Income Multifamily Initiative Impact Evaluation. CADMUS_2015_Low_Income_Multifamily_Impact_Evaluation

2.31 HVAC - Pipe Wrap (Heating)

Measure Code	IE-HVAC-PW
Market	Income Eligible
Program Type	Retrofit
Category	Heating Ventilation and Air Conditioning

Measure Description:

Insulation upgrades to existing heating system pipes.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Pipe Wrap (Heating), Oil (Single Family)	Income Eligible Coordinated Delivery (IE_CD)	EB1a137
Pipe Wrap (Heating), Oil (Multifamily)	Income Eligible Coordinated Delivery (IE_CD)	EB1a073
Pipe Wrap (Heating) (Multifamily)	Income Eligible Coordinated Delivery (IE_CD)	GB1a026

Algorithms for Calculating Primary Energy Impact:

Unit savings are deemed based on study results.[1]

Measure Name	Δ MMBtu
Pipe Wrap (Heating), Gas (Multifamily)	1.14
Pipe Wrap (Heating), Oil (Single Family)	1.14
Pipe Wrap (Heating), Oil (Multifamily)	1.14

Baseline Efficiency:

The baseline efficiency case is the existing equipment prior to the installation of additional insulation.

High Efficiency:

The high efficiency case includes pipe wrap.

Measure Life:

The measure life is 15 years.[2]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Pipe Wrap (Heating)	IE_CD	All	15	n/a	n/a	15

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Pipe Wrap (Heating)	IE_CD	All	1.00	n/a	1.00	n/a	n/a	n/a	n/a

In-Service Rates:
All installations have 100% in service rate since all PAs programs include verification of equipment installations.

Realization Rates:
The realization rates are set to 100% since deemed savings are based on evaluation results.

Coincidence Factors:
Coincidence factors are set to zero since there are no electric savings for this measure.

Impact Factors for Calculating Net Savings:

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Pipe Wrap (Heating), Gas (Multifamily)	IE_CD	All	0.00	0.00	0.00	1.00
Pipe Wrap (Heating), Oil (Single Family)	IE_CD	All	0.00	0.00	0.00	1.00
Pipe Wrap (Heating), Oil (Multifamily)	IE_CD	All	0.00	0.00	0.00	1.00

Non-Energy Impacts:

NEI values are rolled up, component values can be found in Appendix B.

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per kWh	Annual $ per Therm	One-time $ per Therm
Pipe Wrap (Heating), Gas (Multifamily)	IE_CD	All	$6.61				Varies by PA	$0.08
Pipe Wrap (Heating), Oil	IE_CD	All	$6.61					

(Single Family)								
Pipe Wrap (Heating), Oil (Multifamily)	IE_CD	All	$6.61					

Endnotes:

1 : The Cadmus Group (2015). Massachusetts Low-Income Multifamily Initiative Impact Evaluation.
CADMUS_2015_Low_Income_Multifamily_Impact_Evaluation

2 : GDS Associates, Inc. (2007). Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures.
GDS_2007_Measure_Life_Report_Residential_and_CI_Lighting_and_HVAC_Measures

2.32 HVAC - Programmable Thermostat

Measure Code	IE-HVAC-PT
Market	Income Eligible
Program Type	Retrofit
Category	Heating Ventilation and Air Conditioning

Measure Description:

Installation of a programmable thermostat, which gives the ability to adjust heating or air-conditioning operating times according to a pre-set schedule.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Programmable Thermostat, Electric (Single Family)	Income Eligible Coordinated Delivery (IE_CD)	EB1a040
Programmable Thermostat, Gas (Single Family)	Income Eligible Coordinated Delivery (IE_CD)	EB1a041
Programmable Thermostat, Oil (Single Family)	Income Eligible Coordinated Delivery (IE_CD)	EB1a042
Programmable Thermostat, Other (Single Family)	Income Eligible Coordinated Delivery (IE_CD)	EB1a043
Programmable Thermostat, Electric (Multifamily)	Income Eligible Coordinated Delivery (IE_CD)	EB1a092
Programmable Thermostat, Oil (Multifamily)	Income Eligible Coordinated Delivery (IE_CD)	EB1a093
Programmable Thermostat, Other (Multifamily)	Income Eligible Coordinated Delivery (IE_CD)	EB1a094
Programmable Thermostat, Gas (Single Family)	Income Eligible Coordinated Delivery (IE_CD)	GB1a012
Programmable Thermostat, Gas (Multifamily)	Income Eligible Coordinated Delivery (IE_CD)	GB1a034

Algorithms for Calculating Primary Energy Impact:

Unit kWh and MMBtu savings are deemed based on study results.[1][2][3] Demand savings are derived from the demand impact model which is developed as part of the Residential Baseline Study.[4]

Measure Name	ΔkWh	ΔkW	ΔMMBtu
Programmable Thermostat, Electric (Single Family)	330	0.24	
Programmable Thermostat, Gas (Single Family)			2.07
Programmable Thermostat, Oil (Single Family)			2.07
Programmable Thermostat, Other (Single Family)			2.06
Programmable Thermostat, Electric (Multifamily)	257	0.19	
Programmable Thermostat, Gas (Multifamily)			2.07
Programmable Thermostat, Oil (Multifamily)			2.07
Programmable Thermostat, Other (Multifamily)			2.06

Baseline Efficiency:

The baseline efficiency case is an HVAC system without a programmable thermostat.

High Efficiency:

The high efficiency case is an HVAC system that has a programmable thermostat installed.

Measure Life:

The measure life is 19 years.[5]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Programmable Thermostat	IE_CD	All	19	n/a	n/a	19

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Programmable Thermostat, Electric	IE_CD	All	1.00	1.00	n/a	1.00	1.00	0.00	0.43

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
(Single Family)									
Programmable Thermostat, Gas (Single Family)	IE_CD	All	1.00	n/a	1.00	n/a	n/a	n/a	n/a
Programmable Thermostat, Oil (Single Family)	IE_CD	All	1.00	n/a	1.00	n/a	n/a	n/a	n/a
Programmable Thermostat, Other (Single Family)	IE_CD	All	1.00	n/a	1.00	n/a	n/a	n/a	n/a
Programmable Thermostat, Electric (Multifamily)	IE_CD	All	1.00	1.00	n/a	1.00	1.00	0.00	0.43
Programmable Thermostat, Gas (Multifamily)	IE_CD	All	1.00	n/a	1.00	n/a	n/a	n/a	n/a
Programmable Thermostat, Oil (Multifamily)	IE_CD	All	1.00	n/a	1.00	n/a	n/a	n/a	n/a
Programmable Thermostat, Other (Multifamily)	IE_CD	All	1.00	n/a	1.00	n/a	n/a	n/a	n/a

In-Service Rates:
All installations have 100% in service rate since all PAs programs include verification of equipment installations.

Realization Rates:
Realization rates are set to 100% since savings are deemed.

Coincidence Factors:
Summer and winter coincidence factors are estimated using the demand allocation methodology described in the Demand Impact Model which is developed based on the Residential Baseline Study.[6]

Impact Factors for Calculating Net Savings:

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG

Programmable Thermostat	IE_CD	All	0.00	0.00	0.00	1.00

Non-Energy Impacts:

NEI values are rolled up, component values can be found in Appendix B. The thermostat NEI values are per household and the PAs adjust the total value by the average number of thermostats per account depending on the initiative. In the case of income eligible, we assume one thermostat per household.

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per KWh	Annual $ per Therm	One-time $ per Therm
Programmable Thermostat, Electric (Single Family)	IE_CD	All	$44.53		Varies by PA	$0.01		
Programmable Thermostat, Gas (Single Family)	IE_CD	All	$44.53				Varies by PA	$0.08
Programmable Thermostat, Oil (Single Family)	IE_CD	All	$44.53					
Programmable Thermostat, Other (Single Family)	IE_CD	All	$44.53					
Programmable Thermostat, Electric (Multifamily)	IE_CD	All	$16.02		Varies by PA	$0.01		
Programmable Thermostat, Gas (Multifamily)	IE_CD	All	$16.02				Varies by PA	$0.08
Programmable Thermostat, Oil (Multifamily)	IE_CD	All	$16.02					
Programmable Thermostat, Other (Multifamily)	IE_CD	All	$16.02					

Endnotes:

1 : Guidehouse Inc (2021). Residential Wi-Fi and Programmable Thermostat Impacts.
2021_Guidehouse_Thermostat_Impact_Study

2 : Navigant Consulting (2018). Home Energy Services (HES) Impact Evaluation.
2018_Navigant_HES_Impact_Evaluation

3 : The Cadmus Group (2012). Massachusetts Multifamily Program Impact Analysis July 2012 –
Revised May 2013. CADMUS_2012_Multifamily_Impacts_Analysis_Report

4 : Guidehouse (2020). Residential Baseline Study Phase 4
2020_Guidehouse_Residential_Baseline_Phase_4

5 : Guidehouse (2021). Comprehensive TRM Review. 2021_Guidehouse_TRM_Final_Report

6 : Guidehouse (2020). Residential Baseline Study Phase 4
2020_Guidehouse_Residential_Baseline_Phase_4

2.33 HVAC - Window AC Replacement (Retrofit)

Measure Code	IE-HVAC-WACR
Market	Income Eligible
Program Type	Retrofit
Category	Heating Ventilation and Air Conditioning

Measure Description:

Replacement of existing inefficient room air conditioners with more efficient models. This is only offered as a measure when an AC timer would not reduce usage during the peak period.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Window AC Replacement (Single Family)	Income Eligible Coordinated Delivery (IE_CD)	EB1a051
Window AC Replacement (Multifamily)	Income Eligible Coordinated Delivery (IE_CD)	EB1a116

Algorithms for Calculating Primary Energy Impact:

Unit savings are deemed based on study results except for National Grid's multifamily measure.[1] Demand savings are derived from the demand impact model which is developed as part of the Residential Baseline Study.[2]

Measure Name	Core Initiative	PA	ΔkWh	ΔkW
Window AC Replacement (Single Family)	IE_CD	All	113	0.16
Window AC Replacement (Multifamily)	IE_CD	Eversource, Unitil, CLC	113	0.16

National Grid's multifamily unit savings are calculated using the following algorithms and assumptions:

$\Delta kWh = (Capacity_{existing} /EER_{existing} – Capacity_{new}/EER_{new}) * hours/1000$

$\Delta kW = (Capacity_{exisitng}/EER_{existing} – Capacity_{new}/EER_{new}) /1000$

Where:

$Capacity_{exisitng}$ = size of existing unit in BTUs/hour

Capacitynew = size of new unit in BTUs/hour
EERexisitng = Energy Efficiency Ratio of base AC equipment
EERnew = Energy Efficiency Ratio of new efficient AC equipment
Hours = Equivalent full load hours= 200 [3]

Baseline Efficiency:

The baseline efficiency case is the existing air conditioning unit.

High Efficiency:

The high efficiency case is an Energy Star room air conditioning unit.

Measure Life:

The measure life is 9 years.[4]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Window AC Replacement (Single Family)	IE_CD	All	9	n/a	n/a	9
Window AC Replacement (Multifamily)	IE_CD	All	9	n/a	n/a	9

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure	Core Initiative	PA	ISR	RR$_E$	RR$_{NE}$	RR$_{SP}$	RR$_{WP}$	CF$_{SP}$	CF$_{WP}$
Window AC Replacement (Single Family)	IE_CD	All	1.00	1.00	n/a	1.00	1.00	0.37	0.00
Window AC Replacement (Multifamily)	IE_CD	All	1.00	1.00	n/a	1.00	1.00	0.37	0.00

In-Service Rates:
All installations have 100% in service rate since all PAs programs include verification of equipment installations.

Realization Rates:
Realization rates are set to 100% since deemed savings are based on evaluation results.

Coincidence Factors:

Summer and winter coincidence factors are estimated using the demand allocation methodology described in the Demand Impact Model which is developed based on the Residential Baseline Study.[5]

Impact Factors for Calculating Net Savings:

Measure Name	Core Initiative	PA	FR	SO$_P$	SO$_{NP}$	NTG
Window AC Replacement (Single Family)	IE_CD	All	0.00	0.00	0.00	1.00
Window AC Replacement (Multifamily)	IE_CD	All	0.00	0.00	0.00	1.00

Non-Energy Impacts:

NEI values are rolled up, component values can be found in Appendix B.

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per kWh	Annual $ per Therm	One-time $ per Therm
Window AC Replacement (Single Family)	IE_CD	All	$49.50		Varies by PA	$0.01		
Window AC Replacement (Multifamily)	IE_CD	All	$49.50		Varies by PA	$0.01		

Endnotes:

1 : The Cadmus Group, Inc. (2015). Massachusetts Low-Income Multifamily Initiative Impact Evaluation. CADMUS_2015_Low_Income_Multifamily_Impact_Evaluation

3 : Guidehouse (2020). Residential Baseline Study Phase 4
2020_Guidehouse_Residential_Baseline_Phase_4

2 : RLW Analytics (2008). Coincidence Factor Study: Residential Room Air Conditioners. Prepared for Northeast Energy Efficiency Partnerships' New England Evaluation and State Program Working Group; Page 32, Table 22 - found by averaging the EFLH values for MA states (Boston and Worcester): (228+172)/2 = 200. RLW_2008_Coincidence_Factor_Study_Residential_Room_Air_Conditioners

4 : Environmental Protection Agency (2009). Life Cycle Cost Estimate for ENERGY STAR Room Air Conditioner. EPA_2009_Lifecycle_Cost_Estimate_for_ENERGY_STAR_Room_Air_Conditioner

5 : Guidehouse (2020). Residential Baseline Study Phase 4
2020_Guidehouse_Residential_Baseline_Phase_4

2.34 Hot Water - Faucet Aerator

Measure Code	IE-WH-FA
Market	Income Eligible
Program Type	Retrofit
Category	Water Heating

Measure Description:

An existing faucet aerator with a high flow rate is replaced with a new low flow aerator.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Faucet Aerator, Electric (Single Family)	Income Eligible Coordinated Delivery (IE_CD)	EB1a029
Faucet Aerator, Gas (Single Family)	Income Eligible Coordinated Delivery (IE_CD)	EB1a030
Faucet Aerator, Oil (Single Family)	Income Eligible Coordinated Delivery (IE_CD)	EB1a031
Faucet Aerator, Other (Single Family)	Income Eligible Coordinated Delivery (IE_CD)	EB1a032
Faucet Aerator, Electric (Multifamily)	Income Eligible Coordinated Delivery (IE_CD)	EB1a089
Faucet Aerator, Oil (Multifamily)	Income Eligible Coordinated Delivery (IE_CD)	EB1a090
Faucet Aerator, Other (Multifamily)	Income Eligible Coordinated Delivery (IE_CD)	EB1a091
Faucet Aerator, Gas (Single Family)	Income Eligible Coordinated Delivery (IE_CD)	GB1a010
Faucet Aerator (Multifamily)	Income Eligible Coordinated Delivery (IE_CD)	GB1a030

Algorithms for Calculating Primary Energy Impact:

Unit savings are deemed based on separate single family[1] and multifamily[2] evaluation study results. Demand savings are derived from the demand impact model which is developed as part of the Residential Baseline Study.[3]

Measure Name	ΔkWh	ΔkW	Δ MMBtu
Faucet Aerator, Electric (Single Family)	40.0	0.01	
Faucet Aerator, Gas (Single Family)			0.20
Faucet Aerator, Oil (Single Family)			0.20
Faucet Aerator, Other (Single Family)			0.20
Faucet Aerator, Electric (Multifamily)	62.0	0.02	
Faucet Aerator, Gas (Multifamily)			0.30
Faucet Aerator, Oil (Multifamily)			0.30
Faucet Aerator, Other (Multifamily)			0.30

Baseline Efficiency:

The baseline efficiency case is the existing faucet aerator with a high flow (1.3 gallons/minute).

High Efficiency:

The high efficiency case is a low flow faucet aerator (1 gallon/minute).

Measure Life:

The measure life is 7 years.[4]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Faucet Aerator	IE_CD	All	7	n/a	n/a	7

Other Resource Impacts:

Residential water savings for faucet aerators in single family are 332 gallons per unit and multifamily are 708 gallons per unit.[5]

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR$_E$	RR$_{NE}$	RR$_{SP}$	RR$_{WP}$	CF$_{SP}$	CF$_{WP}$
Faucet Aerator, Electric	IE_CD	All	1.00	1.00	n/a	1.00	1.00	0.31	0.84

Faucet Aerator, Gas	IE_CD	All	1.00	n/a	1.00	n/a	n/a	n/a	n/a
Faucet Aerator, Oil	IE_CD	All	1.00	n/a	1.00	n/a	n/a	n/a	n/a
Faucet Aerator, Other	IE_CD	All	1.00	n/a	1.00	n/a	n/a	n/a	n/a

In-Service Rates:

All installations have 100% in service rate since programs include verification of equipment installations.

Realization Rates:

Realization rates are set to 100% for deemed measures.

Coincidence Factors:

Summer and winter coincidence factors are estimated using the demand allocation methodology described in the Demand Impact Model which is developed based on the Residential Baseline Study.[6]

Impact Factors for Calculating Net Savings:

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Faucet Aerator (Single Family)	IE_CD	All	0.00	0.00	0.00	1.00
Faucet Aerator (Multifamily)	IE_CD	All	0.00	0.00	0.00	1.00

Non-Energy Impacts:

NEI values are rolled up, component values can be found in Appendix B.[7]

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per KWh	Annual $ per Therm	One-time $ per Therm
Faucet Aerator, Electric (Single Family)	IE_CD	All			Varies by PA	$0.01		
Faucet Aerator, Gas (Single Family)	IE_CD	All					Varies by PA	$0.08
Faucet Aerator, Electric (Multifamily)	IE_CD	All	$0.58		Varies by PA	$0.01		
Faucet Aerator, Gas (Multifamily)	IE_CD	All	$0.58				Varies by PA	$0.08
Faucet Aerator, Oil (Multifamily)	IE_CD	All	$0.58					

Faucet Aerator, Other (Multifamily)	IE_CD	All	$0.58					

Endnotes:

1 : Cadmus Group (2012). Low Income Single Family Impact Evaluation.
CADMUS_2012_Single_Family_Low_Income_Impact_Eval
2 : Cadmus Group (2015). Massachusetts Low-Income Multifamily Initiative Impact Evaluation.
CADMUS_2015_Low_Income_Multifamily_Impact_Evaluation
3 : Guidehouse (2020). Residential Baseline Study Phase 4
2020_Guidehouse_Residential_Baseline_Phase_4
4 : MA Common Assumptions
5 : NMR Group, Inc., Tetra Tech (2011). Massachusetts Special and Cross-Sector Studies Area, Residential and Low-Income Non-Energy Impacts (NEI) Evaluation.
Tetra_Tech_and_NMR_2011_MA_Res_and_LI_NEI_Evaluation
6 : Guidehouse (2020). Residential Baseline Study Phase 4
2020_Guidehouse_Residential_Baseline_Phase_4
7 : NMR Group, Inc., Tetra Tech (2011). Massachusetts Special and Cross-Sector Studies Area, Residential and Low-Income Non-Energy Impacts (NEI) Evaluation.
Tetra_Tech_and_NMR_2011_MA_Res_and_LI_NEI_Evaluation

2.35 Hot Water - Heat Pump Water Heater

Measure Code	IE-WH-HPWH
Market	Income Eligible
Program Type	Time of Sale
Category	Water Heating

Measure Description:

Installation of a heat pump water heater (HPWH) instead of an electric resistance water heater.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Heat Pump Water Heaters (50 gallon) (Single Family)	Income Eligible Coordinated Delivery (IE_CD)	EB1a017
Heat Pump Water Heaters (50 gallon) (Multifamily)	Income Eligible Coordinated Delivery (IE_CD)	EB1a079
Heat Pump Water Heater, >55 gallon (Single Family)	Income Eligible Coordinated Delivery (IE_CD)	EB1a280
Heat Pump Water Heater displacing Oil (Single Family)	Income Eligible Coordinated Delivery (IE_CD)	EB1a281
Heat Pump Water Heater displacing Propane (Single Family)	Income Eligible Coordinated Delivery (IE_CD)	EB1a282
Heat Pump Water Heater, >55 gallon (Multifamily)	Income Eligible Coordinated Delivery (IE_CD)	EB1a283
Heat Pump Water Heater displacing Oil (Multifamily)	Income Eligible Coordinated Delivery (IE_CD)	EB1a284
Heat Pump Water Heater displacing Propane (Multifamily)	Income Eligible Coordinated Delivery (IE_CD)	EB1a285

Algorithms for Calculating Primary Energy Impact:

Unit savings are deemed based on study results for single family.[1] For multifamily, savings are custom calculated.

Measure Name	Water Heating Savings		Heating Savings (Penalty)		Total Savings			
	ΔkWh	ΔMMBTU	ΔkWh	ΔMMBTU	ΔkWh	Max Load Factor	ΔkW	ΔMMBTU
Water Heater, Heat Pump, <55 gallon, Energy Star	1799	0	-86.3	Gas = -0.50 Oil = -0.10 Propane = -0.07	1712	0.00025	0.43	Gas = -0.50 Oil = -0.10 Propane = -0.07
Water Heater, Heat Pump, >55 gallon, UEF 2.70	360	0	0	0	360	0.00025	0.09	0
Heat Pump Water Heater displacing Oil (Single Family)	-1,138	17.4	0	0	-1,138	0.00025	-0.28	17.4
Heat Pump Water Heater displacing Propane (Single Family)	-831	16.4	0	0	-831	0.00025	-0.21	16.4

Baseline Efficiency:

The baseline efficiency case is the existing inefficient water heater.

High Efficiency:

The high efficiency case is an electric heat pump storage water heater < 55 gallon, medium draw pattern, with an UEF of > 2.45.[3]

Measure Life:

The measure life is 13 years.[3]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Heat Pump Water Heater	IE_CD	All	13	n/a	n/a	13

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure	Core Initiative	PA	ISR	RR$_E$	RR$_{NE}$	RR$_S$P	RR$_{WP}$	CF$_{SP}$	CF$_{WP}$
Heat Pump Water Heater	IE_CD	All	1.00	1.00	1.00	1.00	1.00	0.31	0.84

In-Service Rates:

All installations have 100% in service rate since all PAs programs include verification of equipment installations.

Realization Rates:

Realization rates are set to 100% since deemed savings are based on evaluation results.

Coincidence Factors:

Coincidence factors are based on evaluation results.[4]

Impact Factors for Calculating Net Savings:

Measure Name	Core Initiative	PA	FR	SO$_P$	SO$_{NP}$	NTG
Heat Pump Water Heaters (50 gallon)	IE_CD	All	0.00	0.00	0.00	1.00

Non-Energy Impacts:

NEI values are rolled up, component values can be found in Appendix B.

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per kWh	Annual $ per Therm	One-time $ per Therm
Heat Pump Water Heater, Single family	IE_CD	All	$4.64		Varies by PA	$0.01		
Heat Pump Water Heater, Multifamily	IE_CD	All	$1.19		Varies by PA	$0.01		

Endnotes:

1 : Navigant Consulting (2018). Water Heating, Boiler, and Furnace Cost Study (RES 19) Add-On Task 7: Residential Water Heater Analysis Memo. 2018_Navigant_Water_Heater_Analysis_Memo

2 : Energy Star is 2.0 UEF but no models exist that the efficiency level. Lowest available if 2.45 UEF.

3 : Navigant Consulting (2018). Water Heating, Boiler, and Furnace Cost Study (RES 19) Add-On Task 7: Residential Water Heater Analysis Memo. 2018_Navigant_Water_Heater_Analysis_Memo

4 : Navigant Consulting (2018). Water Heating, Boiler, and Furnace Cost Study (RES 19) Add-On Task 7: Residential Water Heater Analysis Memo. 2018_Navigant_Water_Heater_Analysis_Memo

2.36 Hot Water - Low-Flow Showerhead

Measure Code	IE-WH-S
Market	Income Eligible
Program Type	Retrofit
Category	Water Heating

Measure Description:

An existing showerhead with a high flow rate is replaced with a new low flow showerhead.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Low-Flow Showerhead, Electric (Single Family)	Income Eligible Coordinated Delivery (IE_CD)	EB1a025
Low-Flow Showerhead, Gas (Single Family)	Income Eligible Coordinated Delivery (IE_CD)	EB1a026
Low-Flow Showerhead, Oil (Single Family)	Income Eligible Coordinated Delivery (IE_CD)	EB1a027
Low-Flow Showerhead, Other (Single Family)	Income Eligible Coordinated Delivery (IE_CD)	EB1a028
Low-Flow Showerhead, Electric (Multifamily)	Income Eligible Coordinated Delivery (IE_CD)	EB1a080
Low-Flow Showerhead, Oil (Multifamily)	Income Eligible Coordinated Delivery (IE_CD)	EB1a081
Low-Flow Showerhead, Other (Multifamily)	Income Eligible Coordinated Delivery (IE_CD)	EB1a082
Low-Flow Showerhead, Gas (Single Family)	Income Eligible Coordinated Delivery (IE_CD)	GB1a011
Low-Flow Showerhead, Gas (Multifamily)	Income Eligible Coordinated Delivery (IE_CD)	GB1a031

Algorithms for Calculating Primary Energy Impact:

Unit kWh and MMBtu savings are deemed based on study results.[1] [2] Demand savings are derived from the demand impact model which is developed as part of the Residential Baseline Study.[3]

Measure Name	ΔkWh	ΔkW	Δ MMBtu
Low-Flow Showerhead, Electric (Single Family)	188.0	0.05	
Low-Flow Showerhead, Gas (Single Family)			0.9
Low-Flow Showerhead, Oil (Single Family)			1.1
Low-Flow Showerhead, Other (Single Family)			0.9
Low-Flow Showerhead, Electric (Multifamily)	217.0	0.05	
Low-Flow Showerhead, Gas (Multifamily)			1.07
Low-Flow Showerhead, Oil (Multifamily)			1.07
Low-Flow Showerhead, Other (Multifamily)			1.07

Baseline Efficiency:

The baseline efficiency case is the existing showerhead with a baseline flow rate of 2.5 GPM.

High Efficiency:

The high efficiency case is a low flow showerhead having a maximum flow rate between 1.5 and 1.7 GPM.

Measure Life:

The measure life is 15 years.[4]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Low-Flow Showerhead	IE_CD	All	15	n/a	n/a	15

Other Resource Impacts:

Water savings for Single Family are 2,401[5] gallons per unit and multifamily are 1,759[6] gallons per unit.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Low-Flow Showerhead, Electric (Single Family)	IE_CD	All	1.00	1.00	n/a	1.00	1.00	0.31	0.84
Low-Flow Showerhead, Gas (Single Family)	IE_CD	All	1.00	n/a	1.00	n/a	n/a	n/a	n/a

Measure Name	Core Initiative	PA	ISR	RR$_E$	RR$_{NE}$	RR$_{SP}$	RR$_{WP}$	CF$_{SP}$	CF$_{WP}$
Low-Flow Showerhead, Oil (Single Family)	IE_CD	All	1.00	n/a	1.00	n/a	n/a	n/a	n/a
Low-Flow Showerhead, Other (Single Family)	IE_CD	All	1.00	n/a	1.00	n/a	n/a	n/a	n/a
Low-Flow Showerhead, Electric (Multifamily)	IE_CD	All	1.00	1.00	n/a	1.00	1.00	0.31	0.84
Low-Flow Showerhead, Gas (Multifamily)	IE_CD	All	1.00	n/a	1.00	n/a	n/a	n/a	n/a
Low-Flow Showerhead, Oil (Multifamily)	IE_CD	All	1.00	n/a	1.00	n/a	n/a	n/a	n/a
Low-Flow Showerhead, Other (Multifamily)	IE_CD	All	1.00	n/a	1.00	n/a	n/a	n/a	n/a

In-Service Rates:

All installations have 100% in service rate since programs include verification of equipment installations.

Realization Rates:

All PAs use 100% energy realization rate.

Coincidence Factors:

Summer and winter coincidence factors are estimated using the demand allocation methodology described in the Demand Impact Model which is developed based on the Residential Baseline Study.[7]

Impact Factors for Calculating Net Savings:

Measure Name	Core Initiative	PA	FR	SO$_P$	SO$_{NP}$	NTG
Low-Flow Showerhead (Single Family)	IE_CD	All	0.00	0.00	0.00	1.00
Low-Flow Showerhead (Multifamily)	IE_CD	All	0.00	0.00	0.00	1.00

Non-Energy Impacts:

NEI values are rolled up, component values can be found in Appendix B.

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per KWh	Annual $ per Therm	One-time $ per Therm

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per KWh	Annual $ per Therm	One-time $ per Therm
Low-Flow Showerhead, Electric (Single Family)	IE_CD	All		$1.72	Varies by PA	$0.01		
Low-Flow Showerhead, Gas (Single Family)	IE_CD	All		$1.72			Varies by PA	$0.08
Low-Flow Showerhead, Oil (Single Family)	IE_CD	All		$1.72				
Low-Flow Showerhead, Other (Single Family)	IE_CD	All		$1.72				
Low-Flow Showerhead, Electric (Multifamily)	IE_CD	All	$0.58		Varies by PA	$0.01		
Low-Flow Showerhead, Gas (Multifamily)	IE_CD	All	$0.58				Varies by PA	$0.08
Low-Flow Showerhead, Oil (Multifamily)	IE_CD	All	$0.58					
Low-Flow Showerhead, Other (Multifamily)	IE_CD	All	$0.58					

Endnotes:

1 : The Cadmus Group (2012). Low Income Single Family Impact Evaluation.
CADMUS_2012_Single_Family_Low_Income_Impact_Eval
2 : The Cadmus Group (2012). Massachusetts Low-Income Multifamily Initiative Impact Evaluation.
CADMUS_2015_Low_Income_Multifamily_Impact_Evaluation
3 : Guidehouse (2020). Residential Baseline Study Phase 4
2020_Guidehouse_Residential_Baseline_Phase_4
4 : Guidehouse (2021). Comprehensive TRM Review. 2021_Guidehouse_TRM_Final_Report
5 : Staff calculations based on the methodology from The Cadmus Group, Inc. (2012). Home Energy Services Impact Evaluation.
6 : The Cadmus Group (2015). Massachusetts Low-Income Multifamily Initiative Impact Evaluation.
CADMUS_2015_Low_Income_Multifamily_Impact_Evaluation
7 : Guidehouse (2020). Residential Baseline Study Phase 4.
2020_Guidehouse_Residential_Baseline_Phase_4

2.37 Hot Water - Low-Flow Showerhead with Thermostatic Valve

Measure Code	IE-WH-STV
Market	Income Eligible
Program Type	Retrofit
Category	Water Heating

Measure Description:

An existing showerhead is replaced with a low-flow showerhead with an integrated thermostatic shut-off valve (TSV).

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Low-Flow Showerhead with TSV, Electric (Multifamily)	Income Eligible Coordinated Delivery (IE_CD)	EB1a083
Low-Flow Showerhead with TSV, Oil (Multifamily)	Income Eligible Coordinated Delivery (IE_CD)	EB1a084
Low-Flow Showerhead with TSV, Other (Multifamily)	Income Eligible Coordinated Delivery (IE_CD)	EB1a085
Low-Flow Showerhead with TSV, Gas (Multifamily)	Income Eligible Coordinated Delivery (IE_CD)	GB1a032

Algorithms for Calculating Primary Energy Impact:

Unit kWh and MMBtu savings are deemed.[1] Demand savings are derived from the demand impact model which is developed as part of the Residential Baseline Study.[2]

Measure Name	ΔkWh	ΔkW	ΔMMBtu
Low-Flow Showerhead with TSV, Electric (Multifamily)	335	0.08	
Low-Flow Showerhead with TSV, Gas (Multifamily)			1.9
Low-Flow Showerhead with TSV, Oil (Multifamily)			1.7
Low-Flow Showerhead with TSV, Other (Multifamily)			1.7

Baseline Efficiency:

The Baseline Efficiency case is an existing standard-flow showerhead (2.5 GPM) with no thermostatic shut-off valve.

High Efficiency:

The high efficiency case is a low-flow showerhead (1.5 GPM) with integrated thermostatically actuated valve.

Measure Life:

The measure life is 15 years.[3]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Low-Flow Showerhead with TSV (Multifamily)	IE_CD	All	15	n/a	n/a	15

Other Resource Impacts:

Water savings is 2,723 gallons per unit.[4]

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Low-Flow Showerhead with TSV, Electric (Multifamily)	IE_CD	All	1.00	1.00	n/a	1.00	1.00	0.31	0.84
Low-Flow Showerhead with TSV, Gas (Multifamily)	IE_CD	All	1.00	n/a	1.00	n/a	n/a	n/a	n/a
Low-Flow Showerhead with TSV, Oil (Multifamily)	IE_CD	All	1.00	n/a	1.00	n/a	n/a	n/a	n/a
Low-Flow Showerhead with TSV, Other (Multifamily)	IE_CD	All	1.00	n/a	1.00	n/a	n/a	n/a	n/a

In-Service Rates:
All installations have 100% in service rate.

Realization Rates:
Realization rates are set to 100% for deemed measures.

Coincidence Factors:
Summer and winter coincidence factors are estimated using the demand allocation methodology described in the Demand Impact Model which is developed based on the Residential Baseline Study.[5]

Impact Factors for Calculating Net Savings:

Measure Name	Core Initiative	PA	FR	SO$_P$	SO$_{NP}$	NTG
Low-Flow Showerhead with TSV (Multifamily)	IE_CD	All	0.00	0.00	0.00	1.00

Non-Energy Impacts:

NEI values are rolled up, component values can be found in Appendix B.

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per KWh	Annual $ per Therm	One-time $ per Therm
Low-Flow Showerhead with TSV, Electric (Multifamily)	IE_CD	All	$0.58		Varies by PA	$0.01		
Low-Flow Showerhead with TSV, Gas (Multifamily)	IE_CD	All	$0.58				Varies by PA	$0.08
Low-Flow Showerhead with TSV, Oil (Multifamily)	IE_CD	All	$0.58					
Low-Flow Showerhead with TSV, Other (Multifamily)	IE_CD	All	$0.58					

Endnotes:

1 : 2021_Guidehouse_TRM_Final_Report
2 : Guidehouse (2020). Residential Baseline Study Phase 4
2020_Guidehouse_Residential_Baseline_Phase_4
3 : 2021_Guidehouse_TRM_Final_Report
4 : National_Grid_2014_ShowerStart_Savings_Final_2015-2-9
National_Grid_2014_ShowerStart_Savings_Final_2015-2-9
5 : Guidehouse (2020). Residential Baseline Study Phase 4
2020_Guidehouse_Residential_Baseline_Phase_4

2.38 Hot Water - Pipe Wrap (Water Heating)

Measure Code	IE-WH-PW
Market	Income Eligible
Program Type	Retrofit
Category	Water Heating

Measure Description:

Installation of DHW pipe wraps.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Pipe Wrap (Water Heating), Electric (Single Family)	Income Eligible Coordinated Delivery (IE_CD)	EB1a022
Pipe Wrap (Water Heating), Oil (Single Family)	Income Eligible Coordinated Delivery (IE_CD)	EB1a023
Pipe Wrap (Water Heating), Other (Single Family)	Income Eligible Coordinated Delivery (IE_CD)	EB1a024
Pipe Wrap (Water Heating), Electric (Multifamily)	Income Eligible Coordinated Delivery (IE_CD)	EB1a070
Pipe Wrap (Water Heating), Oil (Multifamily)	Income Eligible Coordinated Delivery (IE_CD)	EB1a071
Pipe Wrap (Water Heating), Other (Multifamily)	Income Eligible Coordinated Delivery (IE_CD)	EB1a072
Pipe Wrap, Gas (Water Heating) (Single Family)	Income Eligible Coordinated Delivery (IE_CD)	GB1a009
Pipe Wrap (Water Heating) (Multifamily)	Income Eligible Coordinated Delivery (IE_CD)	GB1a025

Algorithms for Calculating Primary Energy Impact:

Unit savings are deemed based on study results where unit is a household with pipe wrap installed on hot water pipes.[1] Demand savings are derived from the demand impact model which is developed as part of the Residential Baseline Study.[2]

Measure Name	ΔkWh	ΔkW	Δ MMBtu
Pipe Wrap (Water Heating), Electric (Single Family)	41	0.01	
Pipe Wrap (Water Heating), Electric (Multifamily)	129	0.03	
Pipe Wrap (Water Heating), Gas			0.40
Pipe Wrap (Water Heating), Oil			0.40
Pipe Wrap (Water Heating), Other			0.40

Baseline Efficiency:

The baseline efficiency case is the existing hot water equipment.

High Efficiency:

The high efficiency case includes pipe wrap.

Measure Life:

The measure life is 15 years.[3]

Measure Name	PA	Core Initiative	EUL	OYF	RUL	AML
Pipe Wrap (Water Heating)	All	IE_CD	15	n/a	n/a	15

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR$_E$	RR$_{NE}$	RR$_{SP}$	RR$_{WP}$	CF$_{SP}$	CF$_{WP}$
Pipe Wrap (Water Heating), Electric	IE_CD	All	1.00	1.00	n/a	1.00	1.00	0.31	0.81
Pipe Wrap (Water Heating), Gas	IE_CD	All	1.00	n/a	1.00	n/a	n/a	n/a	n/a
Pipe Wrap (Water Heating), Oil	IE_CD	All	1.00	n/a	1.00	n/a	n/a	n/a	n/a
Pipe Wrap (Water Heating), Other	IE_CD	All	1.00	n/a	1.00	n/a	n/a	n/a	n/a

In-Service Rates:

All installations have 100% in service rate since all PAs programs include verification of equipment installations.

Realization Rates:

The realization rates are set to 100% since deemed savings are based on evaluation results.

Coincidence Factors:

Summer and winter coincidence factors are estimated using the demand allocation methodology described in the Demand Impact Model which is developed based on the Residential Baseline Study.[4]

Impact Factors for Calculating Net Savings:

Measure Name	Core Initiative	PA	FR	SO$_P$	SO$_{NP}$	NTG
Pipe Wrap (Water Heating)	IE_CD	All	0.00	0.00	0.00	1.00

Non-Energy Impacts:

NEI values are rolled up, component values can be found in Appendix B.

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per KWh	Annual $ per Therm	One-time $ per Therm
Pipe Wrap (Water Heating), Electric (Single Family)	IE_CD	All	$48.94		Varies by PA	$0.01		
Pipe Wrap (Water Heating), Gas (Single Family)	IE_CD	All	$48.94				Varies by PA	$0.08
Pipe Wrap (Water Heating), Oil (Single Family)	IE_CD	All	$48.94					
Pipe Wrap (Water Heating), Other (Single Family)	IE_CD	All	$48.94					
Pipe Wrap (Water Heating), Electric (Multifamily)	IE_CD	All	$6.61		Varies by PA	$0.01		
Pipe Wrap (Water Heating), Gas (Multifamily)	IE_CD	All	$6.61				Varies by PA	$0.08
Pipe Wrap (Water Heating), Oil (Multifamily)	IE_CD	All	$6.61					
Pipe Wrap (Water Heating), Other (Multifamily)	IE_CD	All	$6.61					

Endnotes:

1 : Cadmus Group (2012). Massachusetts Low Income Single Family Program Impact Evaluation.
CADMUS_2012_Single_Family_Low_Income_Impact_Eval
2 : Guidehouse (2020). Residential Baseline Study Phase 4
2020_Guidehouse_Residential_Baseline_Phase_4
3 : GDS Associates, Inc. (2007). Measure Life Report: Residential and Commercial/Industrial and HVAC Measures.
GDS_2007_Measure_Life_Report_Residential_and_CI_Lighting_and_HVAC_Measures
4 : Guidehouse (2020). Residential Baseline Study Phase 4
2020_Guidehouse_Residential_Baseline_Phase_4

2.39 Hot Water - Solar Hot Water

Measure Code	IE-S-HW
Market	Income Eligible
Program Type	Early Replacement
Category	Other

Measure Description:

Installation of Solar Hot Water in a residence with existing electric hot water.

BCR Measure IDs:

Measure	Core Initiative	BCR Measure ID
Solar Hot Water (Single Family)	Income Eligible Coordinated Delivery (IE_CD)	EB1a279

Algorithms for Calculating Primary Energy Impact:

ΔkWh = [WHkwh_base] - [(HWHDkwh)*(1-%SHWdesign)]/(%WHsupp)]
Where
WHkwh_base = Federal standards for maximum allowable energy consumption.
HWHDkwh = The total household water heating demand in kWh.
%SHWdesign = The design percent of household water heating demand met by the solar hot water system.
%WHsupp = The efficiency of the supplemental hot water system for household water heating demand not met by the solar hot water system.

Baseline Efficiency:

WHkwh_base = (365 days/year)*(0.000293071 kWh/BTU)*(V)*(ρ)*(Cp)*(ΔT)/UEF
Where
V = Volume of hot water drawn based on draw pattern (Gallon), where V = 10 for the very-small-usage draw pattern, V= 38 for the low-usage draw pattern, V = 55 for the medium-usage draw pattern, V = 84 for high-usage draw pattern
ρ = Water density (lb/gallon) = 8.24
Cp = Specific heat of water (Btu/lb) = 1
ΔT = Difference between inlet and outlet temp (ΔT) = 67
UEF = Uniform Energy Factor (see table below)

Electric Storage Water Heater Conservation Standards[1]

Where:

Vr=Rated Storage Volume (Gallon)

Rated Storage Volume	Draw Pattern	Uniform Energy Factor
<20	Very Small	0.7836 - (0.0013 xVr)
	Low	0.8939 - (0.0008 xVr)
	Medium	0.9112 - (0.0007 xVr)
	High	0.9255 - (0.0006 xVr)
≥20 and ≤55	Very Small	0.8808 - (0.0008 xVr)
	Low	0.9254 - (0.0003 xVr)
	Medium	0.9307 - (0.0002 xVr)
	High	0.9349 - (0.0001 xVr)
>55 and ≤120	Very Small	1.9236 - (0.0011 xVr)
	Low	2.0440 - (0.0011 xVr)
	Medium	2.1171 - (0.0011 xVr)
	High	2.2418 - (0.0011 xVr)
>120	Very Small	0.6802 - (0.0003 xVr)
	Low	0.8620 - (0.0006 xVr)
	Medium	0.9042 - (0.0007 xVr)
	High	0.9437 - (0.0007 xVr)

High Efficiency:

The new system is a solar hot water heater paired with a supplemental electric water heating source.

Measure Life:

The measure life for a new solar hot water system is 20 years.[2]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Solar Hot Water	IE_CD	All	20	n/a	n/a	20

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Solar Hot Water	IE_CD	All	1.00	1.00	1.00	1.00	1.00	0.31	0.81

In-Service Rates:

All installations have 100% in service rate since programs include verification of equipment installations.

Realization Rates:

Realization rates are set to 100% until an evaluation occurs.

Coincidence Factors:

Summer and winter coincidence factors are estimated using the demand allocation methodology described in the Demand Impact Model which is developed based on the Residential Baseline Study.[3]

Impact Factors for Calculating Net Savings:

Net-to-Gross values have not been studied. The default NTG is 1.00.

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Solar Hot Water	IE_CD	All	0.00	0.00	0.00	1.00

Non-Energy Impacts:

There are no non-energy impacts identified with this measure.

Endnotes:

1 : https://www.federalregister.gov/documents/2020/05/21/2020-10564/energy-conservation-program-energy-conservation-standards-for-consumer-water-heaters
2 : GDS_2007_Measure_Life_Report_Residential_and_CI_Lighting_and_HVAC_Measures
3 : 2020_Guidehouse_Residential_Baseline_Phase_4

2.40 Hot Water - Thermostatic Valve

Measure Code	IE-WH-TV
Market	Income Eligible
Program Type	Retrofit
Category	Water Heating

Measure Description:

A stand-alone valve that may be used with existing showerhead. Thermostatic shut-off valve technology is known by the trademarked name ShowerStart™.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Thermostatic Shut-off Valve, Electric (Multifamily)	Income Eligible Coordinated Delivery (IE_CD)	EB1a086
Thermostatic Shut-off Valve, Oil (Multifamily)	Income Eligible Coordinated Delivery (IE_CD)	EB1a087
Thermostatic Shut-off Valve, Other (Multifamily)	Income Eligible Coordinated Delivery (IE_CD)	EB1a088
Thermostatic Shut-offf Valve, Gas (Multifamily)	Income Eligible Coordinated Delivery (IE_CD)	GB1a033

Algorithms for Calculating Primary Energy Impact:

The unit kWh and MMBtu savings are deemed based on engineering analysis.[1] Demand savings are derived from the demand impact model which is developed as part of the Residential Baseline Study.[2]

Measure Name	∆kWh	∆kW	∆ MMBtu
Thermostatic Shut-off Valve, Electric (Multifamily)	69	0.02	
Thermostatic Shut-off Valve, Gas (Multifamily)			0.34
Thermostatic Shut-off Valve, Oil (Multifamily)			0.39
Thermostatic Shut-off Valve, Other (Multifamily)			0.34

Baseline Efficiency:

The Baseline Efficiency case is an existing standard-flow showerhead (2.5 GPM) with no thermostatic shut-off valve.

High Efficiency:

The high efficiency case is a standard-flow showerhead (2.5 GPM) with the addition of the stand-alone thermostatic shut-off valve (the "Ladybug").

Measure Life:

The measure life is 15 years.[3]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Thermostatic Shut-off Valve (Multifamily)	IE_CD	All	15	n/a	n/a	15

Other Resource Impacts:

Water savings are 558 gallons per unit.[4]

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Thermostatic Shut-off Valve, Electric (Multifamily)	IE_CD	All	1.00	1.00	n/a	1.00	1.00	0.31	0.84
Thermostatic Shut-offf Valve, Gas (Multifamily)	IE_CD	All	1.00	1.00	1.00	n/a	n/a	n/a	n/a
Thermostatic Shut-off Valve, Oil (Multifamily)	IE_CD	All	1.00	1.00	1.00	n/a	n/a	n/a	n/a
Thermostatic Shut-off Valve, Other (Multifamily)	IE_CD	All	1.00	1.00	1.00	n/a	n/a	n/a	n/a

In-Service Rates:
All installations have 100% in service rate.

Realization Rates:
Realization rates are set to 100% since savings are deemed.

Coincidence Factors:

Summer and winter coincidence factors are estimated using the demand allocation methodology described in the Demand Impact Model which is developed based on the Residential Baseline Study.[5]

Impact Factors for Calculating Net Savings:

Measure Name	Core Initiative	PA	FR	SO$_P$	SO$_{NP}$	NTG
Thermostatic Shutoff Valve (Multifamily)	IE_CD	All	0.00	0.00	0.00	1.00

Non-Energy Impacts:

NEI values are rolled up, component values can be found in Appendix B.

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per kWh	Annual $ per Therm	One-time $ per Therm
Thermostatic Shut-off Valve, Electric (Multifamily)	IE_CD	All			Varies by PA	$0.01		
Thermostatic Shut-offf Valve, Gas (Multifamily)	IE_CD	All					Varies by PA	$0.08
Thermostatic Shut-off Valve, Oil (Multifamily)	IE_CD	All						
Thermostatic Shut-off Valve, Other (Multifamily)	IE_CD	All						

Endnotes:

1 : National Grid (2014). Review of ShowerStart evolve.
National_Grid_2014_ShowerStart_Savings_Final_2015-2-9
2 : Guidehouse (2020). Residential Baseline Study Phase 4
2020_Guidehouse_Residential_Baseline_Phase_4
3 : 2021_Guidehouse_TRM_Final_Report
4 : National Grid (2014). Review of ShowerStart evolve.
National_Grid_2014_ShowerStart_Savings_Final_2015-2-9
5 : Guidehouse (2020). Residential Baseline Study Phase 4
2020_Guidehouse_Residential_Baseline_Phase_4

2.41 Hot Water - Water Heating System

Measure Code	IE-WH-WHS
Market	Income Eligible
Program Type	Retrofit
Category	Water Heating

Measure Description:

Installation of high efficiency water heating equipment to replace the existing inefficient water heater.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Tankless Water Heater, Oil (Multifamily)	Income Eligible Coordinated Delivery (IE_CD)	EB1a074
Tankless Water Heater, Other (Multifamily)	Income Eligible Coordinated Delivery (IE_CD)	EB1a075
Indirect Water Heater, Other (Multifamily)	Income Eligible Coordinated Delivery (IE_CD)	EB1a076
Standalone Water Heater, Oil (Multifamily)	Income Eligible Coordinated Delivery (IE_CD)	EB1a077
Standalone Water Heater, Other (Multifamily)	Income Eligible Coordinated Delivery (IE_CD)	EB1a078
Indirect Water Heater, Gas (Single Family)	Income Eligible Coordinated Delivery (IE_CD)	GB1a054
Stand Alone Water Heater, Gas (Single Family)	Income Eligible Coordinated Delivery (IE_CD)	GB1a055
On Demand Water Heater, Gas (Multifamily)	Income Eligible Coordinated Delivery (IE_CD)	GB1a027
Indirect Water Heater, Gas (Multifamily)	Income Eligible Coordinated Delivery (IE_CD)	GB1a028
Stand Alone Water Heater, Gas (Multifamily)	Income Eligible Coordinated Delivery (IE_CD)	GB1a029

Algorithms for Calculating Primary Energy Impact:

Eversource and CMA:

The program delivery agency uses vendor calculated energy savings for all allowed measures. These savings values are calculated with custom building simulation model software where the user inputs a set of technical data about the house and the software calculates building heating and cooling loads and other key parameters. The building model is based on thermal transfer, building gains, and a variable-based heating/cooling degree day/hour climate model. This provides an initial estimate of energy use that may be compared with actual billing data to adjust as needed for existing conditions. Then, specific recommendations for improvements are added and savings are calculated using measure-specific heat transfer algorithms.

Rather than using a fixed degree day approach, the building model estimates both heating degree days and cooling degree hours based on the actual characteristics and location of the house to determine the heating and cooling balance point temperatures. Savings from shell measures use standard U-value, area, and degree day algorithms, (see attached for details). Infiltration savings use site-specific seasonal factors to convert measured leakage to seasonal energy impacts. HVAC savings are estimated based on changes in system and/or distribution efficiency improvements, using ASHRAE 152 and BPI recommendations as their basis. Interactivity between architectural and mechanical measures is always included, to avoid overestimating savings due to "adding" individual measure results.

All PAs except for Eversource and CMA:

$$MMBtu = Units \times 18MMBtu/unit \times (1/EF_{BASE}) - (1/EF_{EE})$$

Where:
Unit = Total number of dwelling units utilizing the water heater
18 MMBtu/Unit = Average annual water heating energy demand per dwelling unit [1]
EF_{BASE} = Energy Factor for the baseline water heater
EF_{EE} = Energy Factor for the new efficient water heater

Baseline Efficiency:

The baseline efficiency case is a stand-alone tank water heater is an existing 0.58 UEF standalone water heater.[2]

High Efficiency:

The high efficiency case is a stand-alone storage water heater with an energy factor >= 0.66.[3]

Measure Life:

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML

Indirect Water Heater	IE_CD	All	20[4]	n/a	n/a	20
Stand Alone Water Heater	IE_CD	All	13[5]	n/a	n/a	13
On Demand/Tankless Water Heater	IE_CD	All	20[6]	n/a	n/a	20

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Water Heater, Gas (Multifamily)	IE_CD	Berkshire	1.00	n/a	0.80	n/a	n/a	n/a	n/a
Water Heater, Gas (Multifamily)	IE_CD	Columbia	1.00	n/a	0.96	n/a	n/a	n/a	n/a
Water Heater, Gas (Multifamily)	IE_CD	Eversource	1.00	n/a	1.05	n/a	n/a	n/a	n/a
Water Heater, Gas (Multifamily)	IE_CD	Liberty	1.00	n/a	0.96	n/a	n/a	n/a	n/a
Water Heater, Gas (Multifamily)	IE_CD	National Grid	1.00	n/a	0.75	n/a	n/a	n/a	n/a
Water Heater, Gas (Multifamily)	IE_CD	Unitil	1.00	n/a	0.96	n/a	n/a	n/a	n/a
Water Heater, Oil (Multifamily)	IE_CD	All	1.00	n/a	1.00	n/a	n/a	n/a	n/a
Water Heater, Other (Multifamily)	IE_CD	All	1.00	n/a	1.00	n/a	n/a	n/a	n/a

In-Service Rates:

All installations have 100% in service rate since all PA programs include verification of equipment installations.

Realization Rates:

Realization rates are based on evaluation results. [7]

Coincidence Factors:

There are no electric savings for this measure.

Impact Factors for Calculating Net Savings:

Measure Name	Core Initiative	PA	FR	SO$_P$	SO$_{NP}$	NTG
Water Heater	IE_CD	All	0.00	0.00	0.00	1.00

Non-Energy Impacts:

NEI values are rolled up, component values can be found in Appendix B.

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per kWh	Annual $ per Therm	One-time $ per Therm
Stand Alone Water Heater (Single Family)	IE_CD	All	$1.30				Varies by PA	$0.08
Indirect Water Heater (Single Family)	IE_CD	All	$0.70				Varies by PA	$0.08
Water Heater, Gas (Multifamily)	IE_CD	All	$1.19				Varies by PA	$0.08
Water Heater, Oil/Other (Multifamily)	IE_CD	All	$1.19					

Endnotes:

1 : GDS Associates, Inc. (2009). Natural Gas Energy Efficiency Potential in Massachusetts. GDS_2009_Natural_Gas_Energy_Efficiency_Potential_in_MA
2 : This is the weighted average baseline UEF of the medium and high draw units based in 2016-2017 rebated units. 2021_Guidehouse_TRM_Final_Report
3 : This is the weighted average efficient UEF of the medium and high draw units based in 2016-2017 rebated units. 2021_Guidehouse_TRM_Final_Report
4 : GDS Associates, Inc. (2009). Natural Gas Energy Efficiency Potential in Massachusetts. GDS_2009_Natural_Gas_Energy_Efficiency_Potential_in_MA
5 : DOE (2008). ENERGY STAR® Residential Water Heaters: Final Criteria Analysis. Prepared for the DOE; Page 10. DOE_2008_ENERGY_STAR_Residential_Water_Heaters_Final_Criteria_Analysis
6 : DOE (2008). ENERGY STAR® Residential Water Heaters: Final Criteria Analysis. Prepared for the DOE; Page 10. DOE_2008_ENERGY_STAR_Residential_Water_Heaters_Final_Criteria_Analysis
7 : The Cadmus Group (2015). Massachusetts Low-Income Multifamily Initiative Impact Evaluation. CADMUS_2015_Low_Income_Multifamily_Impact_Evaluation

2.42 Lighting - Income Eligible

Measure Code	IE-L-LEDB
Market	Income Eligible
Program Type	Lost Opportunity, New Construction, Retrofit
Category	Lighting

Measure Description:

The installation of Light-Emitting Diode (LED) bulbs and fixtures. LEDs offer comparable luminosity to incandescent and halogen bulbs at significantly less wattage and significantly longer lamp lifetimes.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
LED Bulb (Single Family)	Income Eligible Coordinated Delivery (IE_CD)	EB1a033
LED Bulb (Specialty) (Single Family)	Income Eligible Coordinated Delivery (IE_CD)	EB1a034
LED Bulb (Reflectors) (Single Family)	Income Eligible Coordinated Delivery (IE_CD)	EB1a035
LED Bulb (Multifamily)	Income Eligible Coordinated Delivery (IE_CD)	EB1a103
LED Bulb (Specialty) (Multifamily)	Income Eligible Coordinated Delivery (IE_CD)	EB1a104
LED Bulb (Reflectors) (Multifamily)	Income Eligible Coordinated Delivery (IE_CD)	EB1a105
LED Bulb, Common Area (Multifamily)	Income Eligible Coordinated Delivery (IE_CD)	EB1a108
Indoor Fixture (Single Family)	Income Eligible Coordinated Delivery (IE_CD)	EB1a036
LED Fixture, Indoor In Unit (Multifamily)	Income Eligible Coordinated Delivery (IE_CD)	EB1a107
LED Fixture, Outdoor In Unit (Multifamily)	Income Eligible Coordinated Delivery (IE_CD)	EB1a106

LED Fixture, Indoor Common Area (Multifamily)	Income Eligible Coordinated Delivery (IE_CD)	EB1a109
LED Fixture, Linear Indoor Common Area (Multifamily)	Income Eligible Coordinated Delivery (IE_CD)	EB1a110
LED Fixture, Outdoor Common Area (Multifamily)	Income Eligible Coordinated Delivery (IE_CD)	EB1a111

Algorithms for Calculating Primary Energy Impact:

Factors for Calculating Savings for Residential Lighting

Delta watts[1] and hours of use[2] noted in the table below for deemed measures are based on evaluation results. For vendor-calculated measures, delta watts are based on verification of pre-installation wattage, and hours of use are input by the vendor based on space type. For Income Eligible In-Unit Fixtures, vendors reference the 2014 Northeast HOU Study (see table below).[3] For Income Eligible common area measures, vendors calculate the hours based on site conditions.

Savings are then calculated per the algorithm below.
$\Delta kWh = ((QTY_{PRE} \times Watts_{PRE}) - (QTY_{EE} \times Watts_{EE}) \times Hours)/1000$
$\Delta kW = \Delta kWh \times kW/kWh$

Where:
QTYPRE   = Quantity of pre-retrofit fixtures/bulbs
QTYEE   = Quantity of efficient fixtures/bulbs installed
WattsPRE = Rated watts of pre-retrofit fixtures/bulbs
WattsEE   = Rated watts of efficient fixtures/bulbs installed
Hours = Annual hours of operation for pre-retrofit case. Note that any reduction in hours of operation due to the addition of lighting controls are calculated separately; refer to the relevant TRM entry.
kW/kWh   = Average kW reduction per kWh reduction: 0.00025 kW/kWh[4]

Measure Name	Core Initiative	Δ Watts	Annual HOU	# of Bulbs	ΔKWh	ΔkW
LED Bulb (Single Family)	IE_CD	43	949	1	40.8	0.01
LED Bulb (Specialty) (Single Family)	IE_CD	36	949	1	34.2	0.01
LED Bulb (Reflectors) (Single Family)	IE_CD	45	949	1	42.7	0.01

Measure Name	Core Initiative	Δ Watts	Annual HOU	# of Bulbs	ΔKWh	ΔkW
LED Bulb (Multifamily)	IE_CD	43	949	1	40.8	0.01
LED Bulb (Specialty) (Multifamily)	IE_CD	36	949	1	34.2	0.01
LED Bulb (Reflectors) (Multifamily)	IE_CD	45	949	1	42.7	0.1
LED Bulb, Common Area (Multifamily)	IE_CD	Vendor Input	Varies by Space Type	N/A	Vendor Calculated	Calculated
Indoor Fixture (Single Family)	IE_CD				62	0.02
LED Fixture, Indoor In Unit (Multifamily)	IE_CD	37.63	803	1.49	41	0.01
LED Fixture, Outdoor In Unit (Multifamily)	IE_CD	37.63	803	2	55	0.01
LED Fixture, Indoor Common Area (Multifamily)	IE_CD	Vendor Calc	6388	Vendor Calc	Vendor Calc	Calculated
LED Fixture, Linear Indoor Common Area (Multifamily)	IE_CD	Vendor Calc	6388	Vendor Calc	Vendor Calc	Calculated
LED Fixture, Outdoor Common Area (Multifamily)	IE_CD	Vendor Calc	6388	Vendor Calc	Vendor Calc	Calculated

Income-Eligible In-Unit Fixture HOU

Space Type	Annual HOU
Bedroom	730
Bathroom	657
Kitchen	1,460
Living Space	1,205
Dining Room	986
Exterior	2,008
Other	621

Baseline Efficiency:

The baseline efficiency case for in-unit bulbs is a combination of an incandescent bulb and halogen bulb. The baseline efficiency case for In-Unit Fixtures and all Common Area bulbs and fixtures is the existing site conditions, as identified by the vendor.

High Efficiency:

The high efficiency case is an LED.

Measure Life:

The table below includes the Expected Useful Life (amount of time the LED is physically expected to last) and Adjusted Measure Life (the amount of time that the PAs claim savings). EULs for bulbs are based on a rated lifetime of 15,000 hours, per ENERGY STAR specifications. EULs for Common Area Fixtures are based on the following rated lives: Indoor - 55,000 hours; Linear - 75,000 hours; Exterior - 50,000 hours. AMLs for bulbs were derived via a consensus process with DOER.

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
LED Bulb (Single Family) LED Bulb (Multi Family) LED Bulb, Reflector (Single Family) LED Bulb, Reflector (Multi Family) LED Bulb, Specialty (Single Family) LED Bulb, Specialty (Multi Family)	IE_CD	All	15	n/a	n/a	1
LED Bulb, Common Area (Multifamily)	IE_CD	All	3	n/a	n/a	1
LED Fixture, Outdoor In Unit (Multifamily)	IE_CD	All	20	n/a	n/a	5
LED Fixture, Indoor Common Area (Multifamily)	IE_CD	All	6	n/a	n/a	6
LED Fixture, Linear Indoor Common Area (Multifamily)	IE_CD	All	8	n/a	n/a	8
LED Fixture, Outdoor Common Area (Multifamily)	IE_CD	All	11	n/a	n/a	11
Indoor Fixture (Single Family)	IE_CD	All	20	n/a	n/a	9

Other Resource Impacts:

There are no other resource impacts. Interactive effects for direct install lighting are assumed to be captured in the realization rates for insulation measures within the same program.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR$_E$	RR$_{NE}$	RR$_{SP}$	RR$_{WP}$	CF$_{SP}$	CF$_{WP}$
LED Bulb (Single Family) LED Bulb (Specialty) (Single Family) LED Bulb (Reflectors) (Single Family) LED Bulb (Multifamily) LED Bulb (Specialty) (Multifamily) LED Bulb (Reflectors) (Multifamily)	IE_CD	All	1.00	1.01	1.00	1.20	0.93	0.55	0.85
LED Bulb, Common Area (Multifamily)	IE_CD	All	1.00	Varies by PA	Varies by PA	Varies by PA	Varies by PA	0.80	0.61
Indoor Fixture (Single Family)	IE_CD	All	1.00	1.01	1.00	1.20	0.93	0.19	0.35
LED Fixture, Indoor In Unit (Multifamily)	IE_CD	All	1.00	1.01	1.00	1.20	0.93	0.19	0.35
LED Fixture, Outdoor In Unit (Multifamily)	IE_CD	All	1.00	1.01	1.00	1.20	0.93	0.19	0.35
LED Fixture, Indoor Common Area (Multifamily)	IE_CD	All	1.00	PA Specific	PA Specific	PA Specific	PA Specific	0.34	0.30
LED Fixture, Linear Indoor Common Area (Multifamily)	IE_CD	All	1.00	PA Specific	PA Specific	PA Specific	PA Specific	0.34	0.30
LED Fixture, Outdoor Common Area (Multifamily)	IE_CD	All	1.00	PA Specific	PA Specific	PA Specific	PA Specific	0.19	0.20

In-Service Rate:
Direct Install ISRs are assumed to be 100%.

Realization Rates:
Realization rates for Multifamily Common Area Lighting are PA specific and based on evaluation.[5]
Realization rates for In-Unit lighting are 100% as vendors are using deemed savings. Electric realization rates have been adjusted to account for interactive effects.[6]

Coincidence Factors:

Summer and winter coincidence factors are estimated using the demand allocation methodology described in the Demand Impact Model which is developed based on the Residential Baseline Study.[7]

Impact Factors for Calculating Net Savings:

Net to gross factors for Income-Eligible is assumed to be 100%.

Measure Name	Core Initiative	PA	FR	SO$_P$	SO$_{NP}$	NTG
LED Bulb (Single Family) LED Bulb (Multi Family) LED Bulb (Specialty) (Single Family) LED Bulb (Specialty) (MultiFamily) LED Bulb (Reflectors) (Single Family) LED Bulb (Reflectors) (MultiFamily) LED Bulb, Common Area (Multifamily) Indoor Fixture (Single Family) LED Fixture, Indoor In Unit (Multifamily) LED Fixture, Outdoor In Unit (Multifamily) LED Fixture, Indoor Common Area (Multifamily) LED Fixture, Linear Indoor Common Area (Multifamily) LED Fixture, Outdoor Common Area (Multifamily)	IE_CD	All	0.0	0.0	0.0	1.0

Non-Energy Impacts:

NEI values are rolled up, component values can be found in Appendix B.

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per KWh	Annual $ per Therm	One-time $ per Therm
LED Bulb (Single Family) LED Bulb (MultiFamily) LED Bulb (Specialty) (Single Family) LED Bulb (Specialty) (MultiFamily) LED Bulb (Reflectors) (Single Family) LED Bulb (Reflectors) (MultiFamily)	IE_CD	All			Rate Discount NEI; Varies by PA	$0.005		
LED Bulb, Common Area	IE_CD	All	$26/Unit.		Rate	$0.005		

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per KWh	Annual $ per Therm	One-time $ per Therm
(Multifamily)			Values are applied per fixture in the BC model, and adjusted for the number of fixtures/unit.		Discount NEI; Varies by PA			
Indoor Fixture (Single Family)	IE_CD	All			Rate Discount NEI; Varies by PA	$0.01		
LED Fixture, Indoor In Unit (Multifamily)	IE_CD	All			Rate Discount NEI; Varies by PA	$0.01		
LED Fixture, Outdoor In Unit (Multifamily)	IE_CD	All			Rate Discount NEI; Varies by PA	$0.01		
LED Fixture, Indoor Common Area (Multifamily)	IE_CD	All	$26/Unit. Values are applied per fixture in the BC model, and adjusted for the number of fixtures/unit.		Rate Discount NEI; Varies by PA	$0.01		
LED Fixture, Linear Indoor Common Area (Multifamily)	IE_CD	All	$26/Unit. Values are applied per fixture in the BC model, and adjusted for the number of		Rate Discount NEI; Varies by PA	$0.01		

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per KWh	Annual $ per Therm	One-time $ per Therm
			fixtures/unit.					
LED Fixture, Outdoor Common Area (Multifamily)	IE_CD	All	$26/Unit. Values are applied per fixture in the BC model, and adjusted for the number of fixtures/unit.		Rate Discount NEI; Varies by PA	$0.01		

Endnotes:

1 : NMR Group, Inc. (2020). Delta Watt Update (MA19R09-E). 2019_NMR_DeltaWattReport

2 : NMR Group, Inc. (2020). Residential Lighting Hours-of-Use Quick Hit Study (MA20R21-E). 2019_NMR_LightingHOU_Update

3 : NMR Group, Inc. (2014). Northeast Residential Hours of Use Study. NMR_2014_ Northeast_Residential_Lighting_HOU

4 : Guidehouse (2020). Residential Baseline Study Phase 4 2020_Guidehouse_Residential_Baseline_Phase_4

5 : Cadmus (2015). Low Income Multifamily Impact Impact Evaluation. CADMUS_2015_Low_Income_Multifamily_Impact_Evaluation

6 : Cadmus (2016). Lighting Interactive Effects Memo. Cadmus_2016_MA_Lighting_Interactive_Effects_Final

7 : Guidehouse (2020). Residential Baseline Study Phase 4. 2020_Guidehouse_Residential_Baseline_Phase_4

2.43 Lighting - Occupancy Sensors

Measure Code	IE-L-OS
Market	Income Eligible
Program Type	Retrofit
Category	Lighting

Measure Description:

The installation of occupancy sensors for lighting fixtures. This measure involves installing an occupancy sensor that controls lighting fixtures and limits their use when the space is unoccupied.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Occupancy Sensor, Common Area (Multifamily)	Income Eligible Coordinated Delivery (IE_CD)	EB1a112

Algorithms for Calculating Primary Energy Impact:

Unit savings are based on one of the following algorithms, as appropriate to the situation.

For on/off sensors, savings are as follows:
ΔkWh = (WattsControlled * Hours * SVG)/ 1000

Where:
Watts controlled = Connected load wattage controlled by Sensor
Hours = Run time of fixture before the installation of sensors
Svg = Percentage by which hours of operation are reduced due to the sensor; site specific

For high/low sensors, savings are as follows:
ΔkWh = ((HighWatts - LowWatts) * Hours)/ 1000

Where:
HighWatts = Full load of fixture
LowWatts = Wattage of fixture when no occupancy is detected; input by auditor, typically 50% of HighWatts
Hours = Run time of fixture (24 hours, fixtures are always on)

Baseline Efficiency:

The baseline condition for this measure is a lighting fixture that is not controlled by an occupancy sensor.

High Efficiency:

The high efficiency case is a lighting fixture that operates with connected occupancy sensors.

Measure Life:

The measure life is 10 years.

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Occupancy Sensor, Common Area	All	All	1.00	1.00	1.00	1.00	1.00	0.15	0.13

In-Service Rates:
In-service rates are set to 100% based on the assumption that all purchased units are installed,

Realization Rates:
Realization rates are set to 100%.

Coincidence Factors:
Coincidence factors come from the Demand Impact Model.[1]

Impact Factors for Calculating Net Savings:

Net to gross factors for Residential Coordinated Delivery are from the Guidehouse NTG evaluation.

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Occupancy Sensor, Common Area (Multifamily)	IE_CD	All	0.00	0.00	0.00	1.00

Non-Energy Impacts:

NEI values are rolled up, component values can be found in Appendix B.

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per	Annual $ per Therm	One-time $ per

						KWh		Therm
Occupancy Sensor, Common Area (Multifamily)	IE_CD	All			Varies by PA	$0.01		

Endnotes:

1 : Guidehouse (2020). Residential Baseline Study Phase 4.
2020_Guidehouse_Residential_Baseline_Phase_4

2.44 Motor - Variable Frequency Drive

Measure Code	IE-MAD-VFD
Market	Income Eligible
Program Type	Retrofit
Category	Motors and Drives

Measure Description:

This measure covers the installation of variable speed drives according to the terms and conditions stated on the statewide worksheet. The measure covers multiple end use types and building types. The installation of this measure saves energy since the power required to rotate a pump or fan at lower speeds requires less power than when rotated at full speed.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Variable Frequency Drive (Multifamily)	Income Eligible Coordinated Delivery (IE_CD)	EB1a118

Algorithms for Calculating Primary Energy Impact:

$\Delta kWh = (HP)(kWh/HP)$
$\Delta kW = (HP)(kW/HP_{SP})$

Where:

HP $\quad$ = Rated horsepower for the impacted motor.
kWh / HP $\quad$ = Annual electric energy reduction based on building and equipment type. See table below.
kW / HP$_{SP}$ = Summer demand reduction based on building and equipment type. See table below.
kW / HP$_{WP}$ = Winter demand reduction based on building and equipment type. See table below.

Savings factors below already account for motor efficiency and consequently an adjustment is not required in the algorithm.

Savings Factors for C&I VFDs (kWh/HP[1] and kW/HP[2])

Savings Factor	Building Type	Building Exhaust Fan	Cooling Tower Fan	Chilled Water Pump	Boiler Feed Water Pump	Hot Water Circulating Pump	MAF - Make-up Air Fan	Return Fan	Supply Fan	WS Heat Pump Circulating Loop
Annual Energy Savings Factors (kWh/HP)	Multi-Family	3202	889	1374	2340	2400	3082	1374	1319	3713
Summer Demand Savings Factors (kW/HP$_{SP}$)	Multi-Family	0.109	-0.023	0.174	0.457	0.091	0.109	0.287	0.274	0.218
Winter Demand Savings Factors (kW/HP$_{WP}$)	Multi-Family	0.109	-0.006	0.184	0.355	0.21	0.109	0.26	0.252	0.282

Baseline Efficiency:

The baseline efficiency case measure varies with equipment type. All baselines assume either a constant or 2-speed motor. Air or water volume/temperature is controlled using valves, dampers, and/or reheats.

High Efficiency:

In the high efficiency case, pump flow or fan air volume is directly controlled using downstream information. The pump or fan will automatically adjust its speed based on inputted set points and the downstream feedback it receives.

Measure Life:

The measure life is 13 years.[3]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Variable Frequency Drive (Multifamily)	IE_CD	All	13	n/a	n/a	13

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Variable Frequency Drive (Multifamily)	IE_CD	All	1.00	1.00	n/a	1.00	1.00	1.00	1.00

In-Service Rates:

All installations have 100% in service rate since all PAs programs include verification of equipment installations.

Realization Rates:

Realization rates are assumed to be 100%.

Coincidence Factors:

Coincidence factors are set to 100% since kW savings are calculated.

Impact Factors for Calculating Net Savings:

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Variable Frequency Drive (Multifamily)	IE_CD	All	0.00	0.00	0.00	1.00

Non-Energy Impacts:

NEI values are rolled up, component values can be found in Appendix B.

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per kWh	Annual $ per Therm	One-time $ per Therm
Variable Frequency Drive (Multifamily)	IE_CD	All			Varies by PA	$0.01		

Endnotes:

1 : Chan, Tumin (2010). Formulation of a Prescriptive Incentive for the VFD and Motors & VFD impact tables at NSTAR.
Chan_2010_Formulation_of_a_Prescriptive_Incentive_for_the_VFD_and_Motors_and_VFD_Impact_Tables_at_NSTAR
2 : For Chilled Water Pump, Hot Water Circ. Pump, Return Fan, Supply Fan, and WSHP Circ. Loop: kW/HP estimates derived from Cadmus (2012). Variable Speed Drive Loadshape Project. Prepared for

the NEEP Regional Evaluation, Measurement & Verification Forum. Other drive type kW/HP savings estimates based on Chan, Tumin (2010). Formulation of a Prescriptive Incentive for the VFD and Motors & VFD impact tables at NSTAR. Prepared for NSTAR.

3 : Energy & Resource Solutions (2005). Measure Life Study. ERS_2005_Measure_Life_Study

2.45 Plug Load - Advanced Power Strip

Measure Code	IE-PL-APS
Market	Income Eligible
Program Type	Retrofit
Category	Behavior

Measure Description:

Advanced power strips can automatically eliminate standby power loads of electronic peripheral devices that are not needed (DVD player, computer printer, scanner, etc.) either automatically or when an electronic control device (typically a television or personal computer) is in standby or off mode.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Smart Strip	Income Eligible Coordinated Delivery (IE_CD)	EB1a120

Algorithms for Calculating Primary Energy Impact:

Unit kWh savings are deemed based on study results.[1] Demand savings are derived from the demand impact model which is developed as part of the Residential Baseline Study.[2]

Savings for Smart Strips

Measure Name	Core Initiative	kWh	kW
Smart Strip	All	105	0.010

Baseline Efficiency:

The baseline efficiency case is the customers' devices as they are currently operating.

High Efficiency:

The high efficiency case is the installation of an Advanced Power Strip.

Measure Life:

The measure life is assumed to be 5 years.

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Smart Strip	IE_CD	All	0.73	0.92	0.92	0.92	1.00	1.00

In-Service Rates:

In-Service Rates are blended and based on evaluation results.[3] [4]

Realization Rates:

Realization rates account for the savings lost due to improper customer set-up/use of devices, as found in the referenced study.[5]

Coincidence Factors:

Summer and winter coincidence factors are based on referenced study.[6]

Impact Factors for Calculating Net Savings:

Measure Name	Core Initiative	PA	NTG
Smart Strip	IE_CD	All	1.00

Non-Energy Impacts:

There are no non-energy impacts identified for this measure.

Endnotes:

1 : NMR Group, Inc. (2019). Advanced Power Strip Metering Study.
2019_NMR_APSMeteringReport_Revised
2 : Guidehouse (2020). Residential Baseline Study Phase 4
2020_Guidehouse_Residential_Baseline_Phase_4
3 : Guidehouse (2021). RCD ISR Analysis. 2021_Guidehouse_RCD ISR 2020 Analysis_FINAL
4 : Guidehouse (2021). Virtual Home Energy Assessment Study.
2021_Guidehouse_VHEA_Report_FINAL
5 : NMR Group, Inc. (2019). Advanced Power Strip Metering Study.
2019_NMR_APSMeteringReport_Revised
6 : NMR Group, Inc. (2019). Advanced Power Strip Metering Study.
2018_NMR_APS_Metering_Report

2.46 Refrigeration - Vending Miser

Measure Code	IE-R-VM
Market	Income Eligible
Program Type	Retrofit
Category	Refrigeration

Measure Description:

Controls can significantly reduce the energy consumption of vending machine lighting and refrigeration systems. Qualifying controls must power down these systems during periods of inactivity but, in the case of refrigerated machines, must always maintain a cool product that meets customer expectations. This measure applies to refrigerated beverage vending machines, non-refrigerated snack vending machines, and glass front refrigerated coolers. This measure should not be applied to ENERGY STAR® qualified vending machines, as they already have built-in controls.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Vending Misers	Income Eligible Coordinated Delivery (IE_CD)	EB1a134

Algorithms for Calculating Primary Energy Impact:

$\Delta kWh = (kWRATED)(Hours)(SAVE)$
$\Delta kW = \Delta kWh / Hours$

Where:
kWrated = Rated kW of connected equipment. Seefor default rated kW by connected equipment type.
Hours = Operating hours of the connected equipment: default of 8,760 hours
SAVE = Percent savings factor for the connected equipment. See table below for values.

Vending Machine and Cooler Controls Savings Factors[1]

Equipment Type	kWRATED	SAVE (%)	ΔkW	ΔkWh
Refrigerated Beverage Vending Machines	0.40	46	0.18	1612

Baseline Efficiency:

The baseline efficiency case is a standard efficiency refrigerated beverage vending machine without a control system capable of powering down lighting and refrigeration systems during periods of inactivity.

High Efficiency:

The high efficiency case is a standard efficiency refrigerated beverage vending machine with a control system capable of powering down lighting and refrigeration systems during periods of inactivity.

Measure Life:

The measure life is 5 years.[2]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Vending Misers	IE_CD	All	5	n/a	n/a	5

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Vending Misers	IE_CD	All	1.00	1.00	1.00	1.00	1.00	0.90	0.90

In-Service Rates:
All installations have 100% in service rate since all PAs' programs include verification of equipment installations.

Realization Rates:
Realization rates are assumed to be 100%.

Coincidence Factors:
Coincidence factors based on staff estimates- assumed that savings occur during off peak hours.

Impact Factors for Calculating Net Savings:

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Vending Misers	IE_CD	All	0.00	0.00	0.00	1.00

Non-Energy Impacts:

NEI values are rolled up, component values can be found in Appendix B.

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per kWh	Annual $ per Therm	One-time $ per Therm
Vending	IE_CD	All			Varies by	$0.01		

Misers					PA			

Endnotes:

1 : USA Technologies Energy Management Product Sheets (2006).
USA_Tech_2006_Energy_Management_Product_Sheets
2 : Energy & Resource Solutions (2005). Measure Life Study. ERS_2005_Measure_Life_Study

3   Commercial & Industrial Efficiency Measures

3.1 Appliance - Dehumidifier

Measure Code	COM-PL-DH
Market	Commercial
Program Type	Time of Sale
Category	Appliances

Measure Description:

Rebate for the purchase of an Energy Star dehumidifier or early retirement of an existing dehumidifier.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Dehumidifier (OMP)	C&I New & Replacement Equipment (CI_EQUIP)	EC2b186

Algorithms for Calculating Primary Energy Impact:

Unit savings are deemed based on the following algorithms and assumptions:
ΔkWh New = Dehumidification Load * ((1/EffBase)-(1/EffEE))
ΔkWh Recycling = Dehumidification Load * ((1/EffRetire)-(1/EffBase))

Where:
Dehumidification Load = Typical annual moisture removal, in Liters/year.   Average annual dehumidifictaion load is 1,520 Liters/year.[1]
EffRETIRE = Average efficiency of model being recycled, in Liters/kWh (1.6 Liters/kWh)
EffBASE = Average efficiency of model meeting the federal standard, in Liters/kWh (2.8 Liters/kWh)
EffEE = Efficiency of ENERGY STAR® model, in Liters/kWh (3.3 Liters/kWh)

Dehumidifier Recycling savings is from an evaluation study.[2]

Demand savings are derived from the demand impact model which is developed as part of the Residential Baseline Study.[3]

Measure Name	ΔkWh	ΔkW
Dehumidifier	82.3	0.02

Baseline Efficiency:

The baseline efficiency for rebates on new equipment is a unit meeting the current federal standard (2.8 Liters/kWh).[4]

High Efficiency:

The high efficiency case for rebates on new equipment is an ENERGY STAR® unit (3.3 Liters/kWh).[6] The high efficiency case for recylcing is a new unit that meets the current federal standard (2.8 Liters/kWh).

Measure Life:

The measure life is 17 years for the dehumidifier and 4 years for dehumidifier recycling. [7]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Dehumidifier	CI_EQUIP	All	17	n/a	n/a	17

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Dehumidifier	CI_EQUIP	All	0.99	1.00	n/a	1.00	1.00	0.82	0.17

In-Service Rates:
In-service rate for units incentivized through rebates is based on evaluation results.[8]   For recycling, in service rates are 100% because recycled units are collected.

Realization Rates:
Realization rates are set to 100% as unit savings are deemed.

Coincidence Factors:
Summer and winter coincidence factors are estimated using the demand allocation methodology described in the Demand Impact Model which is developed based on the Residential Baseline Study.[9]

Impact Factors for Calculating Net Savings:

Net-to-Gross values are based on evaluation results.[10]

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG

Dehumidifier	CI_EQUIP	All	0.25	0.00	0.09	0.84

Non-Energy Impacts:

There are no non-energy impacts identified for this measure.

Endnotes:

1 : Guidehouse (2021). Comprehensive TRM Review. 2021_Guidehouse_TRM_Final_Report
2 : Guidehouse (2021). Appliance Recycling Impact Study
2021_Guidehouse_Appliance_Recycling_2019_Impact_Report
3 : Guidehouse (2020). Residential Baseline Study Phase 4
2020_Guidehouse_Residential_Baseline_Phase_4
4 : 2020 Current Federal Standard: https://www.ecfr.gov/cgi-bin/text-idx?rgn=div8&node=10:3.0.1.4.18.3.9.2
6 : ENERGY STAR Dehumidifiers Version 5
7 : Guidehouse (2021). Comprehensive TRM Review. 2021_Guidehouse_TRM_Final_Report
8 : NMR Group Inc. (2021). Residential Products In Service Rates Memo. 2021_NMR_Products_ISR
9 : Guidehouse (2020). Residential Baseline Study Phase 4
2020_Guidehouse_Residential_Baseline_Phase_4
10 : NMR (2021) C&I Omnibus NTG Study 2021_NMR_C&I_Omnibus_NTG

3.2 Appliance - Refrigerator/Freezer Recycling

Measure Code	COM-A-RFR
Market	Commercial
Program Type	Direct Install, Early Replacement, Early Retirement, Recycling, Retrofit
Category	Appliances, Food Service Equipment

Measure Description:

Recycling of a qualified refrigerator or freezer.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Freezer Recycling	C&I Existing Building Retrofit (CI_RETRO)	EC2a116
Refrigerator Recycling	C&I Existing Building Retrofit (CI_RETRO)	EC2a117

Algorithms for Calculating Primary Energy Impact:

Unit savings are deemed and reflect corresponding Residential product offering. For full detail, please reference the Residential measure savings assumptions (measure code RES-A-RFR).

Measure Name	kWh	kW
Freezer Recycling (Turnkey)	753	0.13
Refrigerator Recycling (Turnkey)	1,005	0.17

Baseline Efficiency:

The baseline efficiency case is an old, inefficient but working refrigerator or freezer.

High Efficiency:

The high efficiency case assumes no replacement of equipment.

Measure Life:

The measure life for product recycling is assumed to be 4 years.

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML

Freezer/Refrigerator Recycling (Turnkey)	CI_RETRO	All	4	n/a	n/a	4

Other Resource Impacts:

There are no other resource impacts associated with these measures.

Impact Factors for Calculating Adjusted Gross Savings:

Measure	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Freezer Recycling (Turnkey)	CI_RETRO	All	1.00	0.83	0.83	0.83	0.83	0.85	0.65
Refrigerator Recycling (Turnkey)	CI_RETRO	All	1.00	0.90	0.90	0.90	0.90	0.85	0.85

<u>**In-Service Rates**</u>:
Measure leveraging default 100% in-service rate.

<u>**Realization Rates:**</u>
Realization rates are set to the residential impact factors for the same measures.

<u>**Coincidence Factors:**</u>
Coincidence factors are set to the residential coincidence factors for the same measures. Summer and winter coincidence factors are estimated using the demand allocation methodology described in the Demand Impact Model which is developed based on the Residential Baseline Study.[6]

Impact Factors for Calculating Net Savings:

All PAs use Statewide prescriptive net-to-gross results.[1]

Measure	Core Initiative	PA	FR	SO_p	SO_{NP}	NTG
Freezer/Refrigerator Recycling (Turnkey)	CI_RETRO	All	0.135	0.053	0.018	0.94

Non-Energy Impacts:

There are no non-energy impacts identified for this measure.

Endnotes:

1 : NMR Group, Inc. (2018). Massachusetts Sponsors' Commercial and Industrial Free-ridership and Spillover Study. 2018_NMR_CI FR-SO Report

3.3 Appliance - Room Air Purifier

Measure Code	COM-PL-RAP
Market	Commercial
Program Type	Time of Sale
Category	Appliances

Measure Description:

Rebates provided for the purchase of an ENERGY STAR® qualified room air cleaner. ENERGY STAR® air cleaners are 40% more energy-efficient than standard models.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Room Air Purifier	C&I New & Replacement Equipment (CI_EQUIP)	EC2b108

Algorithms for Calculating Primary Energy Impact:

Unit savings are deemed per Energy Star appliance calculator.

Measure Name	Building Type	kWh	kW
Room Air Purifier	K-12	214	0.08
Room Air Purifier	Office (Small)	316	0.08
Room Air Purifier	Retail (Small)	373	0.08

Baseline Efficiency:

The baseline efficiency case is a unit with 2.0 CADR/Watt$_{dust}$.

High Efficiency:

The current EnergyStar specification requires a minimum of 2.0 CADR/Watt$_{dust}$. However, the ENERGY STAR average CADR/Watt (Dust) of models available in their US market database (approximately 170 models) is approximately 3.5 CADR/Watt$_{dust}$. Therefore it is assumed that the high efficiency unit has a 3.0 CADR/Watt$_{dust}$

Measure Life:

The measure life is 3 years.[1]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Room Air Purifier	CI_EQUIP	All	3	n/a	n/a	3

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Room Air Purifier	CI_EQUIP	All	0.97	1.00	n/a	1.00	1.00	1.00	1.00

<u>In-Service Rates:</u>
In-service rates are based on evaluation results.[2]

<u>Realization Rates:</u>
Realization rates are set to 100% since unit savings are deemed.

<u>Coincidence Factors:</u>
Summer and winter coincidence factors are calculated assuming that the unit runs continuously, 8760 hours/year.

Impact Factors for Calculating Net Savings:

Net to gross factors are based on evaluation results.[3]

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Room Air Purifier	CI_EQUIP	All	0.25	0.00	0.09	0.84

Non-Energy Impacts:

Impact factors are deemed based on study results.[4]

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per KWh	Annual $ per Therm	One-time $ per Therm
Room Air Purifier	CI_EQUIP	All			0.095			

Endnotes:

1 : Per agreement of MA Statewide Ventilation Subcommittee (2021). Measure assumptions were agreed upon by EEAC and PA stakeholders in support of ventilation measures to aid in alleviating COVID risks.

2 : NMR Group, Inc. (2018). Products Impact Evaluation of In-Service and Short Term Retention Rates Study. NMR_2018_Products_ISR_Study

3 : NMR Group, Inc. (2021). C&I Custom & Prescriptive Omnibus NTG Study. 2021_NMR_C&I_Omnibus_NTG

4 : NMR Group Inc (2021). O&M and Non-O&M NEI Study. 2021_NMR_CIOM and NonOM NEI Study

3.4 Behavior - Building Operator Certification

Measure Code	COM-BS-BOC
Market	Commercial
Program Type	Retrofit
Category	Behavior

Measure Description:

Building Operator Certification (BOC) is a nationally recognized training program designed to educate facilities personnel in the energy and resource efficient operation and maintenance of building systems. Savings include only operations, maintenance, and controls savings.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Other - Building Operator Certification	C&I Existing Building Retrofit (CI_RETRO)	EC2a028
Other - Building Operator Certification Plus	C&I Existing Building Retrofit (CI_RETRO)	EC2a125
Building Operator Certification, Gas	C&I Existing Building Retrofit (CI_RETRO)	GC2a001
Building Operator Certification Plus, Gas	C&I Existing Building Retrofit (CI_RETRO)	GC2a002

Algorithms for Calculating Primary Energy Impact:

Savings are deemed based on study results.[1]

Measure Name	kWh / SF / Student	MMBtu / SF / Student
Building Operator Certification	0.178	0.0007
Building Operator Certification Plus (capital upgrades)	0.364	0.0011

Baseline Efficiency:

No BOC training.

High Efficiency:

Completion and certification in a BOC level I or level II training course.

Measure Life:

Measure life of 5 years.[2]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Building Operator Certification	CI_RETRO	All	5	n/a	n/a	5

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Building Operator Certification	CI_RETRO	All	1.00	1.00	1.00	1.00	1.00	1.00	1.00

In-Service Rates:

All installations have 100% in service rate.

Realization Rates:

Realization rates are set to 100% since savings are based off of evaluation results.

Coincidence Factors:

Coincidence factors are based on Massachusetts Common Assumptions.

Impact Factors for Calculating Net Savings:

All PAs use statewide net-to-gross results.[3]

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Building Operator Certification, Electric	CI_RETRO	All	0.14	0.05	0.02	0.94
Building Operator Certification, Gas	CI_RETRO	All	0.22	0.03	0.00	0.80

Non-Energy Impacts:

There are no non-energy impacts identified for this measure.

Endnotes:

1 : Navigant Consulting (2015). Comprehensive Review of Non-Residential Training and Education Programs, with a Focus on Building Operator Certification. Navigant_2015_BOC_Review
2 : Navigant Consulting (2015). Comprehensive Review of Non-Residential Training and Education Programs, with a Focus on Building Operator Certification. Navigant_2015_BOC_Review
3 : Navigant Consulting (2015). Comprehensive Review of Non-Residential Training and Education Programs, with a Focus on Building Operator Certification. Navigant_2015_BOC_Review

3.5 Building Shell - Air Curtains

Measure Code	COM-BS-ACUR
Market	Commercial
Program Type	Retrofit
Category	Building Shell
Sub Category	Building Shell

Measure Description:

This measure applies to buildings with exterior entryways that utilize overhead doors.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Air Curtains, Electric	C&I New & Replacement Equipment (CI_EQUIP)	EC2b187
Air Curtains, Oil	C&I New & Replacement Equipment (CI_EQUIP)	EC2b188
Air Curtains, Propane	C&I New & Replacement Equipment (CI_EQUIP)	EC2b189
Air Curtains, Gas	C&I New & Replacement Equipment (CI_EQUIP)	GC2b084

Algorithms for Calculating Primary Energy Impact:

Eligibility: no additional features (i.e. heated air curtain), no preexisting barriers (i.e. strip curtains). Control System is installed to ensure air curtain is off when door is closed.

Deemed electric and fuel savings per square foot, per year:[1]

Measure Name	Annual kWh savings per square foot	Annual MMBTU savings per square foot
Air Curtains, Electric	59	n/a
Air Curtains, Oil	(2)	1
Air Curtains, Propane	(2)	1
Air Curtains, Gas	(2)	1

Baseline Efficiency:

No air barriers between indoor/outdoor space when door is open.

High Efficiency:

The high efficiency case is the existing building after the air curtain is installed.

Measure Life:

The measure life is 15 years.[2]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Air Curtains	CI_EQUIP	All	15	n/a	n/a	15

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}[3]	CF_{WP}[3]
Air Curtains, Electric	CI_EQUIP	All	1.00	1.00	1.00	1.00	1.00	0.31	0.81
Air Curtains, Oil	CI_EQUIP	All	1.00	1.00	1.00	n/a	n/a	n/a	n/a
Air Curtains, Propane	CI_EQUIP	All	1.00	1.00	1.00	n/a	n/a	n/a	n/a
Air Curtains, Gas	CI_EQUIP	All	1.00	1.00	1.00	n/a	n/a	n/a	n/a

In-Service Rates:

All installations have 100% in service rate since all PA programs include verification of equipment installations.

Realization Rates:

Realization rates assumed to be 100% until evaluated.

Impact Factors for Calculating Net Savings:

Net to gross factors are based on the 2021 Omnibus NTG Study.[4]

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Air Curtains, Electric	CI_EQUIP	All	0.25	0.002	0.085	0.837
Air Curtains, Oil	CI_EQUIP	All	0.25	0.002	0.085	0.837
Air Curtains, Propane	CI_EQUIP	All	0.25	0.002	0.085	0.837
Air Curtains, Gas	CI_EQUIP	All	0.373	0.026	0.191	0.844

Non-Energy Impacts:

There are no NEIs associated with these measures.

Endnotes:

1 : Electric and fuel savings are based on the IL TRM
2 : Measure life source is the IL TRM
3 : Coincidence factors based on IL TRM
4 : Coincidence factors based on IL TRM
5 : 2021 C&I Prescriptive and Custom Net-to-Gross Omnibus Study (NMR) 2021_NMR_C&I_Omnibus_NTG

3.6 Building Shell - Air Sealing - C&I Multi-Family

Measure Code	COM-BS-ASREU
Market	Commercial
Program Type	Retrofit
Category	Building Shell

Measure Description:

Air sealing will decrease the infiltration of outside air through cracks and leaks in the building.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Air Sealing, Electric (Residential End Use)	C&I Existing Building Retrofit (CI_RETRO)	EC2a059
Air Sealing, Oil (Residential End Use)	C&I Existing Building Retrofit (CI_RETRO)	EC2a060
Air Sealing, Other (Residential End Use)	C&I Existing Building Retrofit (CI_RETRO)	EC2a111
Air Sealing, Gas (Residential End Use)	C&I Existing Building Retrofit (CI_RETRO)	GC2a055

Algorithms for Calculating Primary Energy Impact:

Unit savings are calculated using the following algorithms and assumptions:

$$kWh = (Vol \times ACH \times 0.018 \times HDD \times 24/nheating) / 3,413$$
$$MMBtu = (Vol \times ACH \times 0.018 \times HDD \times 24/nheating) / 1,000,000$$
$$kW = kWh \times kW/kWh$$

Where:

Vol = [ft3]   This is the air volume of the treated space, calculated from the dimensions of the space, which could include the number of floors, the floor area per floor, and the floor-toceiling height, or the dwelling floor area and number of dwellings. The treated space can be the entire building including the common areas, or just the individual dwelling units. (Auditor Input)

ΔACH = [°F-day]   Infiltration reduction in Air Changes per Hour, natural infiltration basis. This will typically be a default value, but the source of the assumption should be transparent and traceable, or it could come from a blower door test. (Stipulated Value or Blower Door Test)

$HDD60$ = Heating degree-days, base 60 from TMYx weather data. See table below.

ηheating = [AFUE, COP, thermal efficiency(%)]   Efficiency of the heating system, as determined on site (Auditor Input)

24 = Conversion factor: 24 hours per day

0.018 = [Btu/ft3- °F]   Air heat capacity: The specific heat of air (0.24 Btu/°F.lb) times the density of air (0.075 lb/ft3)

1,000,000 = Conversion factor: 1,000,000 Btu per MMBtu

3413 = Conversion factor: 3413 Btu/kWh

kW/kWh = Average kW reduction per kWh reduction: 0.00073 kW/kWh[1]

Hours:

Heating hours are characterized by the heating degree days for the facility. The heating degree days and cooling degree hours are looked up based on the nearest weather station to the customer, as selected by the program vendor.

TMYx - City/Station	HDD	CDH
Barnstable Muni Boa	4,241	2,159
Beverly Muni	4,736	3,799
Boston Logan Int'l Arpt	4,156	5,937
Chicopee Falls Westo	5,078	6,642
Lawrence Muni	4,607	5,009
Marthas Vineyard	4,335	2,234
Nantucket Memorial AP	3,900	448
New Bedford Rgnl	4,319	5,082
North Adams	5,420	3,507
Norwood Memorial	4,509	7,230
Otis ANGBb	4,440	2,420
Plymouth Municipal	4,589	4,189
Provincetown (AWOS)	4,103	1,785
Westfield Barnes Muni AP	4,916	4,796
Worchester Regional Arpt	5,082	3,207

These values have been derived from TMYx data downloaded from the Massachusetts Typical Weather - Research and Dataset Development Evaluation.[2] The HDD values were calculated by taking the minimum and maximum temperatures for each day, and calculating a daily average.

Baseline Efficiency:

The baseline efficiency case is the existing building before the air sealing measure is implemented. The baseline building is characterized by the existing air changes per hour (ACHPRE) for multi-family facilities, which is measured prior to the implementation of the air sealing measure. This will typically be a default value of a baseline/pre-retrofit ACH =0.5.

High Efficiency:

The high efficiency case is the existing building after the air sealing measure is implemented. The high efficiency building is characterized by the new air changes per hour (ACHPOST) for multi-family facilities, which is measured after the air sealing measure is implemented. This will typically be a default value of a baseline/pre-retrofit ACH =0.4.

Measure Life:

The measure life is 15 years.[3]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Air Sealing (Residential End Use)	CI_RETRO	All	15	n/a	n/a	15

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Air Sealing, Electric (Residential End Use)	CI_RETRO	All	1.00	0.86	n/a	0.86	0.86	0.00	0.43
Air Sealing, Oil (Residential End Use)	CI_RETRO	All	1.00	0.86	0.86	n/a	n/a	n/a	n/a
Air Sealing, Other (Residential End Use)	CI_RETRO	All	1.00	0.86	0.86	n/a	n/a	n/a	n/a
Air Sealing, Gas (Residential End Use)	CI_RETRO	All	1.00	0.86	0.86	n/a	n/a	n/a	n/a

In-Service Rates:

All installations have 100% in service rate since all PA programs include verification of equipment installations.

Realization Rates:

Realization rates are based on evaluation results.[4]

Coincidence Factors:

Summer and winter coincidence factors are estimated using the demand allocation methodology described in the Demand Impact Model which is developed based on the Residential Baseline Study.[5]

Impact Factors for Calculating Net Savings:

Net to gross factors are based on evaluation results.[6]

Measure Name	Core Initiative	PA	FR	SO$_P$	SO$_{NP}$	NTG
Air Sealing (Residential End Use)	CI_RETRO	All	0.14	0.0	0.0	0.86

Non-Energy Impacts:

NEI values are rolled up, component values can be found in Appendix B.[7]

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per KWh	Annual $ per Therm	One-time $ per Therm
Air Sealing (Residential End Use)	CI_RETRO	All	19.35					

Endnotes:

1 : Guidehouse (2020). Residential Baseline Study Phase 4
2020_Guidehouse_Residential_Baseline_Phase_4
2 : DNV (2023). Massachusetts Typical Weather – Research and Dataset Development Study.
2023_DNV_MA_TMYx-Final_Report
3 : GDS Associates, Inc. (2007). Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures. Prepared for the New England State Program Working Group.
GDS_2007_Measure_Life_Report_Residential_and_CI_Lighting_and_HVAC_Measures
4 : Navigant Consulting (2018). Multi-Family Program Impact and Net-to-Gross Evaluation.
2018_Navigant_Multifamily_Program_Impact_Evaluation
5 : Guidehouse (2020). Residential Baseline Study Phase 4
2020_Guidehouse_Residential_Baseline_Phase_4
6 : Guidehouse (2021). Residential Programs Net-to-Gross Research of RCD and Select Products.
2021_Guidehouse_MA_Res_NTG_Final_Report

7 : NMR Group, Inc., Tetra Tech (2011). Massachusetts Special and Cross-Sector Studies Area, Residential and Low-Income Non-Energy Impacts (NEI) Evaluation.
Tetra_Tech_and_NMR_2011_MA_Res_and_LI_NEI_Evaluation

3.7 Building Shell - Insulation - C&I Metered Multi-Family

Measure Code	COM-BS-IREU
Market	Commercial
Program Type	Retrofit
Category	Building Shell

Measure Description:

Insulation upgrades are applied in existing multifamily facilities.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Insulation, Electric (Residential End Use)	C&I Existing Building Retrofit (CI_RETRO)	EC2a061
Insulation, Central AC in Electrically-Heated Unit (Residential End Use)	C&I Existing Building Retrofit (CI_RETRO)	EC2a062
Insulation, Oil (Residential End Use)	C&I Existing Building Retrofit (CI_RETRO)	EC2a063
Insulation, Other (Residential End Use)	C&I Existing Building Retrofit (CI_RETRO)	EC2a112
Insulation, Gas (Residential End Use)	C&I Existing Building Retrofit (CI_RETRO)	GC2a056
Insulation, Gas, with Central AC (Residential End Use)	C&I Existing Building Retrofit (CI_RETRO)	GC2a057

Algorithms for Calculating Primary Energy Impact:

kW Factors for Vendor Measures[1] :

Measure	kW/kWh Factor
Insulation (Electric)	0.00073
Insulation (Gas, Oil, Other FF)	0.00076
Insulation, Central AC in Electrically-Heated Unit	0.00059

$$MMBtu = ((1/R_{exist} - 1/R_{new})*HDD * 24 * Area) / (1000000 * \eta_{heat})$$

kWh = MMBtu * 293.1

kW = kWh * kW/kWh$_{heat}$

Where:

R$_{exist}$ = Existing effective R-value (R-ExistingInsulation + R-Assembly),ft2-°F/Btuh

R$_{new}$ = New total effective R-value (R-ProposedMeasure + R-ExistingInsulation+ R-Assembly), ft2-°F/Btuh

Area = Square footage of insulated area

η$_{heat}$ = Efficiency of the heating system (AFUE or COP), site specific

293.1 = Conversion constant (1MMBtu = 293.1 kWh)

24   = Conversion for hours per day

HDD = Heating Degree Days; dependent on location, see table below

1,000,000 = Conversion from Btu to MMBtu

kW/kWh$_{heat}$ = Average annual kW reduction per kWh reduction: 0.00073 kW/kWh

If Facility has central cooling then also calculate air conditioning savings:

kWh$_{cool}$ = ((1/R$_{exist}$ - 1/R$_{new}$) * CDH * DUA * Area) / (1000 Btu/kBtu * ηcool)

kW = kWh * kW/kWh$_{cool}$

Where:

R$_{exist}$ = Existing effective R-value (R-ExistingInsulation + R-Assembly),ft2-°F/Btuh

R$_{new}$ = New total effective R-value (R-ProposedMeasure + R-ExistingInsulation+ R-Assembly), ft2-°F/Btuh

DUA = Discretionary Use Adjustment to account for the fact that people do not always operate their air conditioning system when the outside temperature is greater than 75°F = 0.75[2]

Area = Square footage of insulated area

ηcool = Efficiency of air conditioning equipment (SEER), site specific

CDH = Cooling Degree Hours; dependent on location, see table below

kW/kWh$_{cool}$ = Average annual kW reduction per kWh reduction: 0.00073 kW/kWh

Hours:

Heating hours are characterized by the heating degree days for the facility. The heating degree days and cooling degree hours are looked up based on the nearest weather station to the customer, as selected by the program vendor.

TMYx - City/Station	HDD	CDH
Barnstable Muni Boa	4,241	2,159
Beverly Muni	4,736	3,799
Boston Logan Int'l Arpt	4,156	5,937
Chicopee Falls Westo	5,078	6,642

TMYx - City/Station	HDD	CDH
Lawrence Muni	4,607	5,009
Marthas Vineyard	4,335	2,234
Nantucket Memorial AP	3,900	448
New Bedford Rgnl	4,319	5,082
North Adams	5,420	3,507
Norwood Memorial	4,509	7,230
Otis ANGBb	4,440	2,420
Plymouth Municipal	4,589	4,189
Provincetown (AWOS)	4,103	1,785
Westfield Barnes Muni AP	4,916	4,796
Worchester Regional Arpt	5,082	3,207

These values have been derived from TMYx data downloaded from the Massachusetts Typical Weather - Research and Dataset Development Evaluation.[3] The HDD values were calculated by taking the minimum and maximum temperatures for each day, and calculating a daily average.

Baseline Efficiency:

The baseline efficiency case is characterized by the total R-value of the existing attic, basement or sidewall (Rexisit). This is calculated as the R-value of the existing insulation, estimated by the program contractor, plus the R-value of the ceiling, floor, or wall (for all projects: RCEILING = 3.36; RFLOOR = 6.16; RWALL = 6.65).[4]

High Efficiency:

The high efficiency case is characterized by the total R-value of the attic after the installation of additional attic, basement or sidewall insulation. This is calculated as the sum of the existing R-value (Rexisit) plus the R-value of the added insulation.

Measure Life:

The measure life is 25 years.[5]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Insulation	CI_RETRO	All	25	n/a	n/a	25

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Insulation, Electric (Residential End Use)	CI_RETRO	All	1.00	0.86	n/a	0.86	0.86	0.00	0.43
Insulation, Central AC in Electrically-Heated Unit (Residential End Use)	CI_RETRO	All	1.00	0.86	n/a	0.86	0.86	0.37	0.0
Insulation, Gas (Residential End Use)	CI_RETRO	All	1.00	n/a	0.86	n/a	n/a	0.37	0.0
Insulation, Gas, with Central AC (Residential End Use)	CI_RETRO	All	1.00	1.00	0.86	1.00	1.00	0.37	0.0
Insulation, Oil (Residential End Use)	CI_RETRO	All	1.00	n/a	0.86	n/a	n/a	0.37	0.0
Insulation, Other (Residential End Use)	CI_RETRO	All	1.00	n/a	0.86	n/a	n/a	0.37	0.0

In-Service Rates:
All installations have 100% in service rate since all PA programs include verification of equipment installations.

Realization Rates:
Realization rates are based on evaluation results.[6]

Coincidence Factors:
Summer and winter coincidence factors are estimated using the demand allocation methodology described in the Demand Impact Model which is developed based on the Residential Baseline Study.[7]

Impact Factors for Calculating Net Savings:

Net to gross factors based on evaluation results.[8]

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Insulation (Residential End Use)	CI_RETRO	All	0.14	0.0	0.0	0.86

Non-Energy Impacts:

NEI values are rolled up, component values can be found in Appendix B.

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per KWh	Annual $ per Therm	One-time $ per Therm
Insulation (Residential End Use)	CI_RETRO	All	$47.31					

Endnotes:

1 : Guidehouse (2020). Residential Baseline Study Phase 4
2020_Guidehouse_Residential_Baseline_Phase_4
2 : The Cadmus Group (2012). Massachusetts 2011 Residential Retrofit Multifamily Program Impact Analysis. CADMUS_2012_Multifamily_Impacts_Analysis_Report
3 : DNV (2023). Massachusetts Typical Weather – Research and Dataset Development Study.
2023_DNV_MA_TMYx-Final_Report
4 : Assumptions from National Grid program vendor.
5 : GDS Associates (2007). Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures.
GDS_2007_Measure_Life_Report_Residential_and_CI_Lighting_and_HVAC_Measures
6 : Navigant Consulting (2018). Multi-Family Program Impact and Net-to-Gross Evaluation.
2018_Navigant_Multifamily_Program_Impact_Evaluation
7 : Guidehouse (2020). Residential Baseline Study Phase 4
2020_Guidehouse_Residential_Baseline_Phase_4
8 : Guidehouse (2021). Residential Programs Net-to-Gross Research of RCD and Select Products.
2021_Guidehouse_MA_Res_NTG_Final_Report

3.8 Compressed Air - Air Nozzle

Measure Code	COM-CA-AN
Market	Commercial
Program Type	Early Replacement, Lost Opportunity, New Construction
Category	Compressed Air

Measure Description:

Covers the installation of engineered air nozzles which provide effective air nozzle action while reducing compressed air system air flow.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Compressed Air – Air Nozzle	C&I New Buildings & Major Renovations (CI_NB&MR)	EC1a007
Compressed Air – Air Nozzle	C&I New & Replacement Equipment (CI_EQUIP)	EC2b007

Algorithms for Calculating Primary Energy Impact:

Savings are calculated in a spreadsheet tool per the following:

$Delta\_kW = Delta\_kWh / hr$
$Delta\_kWh = (FLOW\_base - FLOW\_eng) \times kW\_SCFM \times USE \times hr$

Where:
FLOW_base = open nozzle flow at 100 psi (site specific)
FLOW_eng = engineered nozzle flow at 100 psi (site specific)
hr = annual operating hours
kW_SCFM = 0.29 (site specific if available)
USE = 0.05 (site specific if available)

Baseline Efficiency:

The baseline is a standard nozzle on a compressed air system.

High Efficiency:

The high efficient case is the same air compressor with an engineered nozzle.

Measure Life:

The measure life is 13 years.[1]

Measure Name	PA	Core Initiative	EUL	OYF	RUL	AML
Air Nozzle	All	CI_NB&MR, CI_EQUIP	13	n/a	n/a	13

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Air Nozzle	CI_NB&MR, CI_EQUIP	All	1.00	1.00	n/a	1.00	1.00	0.27	0.26

In-Service Rates:

All installations have 100% in-service rates since PA programs include verification of equipment installations.

Realization Rates:

RRs set to 1.0 since unevaluated.

Coincidence Factors:

CFs from 2016 DMI impact evaluation of CAIR.

Impact Factors for Calculating Net Savings:

All PAs use statewide prescriptive net-to-gross values based on study results.[2] [3]

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Air Nozzle	CI_NB&MR	All	0.583	0.225	0.00	0.642
Air Nozzle	CI_EQUIP	All	0.25	0.0	0.09	0.84

Non-Energy Impacts:

NEIs for this measure are from the 2021 C&I O&M and non-O&M NEI study.

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per	Annual $ per Therm	One-time $ per

						kWh		Therm
Compressed Air - Air Nozzle	CI_NB&MR	All	0	0	$0.042	0	0	0
Compressed Air - Air Nozzle	CI_EQUIP	All	0	0	$0.00	0	0	0

Endnotes:

1 : Energy & Resource Solutions (2005). Measure Life Study. ERS_2005_Measure_Life_Study
2 : NMR Group, Inc. (2021). C&I Omnibus NTG Study 2021_NMR_C&I_Omnibus_NTG
3 : NMR Group, Inc. (2021). Non Residential New Construction NTG Report.
2021_NMR_Non_Residential_New_Construction_NTG_Report

3.9 Compressed Air - High Efficiency Air Compressor

Measure Code	COM-CA-HEAC
Market	Commercial
Program Type	Early Replacement, Lost Opportunity
Category	Compressed Air

Measure Description:

Covers the installation of oil flooded, rotary screw compressors with Variable Speed Drive or Variable Displacement capacity control with properly sized air receiver. Efficient air compressors use various control schemes to improve compression efficiencies at partial loads.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Compressed Air - High Efficiency Air Compressors	C&I New & Replacement Equipment (CI_EQUIP)	EC2b003

Algorithms for Calculating Primary Energy Impact:

$\Delta kWh = (HP_{COMPRESSOR}) \times (Save) \times (Hours)$
$\Delta kW = (HP_{COMPRESSOR}) \times (Save)$

Where:
$HP_{COMPRESSOR}$ = Nominal rated horsepower of high efficiency air compressor.
Save = Air compressor kW reduction per HP: 0.189. [1]
 Hours = Annual operating hours of the air compressor.

Baseline Efficiency:

The baseline efficiency case is a typical load/unload compressor.

High Efficiency:

The high efficiency case is an oil-flooded, rotary screw compressor with Variable Speed Drive or Variable Displacement capacity control with a properly sized air receiver. Air receivers are designed to provide a supply buffer to meet short-term demand spikes which can exceed the compressor capacity. Installing a larger receiver tank to meet occasional peak demands can allow for the use of a smaller compressor.

Measure Life:

The measure life is 15 years.[2]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Compressed Air - High Efficiency Air Compressors	CI_EQUIP	All	15	n/a	n/a	15

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Compressed Air - High Efficiency Air Compressors	CI_EQUIP	All	1.00	1.39	1.39	1.00	1.00	0.27	0.26

In-Service Rates:

All installations have 100% in service rate since PA programs include verification of equipment installations.

Realization Rates:

RR from the prospective results of the 2015 study of prescriptive compressed air. The RR adjusts for differences in operating hours between PA tracking assumptions and on-site findings. The RR must be coupled with the updated kW/HP results from the same study, referenced in the Algorithm section above.[3]

Coincidence Factors:

CFs from the prospective results of the 2015 study of prescriptive compressed air.[4]

Impact Factors for Calculating Net Savings:

All PAs use statewide prescriptive net-to-gross values based on the 2021 C&I Omnibus NTG Study[5]

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Compressed Air - High Efficiency Air Compressor	CI_EQUIP	All	0.25	0.00	0.09	0.84

Non-Energy Impacts:

NEIs for this measure are from the 2021 C&I O&M and non-O&M NEI study.

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per kWh	Annual $ per Therm	One-time $ per Therm
Compressed Air - High-Efficiency Air Compressor	CI_EQUIP	All	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00

Endnotes:

1 : DNV GL (2015). Impact Evaluation of Prescriptive Chiller and Compressed Air Installations. Prepared for the MA PAs and EEAC. Result for VSD 25-75 HP used since "All" result includes savings from load/unload compressors, which are now baseline.
DNVGL_2015_Impact_Eval_Prescriptive_Chiller_CAIR_FINAL
2 : Energy & Resource Solutions (2005). Measure Life Study. ERS_2005_Measure_Life_Study
3 : DNV GL (2015). Impact Evaluation of Prescriptive Chiller and Compressed Air Installations. DNVGL_2015_Impact_Eval_Prescriptive_Chiller_CAIR_FINAL
4 : DNV GL (2015). Impact Evaluation of Prescriptive Chiller and Compressed Air Installations. DNVGL_2015_Impact_Eval_Prescriptive_Chiller_CAIR_FINAL
5 : NMR Group, Inc. (2021). C&I Omnibus NTG Study 2021_NMR_C&I_Omnibus_NTG

3.10 Compressed Air - Low Pressure Drop Filter

Measure Code	COM-CA-LPDF
Market	Commercial
Program Type	Lost Opportunity, New Construction, Retrofit
Category	Compressed Air

Measure Description:

Filters remove solids and aerosols from compressed air systems. Low pressure drop filters have longer lives and lower pressure drops than traditional coalescing filters, resulting in higher efficiencies.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Compressed Air – Low Pressure Drop Filters	C&I New Buildings & Major Renovations (CI_NB&MR)	EC1a005
Compressed Air – Low Pressure Drop Filters	C&I Existing Building Retrofit (CI_RETRO)	EC2a004
Compressed Air – Low Pressure Drop Filters	C&I New & Replacement Equipment (CI_EQUIP)	EC2b005

Algorithms for Calculating Primary Energy Impact:

$$\Delta kWh = [(HPcomp) \times (0.7457) / eff] \times [((Existing\ P) - (Adjusted\ P)) / (2 \times 100)] \times (Hours)$$
$$\Delta kW = [(HPcomp) \times (0.7457) / eff] \times [((Existing\ P) - (Adjusted\ P)) / (2 \times 100)]$$

Where:
ΔkWh = Energy savings
ΔkW = Demand savings
HP_{COMP} = Average compressor load. Site specific.
0.7457 = Conversion from HP to kW
eff = Full Load NEMA Premium Motor Efficiency - see below
2 x 100 = % Savings calculated with the assumption that for every 2 psi increase in discharge pressure, energy consumption will increase by approximately 1%
Hours = Annual operating hours of the lower pressure drop filter. Site specific.

NEMA Premium Motor Full Load Efficiency:

HP	Efficiency
15	92.4%

HP	Efficiency
20	93.0%
25	93.6%
30	93.6%
40	94.1%
50	94.5%
60	95.0%
75	95.4%

Savings algorithm source: PA calculation tool, "Prescriptive_CAIR_ZLD_LPDF_Tool.xlsx" (2016)

Baseline Efficiency:

The baseline efficiency case is a standard coalescing filter with initial drop of between 1 and 2 pounds per sq inch (psi) with an end of life drop of 10 psi.

High Efficiency:

The high efficiency case is a low pressure drop filter with initial drop not exceeding 1 psi over life and 3 psi at element change. Filters must be deep-bed, "mist eliminator" style and installed on a single operating compressor rated 15 - 75 HP.

Measure Life:

The measure life is 5 years. This measure was determined to be an add-on single baseline measure for retrofit installations.[1]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Compressed Air - Low Pressure Drop Filters	CI_NB&MR, CI_EQUIP	All	5	n/a	n/a	5
Compressed Air - Low Pressure Drop Filters	CI_RETRO	All	5	1	n/a	5

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR$_E$	RR$_{NE}$	RR$_{SP}$	RR$_{WP}$	CF$_{SP}$	CF$_{WP}$
Compressed Air - Low Pressure Drop Filters	CI_NB&MR, CI_EQUIP, CI_RETRO	National Grid, Unitil	1.00	1.00	n/a	1.00	1.00	0.27	0.26
Compressed Air - Low Pressure Drop Filters	CI_NB&MR, CI_EQUIP, CI_RETRO	Eversource, CLC	1.00	1.25	n/a	0.95	0.80	0.27	0.26

In-Service Rates:

All installations have 100% in service rate since PA programs include verification of equipment installations.

Realization Rates:
- National Grid, Unitil: RRs based on impact evaluation of PY 2004 compressed air installations.[2]
- Eversource, CLC: energy and demand RRs from impact evaluation of NSTAR 2006 compressed air installations[3]

Coincidence Factors:
- National Grid, Unitil: CFs based on impact evaluation of PY 2004 compressed air installations[4]
- Eversource, CLC: on-peak CFs based on standard assumptions.

Impact Factors for Calculating Net Savings:

All PAs use statewide prescriptive net-to-gross values based on study results.[5] [6]

Measure Name	Core Initiative	PA	FR	SO$_P$	SO$_{NP}$	NTG
Compressed Air - Low Pressure Drop Filters	CI_NB&MR	All	0.58	0.23	0.00	0.65
Compressed Air - Low Pressure Drop Filters	CI_EQUIP	All	0.25	0.00	0.09	0.84
Compressed Air - Low Pressure Drop Filters	CI_RETRO	All	0.18	0.00	0.05	0.88

Non-Energy Impacts:

NEIs for this measure are from the 2021 C&I O&M and non-O&M NEI study.

Measure Name	Core Initiative	PA	Annual $ per	One-time $	Annual $ per	One-time $	Annual $ per	One-time $

			Unit	per Unit	kWh	per kWh	Therm	per Therm
Compressed Air - Low-Pressure Drop Filter	CI_NB&MR	All	$0.00	$0.00	$0.042	$0.00	$0.00	$0.00
Compressed Air - Low-Pressure Drop Filter	CI_RETRO	All	$0.00	$0.00	$0.005	$0.00	$0.00	$0.00
Compressed Air - Low-Pressure Drop Filter	CI_EQUIP	All	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00

Endnotes:

1 : Energy & Resource Solutions (2005). Measure Life Study. ERS_2005_Measure_Life_Study

2 : DMI (2006). Impact Evaluation of 2004 Compressed Air Prescriptive Rebates. Results analyzed in RLW Analytics (2006). Sample Design and Impact Evaluation Analysis for Prescriptive Compressed Air Measures in Energy Initiative and Design 2000 Programs.
DMI_2006_Impact_Evaluation_of_2004_Compressed_Air_Prescriptive_Rebates

3 : RLW Analytics (2008). Business & Construction Solutions (BS/BC) Programs Measurement & Verification - 2006 Final Report.
RLW_2008_Business_and_Construction_Solutions_Programs_Measurement_and_Verification_2006_Final_Report

4 : DMI (2006). Impact Evaluation of 2004 Compressed Air Prescriptive Rebates. Results analyzed in RLW Analytics (2006). Sample Design and Impact Evaluation Analysis for Prescriptive Compressed Air Measures in Energy Initiative and Design 2000 Programs.
DMI_2006_Impact_Evaluation_of_2004_Compressed_Air_Prescriptive_Rebates

5 : NMR Group, Inc. (2021). C&I Omnibus NTG Study 2021_NMR_C&I_Omnibus_NTG

6 : NMR Group, Inc. (2021). Non Residential New Construction NTG Report.
2021_NMR_Non_Residential_New_Construction_NTG_Report

3.11 Compressed Air - Refrigerated Air Dryer

Measure Code	COM-CA-RAD
Market	Commercial
Program Type	Lost Opportunity, New Construction
Category	Compressed Air

Measure Description:

The installation of cycling or variable frequency drive (VFD)-equipped refrigerated compressed air dryers. Refrigerated air dryers remove the moisture from a compressed air system to enhance overall system performance. An efficient refrigerated dryer cycles on and off or uses a variable speed drive as required by the demand for compressed air instead of running continuously. Only properly sized refrigerated air dryers used in a single-compressor system are eligible.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Compressed Air - Refrigerated Air Dryers	C&I New Buildings & Major Renovations (CI_NB&MR)	EC1a004
Compressed Air - Refrigerated Air Dryers	C&I New & Replacement Equipment (CI_EQUIP)	EC2b004

Algorithms for Calculating Primary Energy Impact:

$\Delta kWh = (CFM_{DRYER}) \times (Save) \times (HRS)$
$\Delta kW = (CFM_{DRYER}) \times (Save)$

Where:
CFM_{DRYER} = Full flow rated capacity of the refrigerated air dryer in cubic feet per minute (CFM). Obtain from equipment's Compressed Air Gas Institute Datasheet.
Save = Refrigerated air dryer kW reduction per dryer full flow rated CFM: 0.00554.[1]
Hours = Annual operating hours of the refrigerated air dryer.

Baseline Efficiency:

The baseline efficiency case is a non-cycling refrigerated air dryer.

High Efficiency:

The high efficiency case is a cycling refrigerated dryer or a refrigerated dryer equipped with a VFD.

Measure Life:

The measure life is 15 years.[2]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Compressed Air - Refrigerated Air Dryers	CI_NB&MR, CI_EQUIP	All	15	n/a	n/a	15

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Compressed Air - Refrigerated Air Dryers	CI_NB&MR, CI_EQUIP	All	1.00	1.56	n/a	1.00	1.00	0.22	0.22

In-Service Rates:
All installations have 100% in service rate since PA programs include verification of equipment installations.

Realization Rates:
RR from the prospective results of the 2015 study of prescriptive compressed air. The RR adjusts for differences in operating hours between PA tracking assumptions and on site findings. The RR must be coupled with the updated kW/CFM results from the same study.[3]

Coincidence Factors:
CFs from the prospective results of the 2015 study of prescriptive compressed air.[4]

Impact Factors for Calculating Net Savings:

All PAs use statewide prescriptive net-to-gross values based on study results.[5] [6]

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Compressed Air - Refrigerated Air Dryers	CI_NB&MR	All	0.58	0.23	0.00	0.65
Compressed Air - Refrigerated Air Dryers	CI_EQUIP	All	0.25	0.00	0.09	0.84

Non-Energy Impacts:

NEIs for this measure are from the 2021 C&I O&M and non-O&M NEI study. Health & safety NEI impacts are negotiated based on discussions with EEAC consultants.

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per kWh	Annual $ per Therm	One-time $ per Therm
Compressed Air - Refrigerated Air Dryer	CI_NB&MR	All	$0.00	$0.00	$0.004	$0.00	$0.00	$0.00
Compressed Air - Refrigerated Air Dryer	CI_EQUIP	All	$0.00	$0.00	$0.000	$0.00	$0.00	$0.00

Endnotes:

1 : DNV GL (2015). Impact Evaluation of Prescriptive Chiller and Compressed Air Installations. DNVGL_2015_Impact_Eval_Prescriptive_Chiller_CAIR_FINAL
2 : Energy & Resource Solutions (2005). Measure Life Study. ERS_2005_Measure_Life_Study
3 : DNV GL (2015). Impact Evaluation of Prescriptive Chiller and Compressed Air Installations. DNVGL_2015_Impact_Eval_Prescriptive_Chiller_CAIR_FINAL
4 : DNV GL (2015). Impact Evaluation of Prescriptive Chiller and Compressed Air Installations. DNVGL_2015_Impact_Eval_Prescriptive_Chiller_CAIR_FINAL
5 : NMR Group, Inc. (2021). C&I Omnibus NTG Study 2021_NMR_C&I_Omnibus_NTG
6 : NMR Group, Inc. (2021). Non Residential New Construction NTG Report. 2021_NMR_Non_Residential_New_Construction_NTG_Report

3.12 Compressed Air - Zero Loss Condensate Drain

Measure Code	COM-CA-ZLCD
Market	Commercial
Program Type	Lost Opportunity, New Construction, Retrofit
Category	Compressed Air

Measure Description:

Drains remove water from a compressed air system. Zero loss condensate drains remove water from a compressed air system without venting any air, resulting in less air demand and consequently greater efficiency.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Compressed Air – Zero Loss Condensate Drains	C&I New Buildings & Major Renovations (CI_NB&MR)	EC1a006
Compressed Air – Zero Loss Condensate Drains	C&I Existing Building Retrofit (CI_RETRO)	EC2a005
Compressed Air – Zero Loss Condensate Drains	C&I New & Replacement Equipment (CI_EQUIP)	EC2b006

Algorithms for Calculating Primary Energy Impact:

ΔkWh = (Quantity) x (CFMpipe) x (CFMsave) x (Save) x (Hours)
ΔkW = (Quantity) x (CFMpipe) x (CFMsave) x (Save)

Where:
ΔkWh = Energy savings
ΔkW = Demand savings
CFMpipe = CFM capacity of piping. Site specific.
CFMsaved = Average CFM saved per CFM of piping capacity: 0.049
Save = Average savings per CFM: 0.210 kW/CFM[1]
Hours = Annual operating hours of the zero loss condensate drain

Baseline Efficiency:

The baseline efficiency case is installation of a standard condensate drain on a compressor system.

High Efficiency:

The high efficiency case is installation of a zero loss condensate drain on a single operating compressor rated ≤ 75 HP.

Measure Life:

This measure has been determined to be an add on single baseline measure for retrofit installations.[2]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Compressed Air - Zero Loss Condensate Drains	CI_NB&MR, CI_EQUIP	All	15	n/a	n/a	15
Compressed Air - Zero Loss Condensate Drains	CI_RETRO	All	15	1	n/a	15

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Compressed Air - Zero Loss Condensate Drains	CI_NB&MR, CI_EQUIP, CI_RETRO	National Grid, Unitil	1.00	1.00	1.00	1.00	1.00	0.80	0.54
Compressed Air - Zero Loss Condensate Drains	CI_NB&MR, CI_EQUIP, CI_RETRO	Eversource, CLC	1.00	1.25	1.25	0.95	0.80	0.88	0.69

In-Service Rates:
All installations have 100% in service rate since PA programs include verification of equipment installations.

Realization Rates[3] :
- National Grid, Unitil: RRs based on impact evaluation of PY 2004 compressed air installations.[4]
- Eversource, CLC: energy and demand RRs from impact evaluation of NSTAR 2006 compressed air installations.[5]

Coincidence Factors:
- National Grid, Unitil: CFs based on impact evaluation of PY 2004 compressed air installations.[6]
- Eversource, CLC: on-peak CFs based on standard assumptions.

Impact Factors for Calculating Net Savings:

All PAs use statewide prescriptive net-to-gross values based on study results.[7] [8]

Measure Name	Core Initiative	PA	FR	SO$_P$	SO$_{NP}$	NTG
Compressed Air - Zero Loss Condensate Drain	CI_NB&MR	All	0.58	0.23	0.00	0.65
Compressed Air - Zero Loss Condensate Drain	CI_EQUIP	All	0.25	0.00	0.00	0.84
Compressed Air - Zero Loss Condensate Drain	CI_RETRO	All	0.18	0.00	0.05	0.88

Non-Energy Impacts:

NEIs for this measure are from the 2021 C&I O&M and non-O&M NEI study. Health & safety NEI impacts are negotiated based on discussions with EEAC consultants.

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per kWh	Annual $ per Therm	One-time $ per Therm
Compressed Air - Zero-Loss Condensate Drain	CI_NB&MR	All	$0.00	$0.00	$0.042	$0.00	$0.00	$0.00
Compressed Air - Zero-Loss Condensate Drain	CI_RETRO	All	$0.00	$0.00	$0.005	$0.00	$0.00	$0.00
Compressed Air - Zero-Loss Condensate Drain	CI_EQUIP	All	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00

Endnotes:

1 : Savings algorithm source: PA calculation tool, "Prescriptive_CAIR_ZLD_LPDF_Tool.xlsx" (2016)
2 : Baseline Categories and preliminary Out Year Factors are described at a high level in DNV GL, ERS (2018). Portfolio Model Companion Sheet.. Additional background on the baseline categorization given in DNV GL, ERS (2018). Portfolio Model Methods and Assumptions – Electric and Natural Gas Memo. 2018_DNVGL_ERS_Portfolio_Model_Companion_Sheet
3 : This measure was included in the 2015 DNV GL study of Prescriptive compressed air measures, however, there were not a statistically significant number of sites with this measure selected in the sample, so no impact updates have been made
4 : DMI (2006). Impact Evaluation of 2004 Compressed Air Prescriptive Rebates. Prepared for National Grid; results analyzed in RLW Analytics (2006). Sample Design and Impact Evaluation Analysis for Prescriptive Compressed Air Measures in the Energy Initiative and Design 2000 Programs. Prepared for

National Grid DMI_2006_Impact_Evaluation_of_2004_Compressed_Air_Prescriptive_Rebates

5 : RLW Analytics (2008). Business & Construction Solutions (BS/CS) Programs Measurement & Verification - 2006 Final Report. Prepared for NSTAR Electric and Gas; Table 17. RLW_2008_Business_and_Construction_Solutions_Programs_Measurement_and_Verification_2006_Final_Report

6 : DMI (2006). Impact Evaluation of 2004 Compressed Air Prescriptive Rebates. Prepared for National Grid; results analyzed in RLW Analytics (2006). Sample Design and Impact Evaluation Analysis for Prescriptive Compressed Air Measures in the Energy Initiative and Design 2000 Programs. Prepared for National Grid. DMI_2006_Impact_Evaluation_of_2004_Compressed_Air_Prescriptive_Rebates

7 : NMR Group, Inc. (2021). C&I Omnibus NTG Study 2021_NMR_C&I_Omnibus_NTG

8 : NMR Group, Inc. (2021). Non Residential New Construction NTG Report. 2021_NMR_Non_Residential_New_Construction_NTG_Report

3.13 Custom - C&I Metered Multi-Family

Measure Code	COM-CM-CMREU
Market	Commercial
Program Type	Retrofit
Category	Custom

Measure Description:

Vendors install a variety of electric and gas measures at multifamily facilities. The measures covered in this entry are associated with commercial gas and electric meters. Measures include lighting, HVAC, and domestic hot water equipment and measures.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Custom - HVAC (Residential End Use)	C&I Existing Building Retrofit (CI_RETRO)	EC2a102
Custom - Water Heating (Residential End Use)	C&I Existing Building Retrofit (CI_RETRO)	EC2a103
Custom - Process (Residential End Use)	C&I Existing Building Retrofit (CI_RETRO)	EC2a105
Custom - Other (Residential End Use)	C&I Existing Building Retrofit (CI_RETRO)	EC2a110
Custom - CHP (Residential End Use)	C&I Existing Building Retrofit (CI_RETRO)	EC2a106
Custom - Lighting Systems (Residential End Use)	C&I Existing Building Retrofit (CI_RETRO)	EC2a104
Custom - Lighting Controls (Residential End Use)	C&I Existing Building Retrofit (CI_RETRO)	EC2a122
Heating, Gas - Custom (Residential End Use)	C&I Existing Building Retrofit (CI_RETRO)	GC2a050
Process, Gas - Custom (Residential End Use)	C&I Existing Building Retrofit (CI_RETRO)	GC2a051
Water Heating, Gas - Custom (Residential	C&I Existing Building Retrofit	GC2a052

End Use)	(CI_RETRO)	
Lighting, Interior - Custom (Residential End Use)	C&I Existing Building Retrofit (CI_RETRO)	GC2a053
Lighting, Exterior - Custom (Residential End Use)	C&I Existing Building Retrofit (CI_RETRO)	GC2a054
Demand Circulator (Residential End Use)	C&I Existing Building Retrofit (CI_RETRO)	GC2a070

Algorithms for Calculating Primary Energy Impact:

Gross energy and demand savings estimates for custom Residential End Use projects are calculated by approved vendors with project-specific details. Energy and demand savings calculations are based on projected or measured changes in equipment efficiencies and operating characteristics and are determined on a case-by-case basis.

Baseline Efficiency:

For retrofit projects, the baseline efficiency case is the same as the existing, or pre-retrofit, case for the facility.

High Efficiency:

The high efficiency scenario is specific to the facility and may include one or more energy efficiency measures.

Measure Life:

Measure lives are determined on a case-by-case basis.

Other Resource Impacts:

Other resource impacts are determined on a case-by-case basis.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Custom - HVAC (Residential End Use)	CI_RETRO	All	1.00	0.86	0.86	0.86	0.86	0.00	0.00
Custom - Water Heating (Residential End Use)	CI_RETRO	All	1.00	0.86	0.86	0.86	0.86	0.00	0.00
Custom - Process	CI_RETRO	All	1.00	0.86	0.86	0.86	0.86	0.00	0.00

Measure Name	Core Initiative	PA	ISR	RR$_E$	RR$_{NE}$	RR$_{SP}$	RR$_{WP}$	CF$_{SP}$	CF$_{WP}$
(Residential End Use)									
Custom - Other (Residential End Use)	CI_RETRO	All	1.00	0.86	0.86	0.86	0.86	0.00	0.00
Custom - Lighting (Residential End Use)	CI_RETRO	CLC	1.00	0.93	0.93	0.94	0.78	custom	custom
	CI_RETRO	Eversource	1.00	1.01	1.01	0.94	0.79	custom	custom
	CI_RETRO	National Grid	1.00	0.96	0.96	1.02	0.93	custom	custom
	CI_RETRO	Unitil	1.00	1.01	1.01	1.00	0.85	custom	custom
Custom - CHP (Residential End Use)	CI_RETRO	CLC	1.00	1.00	1.00	1.00	1.00	varies by PA	varies by PA
	CI_RETRO	Eversource	1.00	1.10	1.22	1.44	1.01	varies by PA	varies by PA
	CI_RETRO	National Grid	1.00	0.91	1.02	1.09	1.05	varies by PA	varies by PA
	CI_RETRO	Unitil	1.00	0.90	1.12	1.26	1.58	varies by PA	varies by PA
All Gas - Custom (Residential End Use)	CI_RETRO	All	1.00	n/a	0.86	n/a	n/a	n/a	n/a

In-Service Rates:

All installations have 100% in-service rates since all PA programs include verification of equipment installations.

Realization Rates:

- Lighting: RRs based on evaluation of PY2018-PY2019 projects.[1]
- CHP - Custom: RRs based on evaluation of PY 2012 projects.[2] Unitil uses statewide results given their small sample size. Note that RR$_{NE}$ applies to project fossil fuel penalty.
- Remaining realization rates are based on multifamily impact evaluation study.[3]

Coincidence Factors:

For all PAs, gross summer and winter peak coincidence factors are custom-calculated for each custom project based on project-specific information. The actual or measured coincidence factors are included in the summer and winter demand realization rates.

Impact Factors for Calculating Net Savings:

All PAs use statewide net-to-gross values based on study results.[4] [5]

Measure Name	Core Initiative	PA	FR	SO$_P$	SO$_{NP}$	NTG
Non-Lighting - Custom (Residential End Use)	CI_RETRO	All	0.14	0.0	0.0	0.86
Lighting - Custom (Residential End Use)	CI_RETRO	All	0.36	0.00	0.02	0.66
CHP - Custom (Residential End Use)	CI_RETRO	All	0.046	0.013	0.053	1.02

Non-Energy Impacts:

NEI values are rolled up, component values can be found in Appendix B.[6]

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per kWh	Annual $ per Therm	One-time $ per Therm
HVAC - Custom (Residential End Use)	CI_RETRO	All			$0.149			
Water Heating - Custom (Residential End Use)	CI_RETRO	All			$0.065			
Process - Custom (Residential End Use)	CI_RETRO	All			$0.098			
Other - Custom (Residential End Use)	CI_RETRO	All			$0.098			
Custom - Lighting Systems (Residential End Use)	CI_RETRO	All			$0.096			
Custom - Lighting Controls (Residential End Use)	CI_RETRO	All			$0.126			
CHP (Residential End Use)	CI_RETRO	All			($0.013)			
Heating, Gas - Custom (Residential End Use)	CI_RETRO	All					($0.037)	
Process, Gas - Custom (Residential End Use)	CI_RETRO	All					($0.045)	

Water Heating, Gas - Custom (Residential End Use)	CI_RETRO	All					$0.349	
Demand Circulator, Gas (Residential End Use)	CI_RETRO	All					($0.037)	

Endnotes:

1 : Impact Evaluation of PY2018-2019 Custom Electric Installations, Draft Results Memo. DNV GL (2021) 2021_DNV_Custom_Electric_MA20C04

2 : KEMA 2013. Massachusetts Combined Heat and Power Program Impact Evaluation, 2011-2012 KEMA_2013_MA_CI_CHP_IMPACT_EVAL

3 : Navigant Consulting (2018). Multi-Family Program Impact and Net-to-Gross Evaluation 2018_Navigant_Multifamily_Program_Impact_Evaluation

4 : NMR Group, Inc. (2021). C&I Prescriptive and Custom NTG Omnibus Study 2021_NMR_Prescriptive and Custom Net-to-Gross Omnibus Study

5 : 2021_Guidehouse_MA_Res_NTG_Final_Report

6 : NMR Group, Inc. (2021). C&I O&M and Non-O&M Non-Energy Impacts Study. 2021_NMR_CIOM and NonOM NEI Study

3.14 Custom - C&I Turnkey

Measure Code	COM-CM-CMTRN
Market	Commercial
Program Type	Lost Opportunity, New Construction, Retrofit
Category	Custom

Measure Description:

The Custom project track is offered for energy efficiency projects involving complex site-specific applications that require detailed engineering analysis and/or projects which do not qualify for incentives under any of the prescriptive rebate offering. Projects offered through the custom approach must pass a cost-effectiveness test based on project-specific costs and savings.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Custom - Compressed Air (Turnkey)	C&I Existing Building Retrofit (CI_RETRO)	EC2a043
Custom - Water Heating (Turnkey)	C&I Existing Building Retrofit (CI_RETRO)	EC2a044
Custom - HVAC (Turnkey)	C&I Existing Building Retrofit (CI_RETRO)	EC2a046
Custom - Envelope (Turnkey)	C&I Existing Building Retrofit (CI_RETRO)	EC2a164
Custom - Retrocommissioning (Turnkey)	C&I Existing Building Retrofit (CI_RETRO)	EC2a113
Custom - Motors & VFD (Turnkey)	C&I Existing Building Retrofit (CI_RETRO)	EC2a053
Custom - Process (Turnkey)	C&I Existing Building Retrofit (CI_RETRO)	EC2a056
Custom - Refrigeration (Turnkey)	C&I Existing Building Retrofit (CI_RETRO)	EC2a057
Custom - Other (Turnkey)	C&I Existing Building Retrofit (CI_RETRO)	EC2a058
Custom - Lighting Systems (Turnkey)	C&I Existing Building Retrofit	EC2a052

Measure Name	Core Initiative	BCR Measure ID
	(CI_RETRO)	
Custom - Lighting Controls (Turnkey)	C&I Existing Building Retrofit (CI_RETRO)	EC2a121
Building Shell, Gas - Custom (Turnkey)	C&I Existing Building Retrofit (CI_RETRO)	GC2a028
Controls, Gas - Custom (Turnkey)	C&I Existing Building Retrofit (CI_RETRO)	GC2a029
Foodservice, Gas - Custom (Turnkey)	C&I Existing Building Retrofit (CI_RETRO)	GC2a030
Heat Recovery, Gas - Custom (Turnkey)	C&I Existing Building Retrofit (CI_RETRO)	GC2a031
Heating, Gas - Custom (Turnkey)	C&I Existing Building Retrofit (CI_RETRO)	GC2a032
Other, Gas - Custom (Turnkey)	C&I Existing Building Retrofit (CI_RETRO)	GC2a033
Process, Gas - Custom (Turnkey)	C&I Existing Building Retrofit (CI_RETRO)	GC2a034
Steam Trap, Gas - Custom (Turnkey)	C&I Existing Building Retrofit (CI_RETRO)	GC2a035
Water Heating, Gas - Custom (Turnkey)	C&I Existing Building Retrofit (CI_RETRO)	GC2a036
Retrocommissioning (Turnkey)	C&I Existing Building Retrofit (CI_RETRO)	GC2a073

Algorithms for Calculating Primary Energy Impact:

Gross energy and demand savings estimates for custom projects are calculated using engineering analysis with project-specific details. Custom analyses typically include a weather dependent load bin analysis, whole building energy model simulation, end-use metering or other engineering analysis and include estimates of savings, costs, and an evaluation of the projects' cost-effectiveness.

Baseline Efficiency:

Custom project baselines should be developed in accordance with the MA Baseline Framework[1] and the MA C&I Baseline Repository. Retrofit projects will use the existing system or performance as the first year savings baseline. Lost opportunity projects will generally refer to code, if applicable, or Industry

Standard Practice (ISP), although there may be exceptions. If code does not apply and an ISP is not available, engineering judgement should be used to determine a project baseline.

High Efficiency:

The high efficiency scenario is specific to the custom project and may include one or more energy efficiency measures. Energy and demand savings calculations are based on projected or measured changes in equipment efficiencies and operating characteristics and are determined on a case-by-case basis. The project must be proven cost-effective in order to qualify for energy efficiency incentives.

Measure Life:

For both lost-opportunity and retrofit custom applications, the measure life is determined on a case-by-case basis.[2]

Other Resource Impacts:

Other resource impacts are determined on a case-by-case basis for custom projects.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Lighting, Electric	CI_RETRO	NGRID	1.00	0.93	n/a	0.91	1.03	custom	custom
Refrigeration, Electric	CI_RETRO	NGRID	1.00	1.049	n/a	0.941	1.174	custom	custom
Other, Electric	CI_RETRO	NGRID	1.00	1.049	n/a	0.941	1.174	custom	custom
Lighting, Electric	CI_RETRO	ES, CLC	1.00	0.93	n/a	0.91	1.03	custom	custom
Other Non-Lighting, Electric	CI_RETRO	ES	1.00	0.946	n/a	1.265	1.415	custom	custom
Other Non-Lighting, Electric	CI_RETRO	CLC	1.00	1.049	n/a	0.941	1.174	custom	custom
Lighting, Electric	CI_RETRO	Unitil	1.00	0.93	n/a	0.91	1.03	custom	custom
Non-Lighting, Electric	CI_RETRO	Unitil	1.00	0.946	n/a	1.265	1.415	custom	custom
All Custom, Gas	CI_RETRO	ES	1.00	n/a	0.87	n/a	n/a	n/a	n/a
All Custom, Gas	CI_RETRO	NGRID	1.00	n/a	0.77	n/a	n/a	n/a	n/a
All Custom, Gas	CI_RETRO	EGMA	1.00	n/a	0.82	n/a	n/a	n/a	n/a
All Custom, Gas	CI_RETRO	All Other	1.00	n/a	0.79	n/a	n/a	n/a	n/a

In-Service Rates:

All installations have 100% in-service rates since all PA programs include verification of equipment installations.

Realization Rates:

- All PAs use lighting results from 2018 small business impact study, which included samples of both custom and prescriptive.[3] All PAs use electric non-lighting results from the 2020 small business impact study, which included samples of both custom and prescriptive.[4]
- Gas RRs: Eversource, National Grid, and EGMAuse PA specific results based on evaluation of PY2021-PY2022 projects, while other PAs use statewide average.[5]

Coincidence Factors:

For all PAs, gross summer and winter peak coincidence factors are custom-calculated for each custom project based on project-specific information. The actual or measured coincidence factors are included in the summer and winter demand realization rates.

Impact Factors for Calculating Net Savings:

Custom net-to-gross values are from the 2021 Omnibus Net-to-Gross Study.[6]

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
All Custom Gas, Turnkey	CI_RETRO	All	0.017	0.00	0.00	0.98
All Custom Electric Non-Lighting, Turnkey	CI_RETRO	All	0.077	0.013	0.004	0.94
All Custom Electric Lighting, Turnkey	CI_RETRO	All	0.13	0.014	0.003	0.80

Non-Energy Impacts:

Non-energy impacts are from the 2021 C&I O&M and non-O&M NEI Study[7].

Measure	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual per kWh	One-time $ per KWh	Annual per therm	One-time $ per Therm
Building Shell, Gas - Custom (Turnkey)	CI_RETRO	All	n/a	n/a	$ -	n/a	$ 0.322	n/a
Faucet Aerator, Gas (Turnkey)	CI_RETRO	All	n/a	n/a	$ -	n/a	$ 0.357	n/a
Low-Flow Showerhead, Gas (Turnkey)	CI_RETRO	All	n/a	n/a	$ -	n/a	$ 0.357	n/a
Steam Trap, Gas - Custom (Turnkey)	CI_RETRO	All	n/a	n/a	$ -	n/a	$ 0.349	n/a

Measure	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual per kWh	One-time $ per KWh	Annual per therm	One-time $ per Therm
Water Heating, Gas - Custom (Turnkey)	CI_RETRO	All	n/a	n/a	$ -	n/a	$ 0.349	n/a
Steam Trap, Gas - (Turnkey)	CI_RETRO	All	n/a	n/a	$ -	n/a	$ 0.080	n/a
Steam Trap, Gas - Prescriptive (Turnkey)	CI_RETRO	All	n/a	n/a	$ -	n/a	$ 0.080	n/a
Steam Trap, Gas (Turnkey)	CI_RETRO	All	n/a	n/a	$ -	n/a	$ 0.080	n/a
HVAC - Custom (Turnkey)	CI_RETRO	All	n/a	n/a	$ 0.051	n/a	$ -	n/a
Envelope (Turnkey)	CI_RETRO	All	n/a	n/a	$0.149	n/a	n/a	n/a
Programmable Thermostats (Turnkey)	CI_RETRO	All	n/a	n/a	$ 0.247	n/a	$ -	n/a
Programmable Thermostat, Gas (Turnkey)	CI_RETRO	All	n/a	n/a	$ -	n/a	$ 2.800	n/a
Wi-Fi Thermostat, Gas (Turnkey)	CI_RETRO	All	n/a	n/a	$ -	n/a	$ 2.800	n/a
Duct Sealing, Gas (Turnkey)	CI_RETRO	All	n/a	n/a	$ -	n/a	$ 0.593	n/a
Duct Insulation, Gas (Turnkey)	CI_RETRO	All	n/a	n/a	$ -	n/a	$ 0.593	n/a
Energy Management System (Turnkey)	CI_RETRO	All	n/a	n/a	$ 0.222	n/a	$ -	n/a
Controls, Gas - Custom (Turnkey)	CI_RETRO	All	n/a	n/a	$ -	n/a	$ (0.037)	n/a
Heat Recovery, Gas - Custom (Turnkey)	CI_RETRO	All	n/a	n/a	$ -	n/a	$ (0.037)	n/a
Heating, Gas - Custom (Turnkey)	CI_RETRO	All	n/a	n/a	$ -	n/a	$ (0.037)	n/a
Pipe Wrap (Water Heating), Gas	CI_RETRO	All	n/a	n/a	$ -	n/a	$	n/a

Measure	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual per kWh	One-time $ per KWh	Annual per therm	One-time $ per Therm
, <=1.5" (Turnkey)	O						0.863	
Pipe Wrap (Water Heating), Gas , 2" (Turnkey)	CI_RETRO	All	n/a	n/a	$ -	n/a	$ 0.863	n/a
Pipe Wrap Steam, Gas , <=1.5" (Turnkey)	CI_RETRO	All	n/a	n/a	$ -	n/a	$ 0.863	n/a
Pipe Wrap Steam, Gas , 3" (Turnkey)	CI_RETRO	All	n/a	n/a	$ -	n/a	$ 0.863	n/a
Boiler Reset Control (Turnkey)	CI_RETRO	All	n/a	n/a	$ -	n/a	$ 0.863	n/a
Lighting Controls - Interior (Turnkey)	CI_RETRO	All	n/a	n/a	$ 0.127	n/a	$ -	n/a
Lighting Controls - Exterior (Turnkey)	CI_RETRO	All	n/a	n/a	$ 0.127	n/a	$ -	n/a
Compressed Air - Custom (Turnkey)	CI_RETRO	All	n/a	n/a	$ 0.018	n/a	$ -	n/a
Motors & VFD - Custom (Turnkey)	CI_RETRO	All	n/a	n/a	$ 0.018	n/a	$ -	n/a
VFD - Prescriptive (Turnkey)	CI_RETRO	All	n/a	n/a	$ 0.002	n/a	$ -	n/a
VFD with Motor - Prescriptive (Turnkey)	CI_RETRO	All	n/a	n/a	$ 0.002	n/a	$ -	n/a
Retrocomissioning (Turnkey)	CI_RETRO	All	n/a	n/a	$ -	n/a	$ 1.619	n/a
Retrocomissioning, Gas - Custom (Turnkey)	CI_RETRO	All	n/a	n/a	$ -	n/a	$ 0.153	n/a
Refrigeration - Custom (Turnkey)	CI_RETRO	All	n/a	n/a	$ 0.077	n/a	$ -	n/a
Other - Custom (Turnkey)	CI_RETRO	All	n/a	n/a	$ 0.065	n/a	$ -	n/a
Other, Gas - Custom (Turnkey)	CI_RETRO	All	n/a	n/a	$ -	n/a	$ 0.607	n/a

Measure	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual per kWh	One-time $ per KWh	Annual per therm	One-time $ per Therm
Hot Water - Custom (Turnkey)	CI_RETRO	All	n/a	n/a	$ 0.065	n/a	$ -	n/a
Lighting Systems - Interior (Turnkey)	CI_RETRO	All	n/a	n/a	$ 0.048	n/a	$ -	n/a
Lighting Systems - Exterior (Turnkey)	CI_RETRO	All	n/a	n/a	$ 0.048	n/a	$ -	n/a
Lighting - Custom (Turnkey)	CI_RETRO	All	n/a	n/a	$ 0.095	n/a	$ -	n/a
Process - Custom (Turnkey)	CI_RETRO	All	n/a	n/a	$ 0.098	n/a	$ -	n/a
Food Services, Gas - Custom (Turnkey)	CI_RETRO	All	n/a	n/a	$ -	n/a	$ 3.399	n/a
Process, Gas - Custom (Turnkey)	CI_RETRO	All	n/a	n/a	$ -	n/a	$ (0.045)	n/a
Pre-Rinse Spray Valve (Turnkey)	CI_RETRO	All	n/a	n/a	$ -	n/a	$ 0.357	n/a

Endnotes:

1 : DNV GL (2017). Massachusetts Commercial Industrial Baseline Framework.
2017_DNVGL_MA_Baseline_Framework

2 : Energy & Resource Solutions (2005). Measure Life Study. ERS_2005_Measure_Life_Study

3 : DNV GL (2018). Impact Evaluation of Small Business Lighting Measured (Phase I).

4 : DNV GL (2020). Impact Evaluation of PY 2017 Small Business Initiative Non-Lighting Measures.

5 : DNV (2023). Massachusetts Impact Evaluation of PY2021/PY2022 Custom Gas Installations.
2023_DNV_PY2021-22_Custom_Gas_Impact

6 : NMR Group, Inc. (2021). C&I Omnibus NTG Study 2021_NMR_C&I_Omnibus_NTG

7 : NMR Group Inc. (2021). C&I O&M and non-O&M NEI Study. 2021_NMR_CIOM and NonOM NEI Study

3.15 Custom - Large C&I

Measure Code	COM-CM-CMLCI
Market	Commercial
Program Type	Custom
Category	Custom

Measure Description:

The Custom project track is offered for gas and electric energy efficiency projects involving complex site-specific applications that require detailed engineering analysis and/or projects which do not qualify for incentives under any of the prescriptive rebate offering. Projects offered through the custom approach must pass a cost-effectiveness test based on project-specific costs and savings.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Custom - CHP	C&I New Buildings & Major Renovations (CI_NB&MR)	EC1a028
Custom - Fuel Cell	C&I New Buildings & Major Renovations (CI_NB&MR)	EC1a054
Custom - Comprehensive Design (Legacy)	C&I New Buildings & Major Renovations (CI_NB&MR)	EC1a001
Custom - Zero Net Energy Design Approach	C&I New Buildings & Major Renovations (CI_NB&MR)	EC1a065
Custom - Whole Building EUI Approach	C&I New Buildings & Major Renovations (CI_NB&MR)	EC1a066
Custom - Modeled Approach	C&I New Buildings & Major Renovations (CI_NB&MR)	EC1a067
Custom - Compressed Air	C&I New Buildings & Major Renovations (CI_NB&MR)	EC1a002
Custom - HVAC	C&I New Buildings & Major Renovations (CI_NB&MR)	EC1a010
Custom - Envelope	C&I New Buildings & Major Renovations (CI_NB&MR)	EC1a064

Measure Name	Core Initiative	BCR Measure ID
Custom - Lighting Controls	C&I New Buildings & Major Renovations (CI_NB&MR)	EC1a055
Custom - Indoor Agriculture	C&I New Buildings & Major Renovations (CI_NB&MR)	EC1a068
Custom - Motors & VFD	C&I New Buildings & Major Renovations (CI_NB&MR)	EC1a024
Custom - Process	C&I New Buildings & Major Renovations (CI_NB&MR)	EC1a026
Custom - Refrigeration	C&I New Buildings & Major Renovations (CI_NB&MR)	EC1a027
Custom - Water Heating	C&I New Buildings & Major Renovations (CI_NB&MR)	EC1a009
Custom - Other	C&I New Buildings & Major Renovations (CI_NB&MR)	EC1a029
Compressed Air - High Efficiency Air Compressors	C&I New Buildings & Major Renovations (CI_NB&MR)	EC1a003
Custom - CHP	C&I Existing Building Retrofit (CI_RETRO)	EC2a001
Custom - Fuel Cell	C&I Existing Building Retrofit (CI_RETRO)	EC2a119
Custom - Comprehensive Retrofit	C&I Existing Building Retrofit (CI_RETRO)	EC2a002
Custom - Compressed Air	C&I Existing Building Retrofit (CI_RETRO)	EC2a003
Custom - HVAC	C&I Existing Building Retrofit (CI_RETRO)	EC2a007
Custom - Electrification HVAC (Wx)	C&I Existing Building Retrofit (CI_RETRO)	EC2a115
Custom - Electrification	C&I New Buildings & Major Renovations (CI_NB&MR)	EC1a069
Custom - Electrification (legacy)	C&I New Buildings & Major Renovations (CI_NB&MR)	EC1a070
Custom - Electrification Other	C&I Existing Building Retrofit (CI_RETRO)	EC2a163
Custom - Electrification HVAC (Wx unverified)	C&I Existing Building Retrofit (CI_RETRO)	EC2a166

Measure Name	Core Initiative	BCR Measure ID
Custom - Electrification Process	C&I Existing Building Retrofit (CI_RETRO)	EC2a167
Custom - Electrification Water Heating	C&I Existing Building Retrofit (CI_RETRO)	EC2a168
Custom - Envelope	C&I Existing Building Retrofit (CI_RETRO)	EC2a124
Custom - Retrocommissioning	C&I Existing Building Retrofit (CI_RETRO)	EC2a114
Custom - Lighting Controls	C&I Existing Building Retrofit (CI_RETRO)	EC2a120
Custom - Envelope - Non turnkey Small Business	C&I New & Replacement Equipment (CI_EQUIP)	EC2a165
Custom - Indoor Agriculture	C&I Existing Building Retrofit (CI_RETRO)	EC2a151
Custom - Motors & VFD	C&I Existing Building Retrofit (CI_RETRO)	EC2a019
Custom - Process	C&I Existing Building Retrofit (CI_RETRO)	EC2a024
Custom - Refrigeration	C&I Existing Building Retrofit (CI_RETRO)	EC2a025
Custom - Water Heating	C&I Existing Building Retrofit (CI_RETRO)	EC2a026
Custom - Other	C&I Existing Building Retrofit (CI_RETRO)	EC2a027
Custom - Lighting Controls (Residential End Use)	C&I Existing Building Retrofit (CI_RETRO)	EC2a122
Custom - CHP	C&I New & Replacement Equipment (CI_EQUIP)	EC2b001
Custom - Fuel Cell	C&I New & Replacement Equipment (CI_EQUIP)	EC2b093
Custom - Compressed Air	C&I New & Replacement Equipment (CI_EQUIP)	EC2b002
Custom - HVAC	C&I New & Replacement Equipment (CI_EQUIP)	EC2b009
Custom - Motors & VFD	C&I New & Replacement Equipment (CI_EQUIP)	EC2b023
Custom - Refrigeration	C&I New & Replacement Equipment (CI_EQUIP)	EC2b026
Custom - Water Heating	C&I New & Replacement Equipment (CI_EQUIP)	EC2b027
Custom - Process	C&I New & Replacement Equipment (CI_EQUIP)	EC2b025
Custom - Other	C&I New & Replacement Equipment (CI_EQUIP)	EC2b028
Custom - Lighting Systems	C&I New & Replacement Equipment (CI_EQUIP)	EC2b012

Measure Name	Core Initiative	BCR Measure ID
Custom - Lighting Controls	C&I New & Replacement Equipment (CI_EQUIP)	EC2b094
Building Shell, Gas - Custom	C&I New Buildings & Major Renovations (CI_NB&MR)	GC1a001
Comprehensive Design, Gas - Custom	C&I New Buildings & Major Renovations (CI_NB&MR)	GC1a002
Controls, Gas - Custom	C&I New Buildings & Major Renovations (CI_NB&MR)	GC1a003
Foodservice, Gas - Custom	C&I New Buildings & Major Renovations (CI_NB&MR)	GC1a004
Heat Recovery, Gas - Custom	C&I New Buildings & Major Renovations (CI_NB&MR)	GC1a005
Heating, Gas - Custom	C&I New Buildings & Major Renovations (CI_NB&MR)	GC1a006
Other, Gas - Custom	C&I New Buildings & Major Renovations (CI_NB&MR)	GC1a007
Process, Gas - Custom	C&I New Buildings & Major Renovations (CI_NB&MR)	GC1a009
Water Heating, Gas - Custom	C&I New Buildings & Major Renovations (CI_NB&MR)	GC1a010
Building Shell, Gas - Custom	C&I Existing Building Retrofit (CI_RETRO)	GC2a003
Controls, Gas - Custom	C&I Existing Building Retrofit (CI_RETRO)	GC2a004
Foodservice, Gas - Custom	C&I Existing Building Retrofit (CI_RETRO)	GC2a005
Heat Recovery, Gas - Custom	C&I Existing Building Retrofit (CI_RETRO)	GC2a006
Heating, Gas - Custom	C&I Existing Building Retrofit (CI_RETRO)	GC2a007
Other, Gas - Custom	C&I Existing Building Retrofit (CI_RETRO)	GC2a008
Ozonated Laundry, Gas - Custom	C&I Existing Building Retrofit (CI_RETRO)	GC2a009
Process, Gas - Custom	C&I Existing Building Retrofit (CI_RETRO)	GC2a010
Steam Trap, Gas - Custom	C&I Existing Building Retrofit (CI_RETRO)	GC2a011

Measure Name	Core Initiative	BCR Measure ID
Water Heating, Gas - Custom	C&I Existing Building Retrofit (CI_RETRO)	GC2a014
Retrocomissioning, Gas - Custom	C&I Existing Building Retrofit (CI_RETRO)	GC2a072
Steam Trap, Gas (Turnkey)	C&I Existing Building Retrofit (CI_RETRO)	GC2a071
Foodservice, Gas - Custom	C&I New & Replacement Equipment (CI_EQUIP)	GC2b001
Heat Recovery, Gas - Custom	C&I New & Replacement Equipment (CI_EQUIP)	GC2b002
Heating, Gas - Custom	C&I New & Replacement Equipment (CI_EQUIP)	GC2b003
Other, Gas - Custom	C&I New & Replacement Equipment (CI_EQUIP)	GC2b004
Process, Gas - Custom	C&I New & Replacement Equipment (CI_EQUIP)	GC2b005
Water Heating, Gas - Custom	C&I New & Replacement Equipment (CI_EQUIP)	GC2b006
Custom - Zero Net Energy Design Approach	C&I New Buildings & Major Renovations (CI_NB&MR)	GC1a044
Custom - Whole Building EUI Approach	C&I New Buildings & Major Renovations (CI_NB&MR)	GC1a045
Custom - Modeled Approach	C&I New Buildings & Major Renovations (CI_NB&MR)	GC1a046
Custom - HVAC (Electrification, Wx verified)	C&I Existing Building Retrofit (CI_RETRO)	GC2a075
Custom - HVAC (Electrification, unverified Wx)	C&I Existing Building Retrofit (CI_RETRO)	GC2a077
Custom - Electrification	C&I New Buildings & Major Renovations (CI_NB&MR)	GC1a047
Custom - Process (Electrification)	C&I Existing Building Retrofit (CI_RETRO)	GC2a078
Custom - Water Heating (Electrification)	C&I Existing Building Retrofit (CI_RETRO)	GC2a079

Algorithms for Calculating Primary Energy Impact:

Gross energy and demand savings estimates for custom projects are calculated using engineering analysis with project-specific details. Custom analyses typically include a weather dependent load bin analysis, whole building energy model simulation, end-use metering or other engineering analysis and include estimates of savings, costs, and an evaluation of the projects' cost-effectiveness.

Baseline Efficiency:

Custom project baselines should be developed in accordance with the MA Baseline Framework[1] and the MA C&I Baseline Repository. Retrofit projects will use the existing system or performance as the first year savings baseline. Lost opportunity projects will generally refer to code, if applicable, or Industry Standard Practice (ISP), although there may be exceptions. If code does not apply and an ISP is not available, engineering judgement should be used to determine a project baseline.

High Efficiency:

The high efficiency scenario is specific to the custom project and may include one or more energy efficiency measures. Energy and demand savings calculations are based on projected or measured changes in equipment efficiencies and operating characteristics and are determined on a case-by-case basis. The project must be proven cost-effective in order to qualify for energy efficiency incentives.

Measure Life:

For both lost-opportunity and retrofit custom applications, the measure life is determined on a case-by-case basis. Dual baseline effects should be considered for retrofit projects.[3]

The Custom Screening Tool drop-down menus provide the following Effective Useful Life (EUL) options for custom measures:

Measure Type	EUL Options in Custom Screening Tool
Boiler, HVAC	5, 10, 15, 20, 25
Boiler, non-HVAC	5, 10, 15, 20, 25
Building Shell	5, 10, 15, 20, 25
Chillers	23
Combined Heat & Power	5, 10, 15, 20, 25
Comprehensive Retrofit	5-25
Compressed Air	13
Compressed Air Equipment (Compressors, Dryers, ZL drains)	15
Compressed Air Equipment and Systems	15

Measure Type	EUL Options in Custom Screening Tool
Cooling Equipment	15
EMS / controls, HVAC	5, 10, 13, 15
EMS / controls, non-HVAC	5, 10, 13, 15
Equipment Insulation, HVAC	10, 15, 20
Equipment Insulation, non-HVAC	10, 15, 20
Food Service	10, 12, 15
Fuel switching, HVAC	5, 10, 15, 20, 25
Fuel switching, non-HVAC	5, 10, 15, 20, 25
Furnace, HVAC	18
Furnace, non-HVAC	18
Heat recovery, HVAC	10, 15, 20
Heat recovery, non-HVAC	10, 15, 20
High Efficiency Motor	20
HVAC	13
HVAC Equipment and Systems	15
Integrated Design Project	5-25
Lighting - Exterior Controls	9, 10
Lighting - Exterior with Controls	15
Lighting - Interior Controls	9, 10
Lighting - Interior with Controls	15
Motors/Drive HVAC	13
Motors/Drive Non-HVAC	13
O&M (leak repair, filter retrofit), CAIR	2, 5
O&M / Retrocommissioning, HVAC	1-5
O&M / Retrocommissioning, non-HVAC	1-5

Measure Type	EUL Options in Custom Screening Tool
Other	5-25
Other, HVAC	5, 10, 15, 20, 25
Other, non-HVAC	10, 15, 20, 25
Process	1-13
Process Equipment	5, 10, 13, 15, 18, 20
Process Equipment and Controls	5, 10
Refrigeration	13
Refrigeration, Commercial	15
Refrigeration, Industrial	20
Steam trap, HVAC	6
Steam trap, non-HVAC	6
Transformer Replacement	20, 25
Verified savings, HVAC	10, 15
Verified savings, non-HVAC	10, 15
VFD on HVAC Equipment	15
VFD on non-HVAC Equipment	15
Water heating, DHW	5, 10, 13, 15

Other Resource Impacts:

Other resource impacts should be determined on a case-by-case basis for custom projects.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RRE	RRNE	RRSP	RRWP	CFSP	CFWP	LSAFE	LSAFNE
Custom Gas, Non-Steam Trap	CI_NB&MR, CI_RETRO, CI_IP&EUL	NGRID	1	n/a	0.77	n/a	n/a	custom	custom	n/a	1.07
		Eversource	1	n/a	0.87	n/a	n/a	custom	custom	n/a	1.03

Measure Name	Core Initiative	PA	ISR	RRE	RRNE	RRSP	RRWP	CFSP	CFWP	LSAFE	LSAFNE
		EGMA	1	n/a	0.90	n/a	n/a	custom	custom	n/a	0.99
		Statewide - Unitil, Liberty, Berkshire	1	n/a	0.80	n/a	n/a	custom	custom	n/a	1.04
Custom Gas, Steam Trap	CI_RETRO	All	1	n/a	1.00	n/a	n/a	custom	custom	n/a	1.00
Custom Electric, Non-Lighting	CI_NB&MR, CI_RETRO, CI_IP&EUL	NGRID	1	0.80	0.80	0.77	0.76	custom	custom	1.03	1.03
		Eversource	1	0.84	0.84	0.82	0.81	custom	custom	0.97	0.97
		CLC (Statewide)	1	0.83	0.83	0.80	0.78	custom	custom	0.99	0.99
		Unitil (Statewide)	1	0.83	0.83	0.80	0.78	custom	custom	0.99	0.99
Custom - Electrification	CI_NB&MR	All	1	0.80	0.80	0.80	0.80	custom	custom	1.00	1.00
Custom - Electrification	CI_RETRO	All	1	0.80	0.80	0.80	0.80	custom	custom	1.00	1.00
Custom - Comprehensive Design (Legacy) - Electric	CI_NB&MR	All	1	0.57	0.57	0.57	0.43	custom	custom	n/a	n/a
Custom - Comprehensive Design (Legacy) -	CI_NB&MR	All	1	n/a	1.01	n/a	n/a	custom	custom	n/a	n/a

Measure Name	Core Initiative	PA	ISR	RRE	RRNE	RRSP	RRWP	CFSP	CFWP	LSAFE	LSAFNE
Gas											
Custom - Zero Net Energy Design Approach - Electric	CI_NB&MR	All	1	0.94	0.94	0.57	0.43	custom	custom	n/a	n/a
Custom - Zero Net Energy Design Approach - Gas	CI_NB&MR	All	1	n/a	0.97	n/a	n/a	custom	custom	n/a	n/a
Custom - Whole Building EUI Approach - Electric	CI_NB&MR	All	1	0.94	0.94	0.57	0.43	custom	custom	n/a	n/a
Custom - Whole Building EUI Approach - Gas	CI_NB&MR	All	1	n/a	0.97	n/a	n/a	custom	custom	n/a	n/a
Custom - Modeled Approach - Electric	CI_NB&MR	All	1	0.57	0.57	0.57	0.43	custom	custom	n/a	n/a
Custom - Modeled Approach - Gas	CI_NB&MR	All	1	n/a	1.01	n/a	n/a	custom	custom	n/a	n/a
CHP - Custom	CI_NB&MR, CI_RETRO, CI_IP&EUL	Eversource	1	1.1	1.22	1.44	1.01	custom	custom	n/a	n/a
		NGRID	1	0.91	1.02	1.09	1.05	custom	custom	n/a	n/a

Measure Name	Core Initiative	PA	ISR	RRE	RRNE	RRSP	RRWP	CFSP	CFWP	LSAFE	LSAFNE
		Unitil	1	0.9	1.12	1.26	1.58	custom	custom	n/a	n/a

In-Service Rates:

All installations have 100% in service rate since all PA programs include verification of equipment installations.

Realization Rates:

- CHP - Custom: RRs based on evaluation of PY 2012 projects[3] . Unitil uses statewide results given their small sample size. Note that RR_{NE} applies to project fossil fuel penalty.
- Comprehensive Design Analysis, Electric and Gas: For Legacy programs and Modeled Approach: gas RRs based on evaluation of PY2014 projects[4] ; electric RRs based on 2021 analysis[5] For Zero Net Energy and Whole Building EUI programs, realization rates are based on negotiated values; all other values are identical to Legacy values.
- Electric Non-Lighting: RRs based on evaluation of PY2020-PY2022 projects.[6]
- Gas (all): RRs based on evaluation of PY2021-PY2022 projects.[7]
- Electrification: RR based on desk review of in-progress projects initiated between 1/1/2022 and 4/30/2023.[8]

Coincidence Factors:

For all PAs, gross summer and winter peak coincidence factors are custom-calculated for each custom project based on project-specific information. The actual or measured coincidence factors are included in the summer and winter demand realization rates.

Impact Factors for Calculating Net Savings:

Net-to-gross values for Custom Gas and Custom Electric are taken from the 2021 C&I Omnibus NTG Study.[9]

Net-to-gross values for the Custom New Buildings & Major Renovations programs are taken from the 2021 Non-Residential New Construction Net-to-Gross Study.[10]

Measure Name	Core Initiative	PA	FR	SOP	SONP	NTG
Custom Electric - Non-Lighting	CI_NB&MR	All	58.30%	22.70%	n/a	64.40%
	CI_EQUIP	All	38.20%	0.00%	2.40%	64.20%
	CI_RETRO	All	17.10%	1.60%	7.70%	102.00%
All Custom Gas	CI_NB&MR	All	58.30%	22.70%	n/a	64.40%
	CI_EQUIP	All	5.10%	0.10%	0.00%	95.00%

	CI_RETRO	All	19.60%	0.20%	0.00%	80.60%
Custom-Electrification*	CI_NB&MR	All	93.0%	0.0%	0.0%	7.0%
Custom-Electrification**	CI_NB&MR	All				69%
Custom - Comprehensive Design (Legacy)	CI_NB&MR	All	58.30%	22.70%	n/a	64.40%
Custom - Zero Net Energy Design Approach	CI_NB&MR	All	n/a	n/a	n/a	73%
Custom - Whole Building EUI Approach	CI_NB&MR	All	n/a	n/a	n/a	73%
Custom - Modeled Approach	CI_NB&MR	All	58.30%	22.70%	n/a	64.40%

*Applied to projects that enrolled in the program prior to rolling out incentives in April 2022 but for which the PAs will claim fuel switching savings

**Applied to projects that enrolled in the program after rolling out incentives in April 2022

Non-Energy Impacts:

All non-energy impacts should be determined on a case-by-case basis. Default NEIs are provided in the table below for retrofit and new building applications. NEIs were updated in 2021 via the C&I O&M and non-O&M NEI Study.[11] Additional NEI updates from the 2022 C&I Health & Safety NEI study.[12]

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per KWh	Annual $ per Therm	One-time $ per Therm
Envelope	CI_NB&MR	All			$0.133		$0.483	

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per KWh	Annual $ per Therm	One-time $ per Therm
Envelope	CI_RETRO	All			$0.149			
Comprehensive Design	CI_NB&MR	All			$0.104		$0.483	
Compressed Air	CI_NB&MR	All			$0.030		$0.348	
Controls, Gas	CI_NB&MR	All			n/a		($0.045)	
Food Service	CI_NB&MR, CI_EQUIP	All			$0.051		$3.40	
Heat Recovery, Gas	CI_NB&MR	All			n/a		($0.045)	
HVAC	CI_NB&MR	All			$0.133		($0.037)	
Envelope- Non Turnkey Small Business	CI_RETRO	All			$0.149			
Lighting	CI_NB&MR	All			$0.018		n/a	
Motors & VFD	CI_NB&MR	All			$0.018		n/a	
Other	CI_NB&MR	All			$0.070		n/a	
Process	CI_NB&MR	All			$0.013		$0.607	
Process, Gas	CI_NB&MR	All			$0.091		($0.045)	
Refrigeration	CI_NB&MR	All			$0.098		n/a	
Boilers	CI_NB&MR	All			n/a		($0.037)	
Water Heating	CI_NB&MR	All			$0.101		$0.00	
Water Heating, Gas	CI_NB&MR	All			n/a		$0.349	
Comprehensive Retrofit	CI_RETRO	All			$0.113		$0.483	
Compressed Air	CI_RETRO, CI_EQUIP	All			$0.056		$0.349	
Controls, Gas	CI_RETRO	All			$0.030		($0.04)	
Food Service	CI_RETRO	All			$0.030		$3.40	

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per KWh	Annual $ per Therm	One-time $ per Therm
Heat Recovery, Gas	CI_RETRO	All			n/a		($0.037)	
Heat Recovery, Gas	CI_EQUIP						($0.054)	
HVAC	CI_RETRO	All			$0.149		($0.037)	
HVAC	CI_EQUIP	All			$0.133		($0.054)	
HVAC - Electrification	CI_RETRO	All			$0.149		n/a	
Lighting Controls	CI_NB&MR, CI_EQUIP	All			$0.116			
Lighting Controls	CI_RETRO	All			$0.130			
Lighting Controls (Residential End Use)	CI_RETRO	All			$0.130			
Motors & VFD	CI_RETRO, CI_EQUIP	All			n/a		$0.153	
Process	CI_RETRO	All			$0.056		$0.607	
Process	CI_EQUIP	All			$0.065		n/a	
Process, Gas	CI_RETRO	All			$0.095		($0.045)	
Process, Gas	CI_EQUIP	All			$0.065		($0.05)	
Other	CI_RETRO	All			$0.065		n/a	
Other	CI_EQUIP	All			$0.077		n/a	
Other, Gas	CI_EQUIP, CI_RETRO	All			$0.065		$0.61	
Ozonated Laundry, Gas	CI_RETRO	All			n/a		$0.44	
Process	CI_RETRO	All			$0.095		n/a	
Refrigeration	CI_RETRO, CI_EQUIP	All			$0.065		n/a	
Retrocommissioning	CI_RETRO	All			$0.269		$1.44	
CHP	CI_RETRO	All			$(0.015)		n/a	

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per KWh	Annual $ per Therm	One-time $ per Therm
Steam Traps	CI_RETRO	All			$0.065		$0.35	
Water Heating	CI_RETRO, CI_EQUIP	All			n/a		$5.099	
Water Heating, Gas	CI_RETRO	All			n/a		$0.349	
Water Heating, Gas	CI_EQUIP	All			n/a		$0.35	

Endnotes:

1 : DNV GL (2017). Massachusetts Commercial Industrial Baseline Framework 2017_DNVGL_MA_Baseline_Framework

2 : Baseline Categories and preliminary Out Year Factors are described at a high level in DNV GL, ERS (2018). Portfolio Model Companion Sheet. Additional background on the baseline categorization given in DNV GL, ERS (2018). Portfolio Model Methods and Assumptions – Electric and Natural Gas Memo. 2018_DNVGL_ERS_Portfolio_Model_Companion_Sheet

3 : KEMA 2013. Massachusetts Combined Heat and Power Program Impact Evaluation, 2011-2012. KEMA_2013_MA_CI_CHP_IMPACT_EVAL

4 : DNV GL (2018). Massachusetts Commercial and Industrial Impact Evaluation of 2014 Custom CDA Installations.

5 : Massachusetts C&I Custom CDA Results Memo; DNV GL, March 2021

6 : DNV (2023). Impact Evaluation of PY2020/2021/2022 Custom Electric Installations. 2023_DNV_custom electric PY2020-21-22 impact

7 : DNV (2023). Massachusetts Impact Evaluation of PY2021/PY2022 Custom Gas Installations. 2023_DNV_PY2021-22_Custom_Gas_Impact

8 : DNV(2023). Custom Electrification Realization Rate Memo. 2023_DNV_MA22C07-E-CELECTRIF_final memo

9 : C&I Omnibus NTG Study. NMR, 2021. 2021_NMR_C&I_Omnibus_NTG

10 : NMR Group. Inc. (2021). Non Residential New Construction NTG Report. 2021_NMR_Non_Residential_New_Construction_NTG_Report

11 : NMR Group, Inc. (2021). Non O&M and non-O&M NEI study. 2021_NMR_CIOM and NonOM NEI Study

12 : DNV(2022). C&I Health & Safety NEI Study. 2022_DNV_C&I_Heath_&_Safety_NEIs

3.16 Demand - Active Demand Reduction

Measure Code	COM-BE-ADR
Market	Commercial
Program Type	Active Demand Response
Category	Custom

Measure Description:

Active Demand Reduction includes C&I Interruptible Load Curtailment, Winter Interruptible Load, Battery Storage Daily Dispatch, Battery Storage Targeted Dispatch Summer, Battery Storage Targeted Dispatch Winter, Technology-Neutral Daily Dispatch, Technology-Neutral Targeted Dispatch, and Custom.

The Interruptible Load Curtailment offering is technology agnostic and provides an incentive for verifiable shedding of load in response to a signal or communication from the Program Administrators coinciding with system peak conditions. Large C&I customers with the ability to control lighting, comfort, and/or process loads can use this demand reduction performance offering to generate revenue by altering their operations a few times per year. The offering focuses on reducing demand during summer peak events, typically targeting fewer than twenty-five hours per summer.

The Winter Interruptible Load offering is similar to Interruptible Load for the summer, except that the goal is to help promote winter resiliency by finding customers that can reduce electric usage during times of high winter system load. The offering focuses on reducing demand during winter peak events, typically targeting up to five hours per winter. Note, winter interruptible load is not included in the 2022-2024 plan.

The Battery Storage Daily Dispatch offering provides pay-for-performance incentives to customers with battery storage that can reduce load on a daily basis. Customers are routinely dispatched to reduce regional peak loads on non-holiday weekdays July - September.

The Battery Storage Targeted Dispatch Summer offering provides pay-for-performance incentives to customers with battery storage that can reduce load during peak events. Customers are dispatched up to eight times during the summer with the goal of reducing regional peak loads, specifically the annual system peak hour.

The Battery Storage Targeted Dispatch Winter offering provides pay-for-performance incentives to customers with battery storage that can reduce load during peak events. Customers are dispatched up to five times during the winter the goal of reducing regional peak loads.

The Technology-Neutral Daily Dispatch offering provides pay-for-performance incentives to customers with technology that can reduce load on a daily basis. Customers are routinely dispatched to reduce regional peak loads on non-holiday weekdays July - September.

The Technology-Neutral Targeted Dispatch offering provides pay-for-performance incentives to customers with technology that can reduce load during peak events. Customers are dispatched up to eight times during the summer with the goal of reducing regional peak loads with a focus on the annual system peak hour.

Custom Active Demand Reduction is site specific.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Interruptible Load	C&I Active Demand Reduction (CI_ADR)	EC2c001
Battery Storage Daily Dispatch, discharge (savings) Summer	C&I Active Demand Reduction (CI_ADR)	EC2c003
Battery Storage Daily Dispatch, charge (consumption) Summer	C&I Active Demand Reduction (CI_ADR)	EC2c011
Battery Storage Targeted Dispatch, discharge (savings) Summer	C&I Active Demand Reduction (CI_ADR)	EC2c004
Battery Storage Targeted Dispatch, charge (consumption) Summer	C&I Active Demand Reduction (CI_ADR)	EC2c012
Technology-Neutral Daily Dispatch, discharge Summer	C&I Active Demand Reduction (CI_ADR)	EC2c008
Technology-Neutral Targeted Dispatch, discharge Summer	C&I Active Demand Reduction (CI_ADR)	EC2c015
Custom - ADR	C&I Active Demand Reduction (CI_ADR)	EC2c006

Algorithms for Calculating Primary Energy Impact:

The Active Demand Reduction measure generates site-specific demand savings. Savings estimates for these projects are calculated using engineering analysis with project-specific details.

Summer kW savings supplied by vendors is the average of the top hour of each day in July and August on which events were called.

Baseline Efficiency:

Baseline conditions will be determined based on technology.

For interruptible load and Technology Neutral Daily and Targeted dispatch , baseline conditions are based on an adjustment settlement baseline with symmetric, additive adjustment. The symmetrically

adjusted settlement baseline is developed based on a pool of the most recent 10 non-holiday weekdays. The baseline shape consists of average load per interval across the eligible days. The baseline is adjusted based on the difference between baseline and facility load in the second hour prior to the event (the baseline adjustment period), and the adjustment can be either to increase or decrease the estimated load reduction (i.e., symmetric adjustment). This adjustment accounts for weather-related and other differences of load magnitude.[1]

For battery storage, both daily dispatch and targeted dispatch, demand reduction is calculated based on the discharge of the battery during a DR event regardless if the battery is operated on non-event days.[2]

For technology-neutral targeted dispatch, the average performance during non-event weekday afternoons is used to calculate the baseline load for events. This analysis method is analogous to the settlement baselines for interruptible load curtailment.

Custom projects will have a custom baseline.

High Efficiency:

N/A, Active Demand Reduction does not directly increase efficiency. Interruptible Load does reduce energy consumption by curtailing use, but does not increase efficiency per se. Storage increases energy consumption due to round trip efficiency losses.

Measure Life:

Because Active Demand Reduction is based on Program Administrators calling demand reduction events each year, the measure life is one year.

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
All Active Demand Reduction measures	CI_ADR	All	1	n/a	n/a	1

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

For summer interruptible load, the peak realization rate is based on the average demand reduction calculated using the evaluated symmetric baseline, divided by the average demand reduction calculated using the reported asymmetric baseline. This rate is what evaluators believe to be most representative of the ratio of evaluated to reported performance.[3]

For battery storage, both daily dispatch and targeted dispatch, demand reduction is calculated based on the discharge of the battery during a DR event regardless if the battery is operated on non-event days. So savings are based on vendor calculations and reported as a 100% RR.

The realization rate for electric kWh (RRE) is assumed to be equal to RRSP.

Unless otherwise noted, realization rates and offerings that have not yet been evaluated at all are listed with a realization rate of 1.0 until evaluation results become available.

Measure Name	Core Initiative	PA	ISR	RR$_E$	RR$_{NE}$	RR$_{SP}$	RR$_{WP}$	CF$_{SP}$	CF$_{WP}$
Interruptible Load	CI_ADR	National Grid	1.00	0.84	1.00	0.84	1.00	1.00	0.00
Interruptible Load	CI_ADR	Unitil	1.00	0.77	1.00	0.77	1.00	1.00	0.00
Interruptible Load	CI_ADR	Eversource	1.00	0.73	1.00	0.73	1.00	1.00	0.00
Interruptible Load	CI_ADR	CLC	1.00	0.82	1.00	0.82	1.00	1.00	0.00
Battery Storage Daily Dispatch, charge (consumption) Summer	CI_ADR	All	1.00	1.00	1.00	1.00	1.00	0.00	0.00
Battery Storage Targeted Dispatch, discharge (savings) Summer	CI_ADR	All	1.00	1.00	1.00	1.00	1.00	1.00	0.00
Battery Storage Targeted Dispatch, charge (consumption) Summer	CI_ADR	All	1.00	1.00	1.00	1.00	1.00	0.00	0.00
Battery Storage Daily Dispatch, discharge (savings) Summer	CI_ADR	All	1.00	1.00	1.00	1.00	1.00	0.00	0.00
Technology-Neutral Daily Dispatch	CI_ADR	Eversource	1.00	0.71	1.00	0.71	1.00	1.00	1.00
Technology-Neutral Daily (Curtailment)	CI_ADR	National Grid	1.00	1.17	1.00	1.17	1.00	1.00	1.00
Technology-Neutral Targeted Dispatch	CI_ADR	Eversource	1.00	0.74	1.00	0.74	1.00	1.00	1.00
Custom	CI_ADR	All	1.00	1.00	1.00	1.00	1.00	1.00	0.00

Impact Factors for Calculating Net Savings:

Measure Name	Core Initiative	PA	FR	SO$_P$	SO$_{NP}$	NTG
All Active Demand Reduction measures	CI_ADR	All	0.00	0.00	0.00	1.00

Non-Energy Impacts:

There are no non-energy impacts identified for this measure.

Endnotes:

1 : For more information and details on the RR values, please refer to the following study: MA21DR05-E-CI - 2021 Summer CI ADR Evaluation Report_FINAL
2 : For more information and reasoning for the battery baseline, please refer to the following letter that was written by the PAs and supported by DOER. 2023_PAs_Battery Storage Baseline Policy Letter
3 : For more information and documentation on the RR, please refer to the following study: MA21DR05-E-CI - 2021 Summer CI ADR Evaluation Report_FINAL

3.17 Envelope - Prescriptive Air Sealing

Measure Code	COM-BS-AS
Market	Commercial
Program Type	Retrofit
Category	Heating Ventilation and Air Conditioning

Measure Description:

Air sealing to an existing building

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Prescriptive Air Sealing, Electric	C&I Existing Building Retrofit (CI_RETRO)	EC2a169
Prescriptive Air Sealing, Oil	C&I Existing Building Retrofit (CI_RETRO)	EC2a170
Prescriptive Air Sealing, Propane	C&I Existing Building Retrofit (CI_RETRO)	EC2a171
Prescriptive Air Sealing, Electric (Turnkey)	C&I Existing Building Retrofit (CI_RETRO)	EC2a175
Prescriptive Air Sealing, Oil (Turnkey)	C&I Existing Building Retrofit (CI_RETRO)	EC2a176
Prescriptive Air Sealing, Propane (Turnkey)	C&I Existing Building Retrofit (CI_RETRO)	EC2a177

Algorithms for Calculating Primary Energy Impact:

Savings are derived from a combination of sources, including the Guidehouse Energy Optimization model[1], TMY meteorological data, residential air sealing program data, and a Lawrence Berkeley National Laboratory model for estimating natural infiltration rates. Savings are deemed per hour of air sealing work.

Deemed Savings (per hour of air sealing work)

Measure Name	Electric Savings - Annual kWh	Oil Savings - MMBtu per year	Propane Savings - MMBtu per year

Measure Name	Electric Savings - Annual kWh	Oil Savings - MMBtu per year	Propane Savings - MMBtu per year
Prescriptive Air Sealing, Electric	175.95	n/a	n/a
Prescriptive Air Sealing, Oil	n/a	0.78	n/a
Prescriptive Air Sealing, Propane	n/a	n/a	0.71
Prescriptive Air Sealing, Electric (Turnkey)	175.95	n/a	n/a
Prescriptive Air Sealing, Oil (Turnkey)	n/a	0.78	n/a
Prescriptive Air Sealing, Propane (Turnkey)	n/a	n/a	0.71

Baseline Efficiency:

The baseline efficiency case is the existing building before the air sealing measure is implemented. The baseline building is characterized by an assumed baseline heating system efficiency, which is derived from the Guidehouse Energy Optimization model, and an assumed heating degree day value of 5485, based on a TMY meteorological data population-weighted average.

High Efficiency:

The high efficiency case is the existing building after the air sealing measure is implemented. The high efficiency building is characterized by the previously mentioned heating system efficiencies and heating degree day values, and by an improved cubic feet per minute (CFM) infiltration rate, based on the amount of air sealing work-hours associated with the project. An assumed pressurized infiltration rate of 62.5 CFM50 saved per hour of air sealing is adjusted using an LBNL infiltration model that assumes a two story building with average wind shielding in order to calculate a natural infiltration rate savings value.

Measure Life:

The measure life is 15 years.[2]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Prescriptive Air Sealing	CI_RETRO	All	15	n/a	n/a	15

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Prescriptive Air Sealing	CI_RETRO	All	1.00	1.00	1.00	1.00	1.00	0.45	0

In-Service Rates:

All installations have 100% in-service rates since all PA programs include verification of equipment installations.

Realization Rates:

Realization rates are set to 100% until evaluated.

Coincidence Factors:

Coincidence factors are zero.

Impact Factors for Calculating Net Savings:

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG[3]
Prescriptive Air Sealing	CI_RETRO	All	0.08	0.01	0.00	0.94

Non-Energy Impacts:

There are no non-energy impacts for this measure.

Endnotes:

1 : Navigant Consulting, Inc. (2020). Energy Optimization Model Updates. 2019_Navigant_EO_Update
2 : GDS Associates, Inc. (2007). Measure Life Report Residential and C&I Lighting and HVAC Measures. GDS_2007_Measure_Life_Report_Residential_and_CI_Lighting_and_HVAC_Measures
3 : NMR Group, Inc. (2021). C&I Prescriptive and Custom Net-to-Gross Omnibus Study. 2021_NMR_C&I_Omnibus_NTG

3.18 Envelope - Prescriptive Air Sealing, Gas

Measure Code	COM-BS-ASG
Market	Commercial
Program Type	Retrofit
Category	Heating Ventilation and Air Conditioning

Measure Description:

Air sealing to an existing building

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Prescriptive Air Sealing, Gas	C&I Existing Building Retrofit (CI_RETRO)	GC2a085
Prescriptive Air Sealing, Gas (Turnkey)	C&I Existing Building Retrofit (CI_RETRO)	GC2a083

Algorithms for Calculating Primary Energy Impact:

Savings are derived from the Guidehouse Energy Optimization model[1], TMY meteorological data, residential air sealing program data, and a Lawrence Berkeley National Laboratory model for estimating natural infiltration rates. Savings are deemed per hour of air sealing work.

Deemed Savings (per hour of air sealing work)

Measure Name	Gas Savings - MMBtu per year
Prescriptive Air Sealing, Gas	0.706
Prescriptive Air Sealing, Gas (Turnkey)	0.706

Baseline Efficiency:

The baseline efficiency case is the existing building before the air sealing measure is implemented. The baseline building is characterized by an assumed baseline heating system efficiency, which is derived from the Guidehouse Energy Optimization model, and an assumed heating degree day value of 5485, based on a TMY meteorological data population-weighted average.

High Efficiency:

The high efficiency case is the existing building after the air sealing measure is implemented. The high efficiency building is characterized by the previously mentioned heating system efficiencies and heating degree day values, and by an improved cubic feet per minute (CFM) infiltration rate, based on the amount of air sealing work-hours associated with the project. An assumed pressurized infiltration rate of 62.5 CFM50 saved per hour of air sealing is adjusted using an LBNL infiltration model that assumes a two story building with average wind shielding in order to calculate a natural infiltration rate savings value.

Measure Life:

The measure life is 15 years.[2]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Prescriptive Air Sealing, Gas	CI_RETRO	All	15	n/a	n/a	15

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Prescriptive Air Sealing, Gas	CI_RETRO	All	1.00	1.00	1.00	1.00	1.00	0.45	0

In-Service Rates:
All installations have 100% in-service rates since all PA programs include verification of equipment installations.

Realization Rates:
Realization rates are set to 100% until evaluated.

Coincidence Factors:
Summer and winter coincidence factors are estimated using the demand allocation methodology described in the Demand Impact Model which is developed based on the Residential Baseline Study.[3]

Impact Factors for Calculating Net Savings:

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG[4]
Prescriptive Air Sealing, Gas	CI_RETRO	All	0.37	0.00	0.03	0.66

Prescriptive Air Sealing, Gas (Turnkey)	CI_RETRO	All	0.29	0.00	0.00	0.72

Non-Energy Impacts:

There are no non-energy impacts for this measure.

Endnotes:

1 : Navigant Consulting, Inc. (2020). Energy Optimization Model Updates. 2019_Navigant_EO_Update
2 : GDS Associates, Inc. (2007). Measure Life Report Residential and C&I Lighting and HVAC Measures. GDS_2007_Measure_Life_Report_Residential_and_CI_Lighting_and_HVAC_Measures
3 : Guidehouse. (2020). MA Residential Baseline Study Phase 4. 2020_Guidehouse_Residential_Baseline_Phase_4
4 : NMR Group, Inc. (2021). C&I Prescriptive and Custom Net-to-Gross Omnibus Study. 2021_NMR_C&I_Omnibus_NTG

3.19 Envelope - Prescriptive Insulation

Measure Code	COM-BS-IN
Market	Commercial
Program Type	Retrofit
Category	Heating Ventilation and Air Conditioning

Measure Description:

Installation of insulation in an existing building

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Prescriptive Insulation, Electric	C&I Existing Building Retrofit (CI_RETRO)	EC2a172
Prescriptive Insulation, Oil	C&I Existing Building Retrofit (CI_RETRO)	EC2a173
Prescriptive Insulation, Propane	C&I Existing Building Retrofit (CI_RETRO)	EC2a174
Prescriptive Insulation, Electric (Turnkey)	C&I Existing Building Retrofit (CI_RETRO)	EC2a178
Prescriptive Insulation, Oil (Turnkey)	C&I Existing Building Retrofit (CI_RETRO)	EC2a179
Prescriptive Insulation, Propane (Turnkey)	C&I Existing Building Retrofit (CI_RETRO)	EC2a180

Algorithms for Calculating Primary Energy Impact:

Savings are derived from a combination of sources, including the Guidehouse Energy Optimization model[1], TMY meteorological data, EIA CBECS data, and Massachusetts building codes. Savings are deemed on a per square foot basis.

Deemed Savings (per sq. ft)

Measure Name	Wall or Attic	Electric Savings - Annual kWh	Oil Savings - MMBtu per year	Propane Savings - MMBtu per year
Prescriptive Insulation, Electric	Wall	3.34	n/a	n/a
Prescriptive Insulation, Electric	Attic	1.30	n/a	n/a

Measure Name	Wall or Attic	Electric Savings - Annual kWh	Oil Savings - MMBtu per year	Propane Savings - MMBtu per year
Prescriptive Insulation, Oil	Wall	1.28	0.009	n/a
Prescriptive Insulation, Oil	Attic	0.50	0.004	n/a
Prescriptive Insulation, Propane	Wall	1.28	n/a	0.008
Prescriptive Insulation, Propane	Attic	0.50	n/a	0.003
Prescriptive Insulation, Electric (Turnkey)	Wall	3.34	n/a	n/a
Prescriptive Insulation, Electric (Turnkey)	Attic	1.30	n/a	n/a
Prescriptive Insulation, Oil (Turnkey)	Wall	1.28	0.009	n/a
Prescriptive Insulation, Oil (Turnkey)	Attic	0.50	0.004	n/a
Prescriptive Air Sealing, Propane (Turnkey)	Wall	1.28	n/a	0.008
Prescriptive Air Sealing, Propane (Turnkey)	Attic	0.50	n/a	0.003

Baseline Efficiency:

The baseline efficiency case is the existing building before the insulation measure is implemented. The baseline building is characterized by an assumed baseline heating system efficiency, which is derived from the Guidehouse Energy Optimization model. It is also characterized by an assumed baseline insulation R-value, which is determined from population weighted average R-values drawn from the EIA's Commercial Building Energy Consumption Survey (CBECS) and historic MA insulation code requirements. These baseline insulation values are R-9.66 for exterior walls and R-21.24 for attics. The baseline building is also characterized by an assumed heating degree day value and cooling degree hours, based on a TMY meteorological data population-weighted average and assumed set points. These values are 5485 and 5841, respectively.

High Efficiency:

The high efficiency case is the existing building after the insulation measure is implemented. The high efficiency case is characterized by the previously mentioned baseline heating system efficiencies, heating degree day values, and cooling degree hours. It is also characterized by an assumed 2021 code-level insulation R-value, which is R-20 for exterior walls, and R-38 for attics.

Measure Life:

The measure life is 25 years.[2]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Prescriptive Insulation	CI_RETRO	All	25	n/a	n/a	25

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Prescriptive Insulation	CI_RETRO	All	1.00	1.00	1.00	1.00	1.00	0.45	0

In-Service Rates:
All installations have 100% in-service rates since all PA programs include verification of equipment installations.

Realization Rates:
Realization rates are set to 100% until evaluated.

Coincidence Factors:
Summer and winter coincidence factors are estimated using the demand allocation methodology described in the Demand Impact Model which is developed based on the Residential Baseline Study.[3]

Impact Factors for Calculating Net Savings:

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG[4]
Prescriptive Insulation	CI_RETRO	All	0.18	0.00	0.05	0.88

Non-Energy Impacts:

There are no non-energy impacts for this measure.

Endnotes:

1 : Navigant Consulting, Inc. (2020). Energy Optimization Model Updates. 2019_Navigant_EO_Update
2 : GDS Associates, Inc. (2007). Measure Life Report Residential and C&I Lighting and HVAC Measures. GDS_2007_Measure_Life_Report_Residential_and_CI_Lighting_and_HVAC_Measures
3 : Guidehouse. (2020). MA Residential Baseline Study Phase 4. 2020_Guidehouse_Residential_Baseline_Phase_4

4 : NMR Group, Inc. (2021). C&I Prescriptive and Custom Net-to-Gross Omnibus Study.
2021_NMR_C&I_Omnibus_NTG

3.20 Envelope - Prescriptive Insulation, Gas

Measure Code	COM-BS-ING
Market	Commercial
Program Type	Retrofit
Category	Heating Ventilation and Air Conditioning

Measure Description:

Installation of insulation in an existing building

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Prescriptive Insulation, Gas	C&I Existing Building Retrofit (CI_RETRO)	GC2a084
Prescriptive Insulation, Gas (Turnkey)	C&I Existing Building Retrofit (CI_RETRO)	GC2a082

Algorithms for Calculating Primary Energy Impact:

Savings are derived from the Guidehouse Energy Optimization model[1], TMY meteorological data, EIA CBECS data, and Massachusetts building codes. Savings are deemed on a per square foot basis.

Deemed Savings (per sq. ft)

Measure Name	Wall or Attic	Electric Savings - Annual kWh	Electric Savings - Max kW	Gas Savings - MMBtu per year
Prescriptive Insulation, Gas	Wall	1.281	0.00094	0.00828
Prescriptive Insulation, Gas	Attic	0.498	0.00036	0.00322
Prescriptive Insulation, Gas (Turnkey)	Wall	1.281	0.00094	0.00828
Prescriptive Insulation, Gas (Turnkey)	Attic	0.498	0.00036	0.00322

Baseline Efficiency:

The baseline efficiency case is the existing building before the insulation measure is implemented. The baseline building is characterized by an assumed baseline heating system efficiency, which is derived from the Guidehouse Energy Optimization model. It is also characterized by an assumed baseline insulation R-value, which is determined from population weighted average R-values drawn from the EIA's Commercial Building Energy Consumption Survey (CBECS) and historic MA insulation code requirements. These baseline insulation values are R-9.66 for exterior walls and R-21.24 for attics. The baseline building is also characterized by an assumed heating degree day value and cooling degree hours, based on a TMY meteorological data population-weighted average and assumed set points. These values are 5485 and 5841, respectively.

High Efficiency:

The high efficiency case is the existing building after the insulation measure is implemented. The high efficiency case is characterized by the previously mentioned baseline heating system efficiencies, heating degree day values, and cooling degree hours. It is also characterized by an assumed 2021 code-level insulation R-value, which is R-20 for exterior walls, and R-38 for attics.

Measure Life:

The measure life is 25 years.[2]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Prescriptive Insulation, Gas	CI_RETRO	All	25	n/a	n/a	25

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Prescriptive Insulation, Gas	CI_RETRO	All	1.00	1.00	1.00	1.00	1.00	0.45	0

In-Service Rates:
All installations have 100% in-service rates since all PA programs include verification of equipment installations.

Realization Rates:
Realization rates are set to 100% until evaluated.

Coincidence Factors:
Summer and winter coincidence factors are estimated using the demand allocation methodology described in the Demand Impact Model which is developed based on the Residential Baseline Study.[3]

Impact Factors for Calculating Net Savings:

Measure Name	Core Initiative	PA	FR	SO$_P$	SO$_{NP}$	NTG[4]
Prescriptive Insulation, Gas	CI_RETRO	All	0.29	0.00	0.05	0.72

Non-Energy Impacts:

There are no non-energy impacts for this measure.

Endnotes:

1 : Navigant Consulting, Inc. (2020). Energy Optimization Model Updates. 2019_Navigant_EO_Update
2 : GDS Associates, Inc. (2007). Measure Life Report Residential and C&I Lighting and HVAC Measures. GDS_2007_Measure_Life_Report_Residential_and_CI_Lighting_and_HVAC_Measures
3 : Guidehouse. (2020). MA Residential Baseline Study Phase 4. 2020_Guidehouse_Residential_Baseline_Phase_4
4 : NMR Group, Inc. (2021). C&I Prescriptive and Custom Net-to-Gross Omnibus Study. 2021_NMR_C&I_Omnibus_NTG

3.21 Food Service - Conveyor Broiler

Measure Code	COM-FSE-CB
Market	Commercial
Program Type	Lost Opportunity, New Construction, Time of Sale
Category	Food Service and Cooking Equipment

Measure Description:

Installation of a energy efficient underfired broiler to replace a conventional automatic constant input rate conveyor broiler. This measure has both electric and gas savings.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Midstream - Conveyor Broiler	C&I New & Replacement Equipment (CI_EQUIP)	EC2b097
Foodservice, Conveyor Broiler - Midstream	C&I New & Replacement Equipment (CI_EQUIP)	GC2b057

Algorithms for Calculating Primary Energy Impact:

Unit savings are deemed based on the SoCalGas Commercial Conveyor Broilers workpaper WPSCGNRCC171226A.[1]

Energy Savings for Conveyor Broiler

Conveyor Size	ΔkWh	Δtherms
<22"	7,144	1,145
22-28"	6,403	1,933
>28"	23,849	3,161

Baseline Efficiency:

Baseline broiler must be an automatic conveyor broiler capable of maintaining a temperature above 600 F with a tested idle rate greater than:

- 40 kBtu/h for a belt narrower than 22"
- 60 kBtu/h for a belt between 22 and 28"

- 70 kBtu/h for a belt wider than 28"

High Efficiency:

The high efficiency case for a conveyor broiler must have a catalyst and an input rate less than 80 kBtu/h or a dual stage or modulating gas valve with a capability of throttling the input rate below 80 kBtu/h. Baseline broiler must be replaced by a broiler similar in size or smaller. Must be installed under a Type II Hood.

Measure Life:

The measure life for a new conveyor broiler is 12 years.[2]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Conveyor Broiler	CI_EQUIP	All	12	n/a	n/a	12

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure	Core Initiative	PA	ISR	SPF	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Conveyor Broiler	CI_EQUIP	All	1.00	1.00	1.00	n/a	1.00	1.00	0.90	0.90

In-Service Rates:
All installations have 100% in service rate since programs include verification of equipment installations.

Realization Rates:
100% realization rates are assumed because savings are based on researched assumptions.

Coincidence Factors:
Coincidence factors are 0.9 for both summer and winter seasons to account for the fact that some restaurants close one day per week and some may not serve both lunch and dinner on weekdays.

Impact Factors for Calculating Net Savings:

All PAs use statewide prescriptive net-to gross results.[3]

Measure	Core Initiative	PA	FR	SO$_P$	SO$_{NP}$	NTG
Conveyor Broiler, Electric	CI_EQUIP	All	25.0%	0.2%	8.5%	83.7%
Conveyor Broiler, Gas	CI_EQUIP	All	37.3%	2.6%	19.1%	84.4%

Non-Energy Impacts:

Non-energy impacts are based on study results.[4]

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per kWh	Annual $ per Therm	One-time $ per Therm
Conveyor Broiler, Electric	CI_EQUIP	ALL	$0.00	$0.00	$0.005	$0.00	$0.00	$0.00
Conveyor Broiler, Gas[5]	CI_EQUIP	ALL	$0.00	$0.00	$0.00	$0.00	$4.58	$0.00

Endnotes:

1 : SoCalGas Work Paper WPSCGNRCC171226A Commercial Conveyor Broilers, Revision 0, December 27, 2017. 2017_SoCalGas_Commercial Conveyor Broilers
2 : SoCalGas Work Paper WPSCGNRCC171226A Commercial Conveyor Broilers, Revision 0, December 27, 2017. 2017_SoCalGas_Commercial Conveyor Broilers
3 : NMR Group, Inc. (2021) Prescriptive and Custom Net-to-Gross Omnibus Study
2021_NMR_C&I_Omnibus_NTG
4 : DNV. (2022). C&I Health and Safety Non-Energy Impacts.
2022_DNV_C&I_Heath_&_Safety_NEIs
5 : DNV. (2022). C&I Health and Safety Non-Energy Impacts.
2022_DNV_C&I_Heath_&_Safety_NEIs

3.22 Food Service - Conveyor Toaster

Measure Code	COM-FSE-CT
Market	Commercial
Program Type	Time of Sale
Category	Food Service and Cooking Equipment

Measure Description:

A conveyor toaster is an appliance that caramelizes and carries bread products on a belt or chain into and through a heated chamber. Conveyor contact toasters are used in high volume, sandwich bun toasting applications. The design features of high performance conveyor toaster (HPCT) vary and can include an internal radiative ambient air heater, heat shields, and dampers at the opening to achieve desired capacity production and energy use per sandwich. Manufacturers might also include variable levels of adjustment to the platen temperature, ambient heater temperature, and belt speed. The combination of adjustable features, insulative design elements, as well as time and energy used while cooking and recovering from cooking will result in different energy consumption during daily operation.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Foodservice, Conveyor Toaster - Midstream	C&I New & Replacement Equipment (CI_EQUIP)	EC2b194

Algorithms for Calculating Primary Energy Impact:

[1] Measure impacts calculated from vendor analysis.

Measure	kWh	kW	MMBtu
Food Service, Conveyor Toaster	2,340	0.361	n/a

Baseline Efficiency:

Since commerical conveyor toasters are not covered by state or national codes, there is little incentive for equipment manufacturers to test their baseline equipment. The base case efficiency for existing models was determined from a sample of economy-grade equipment tested by the Southern California Edison Foodservice Technology Center.

The base case is defined as a standard performance conveyor toaster with an energy per sandwich greater than 3.75 W/bun.

High Efficiency:

The measure case specification was developed from lab-based equipment performance tests (following the test procedures of ASTM F2380-18) conducted by the Pacific Gas & Electric Food Service Technology Center and the Southern California Edison Foodservice Technology Center.

The measure case is defined as a high performance conveyor toaster with an energy per sandwich less than or equal to 3.75 W/bun.

Measure Life:

The measure life is 12 years.[2]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Conveyor Toaster	CI_EQUIP	All	12	n/a	n/a	12

Other Resource Impacts:

There are no other resource impacts associated with this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Conveyor Toaster	CI_EQUIP	All	1.00	n/a	1.00	1.00	1.00	0.90	0.90

In-Service Rates:
The in-service rate is assumed 100% until evaluated.

Realization Rates:
Realization rates are set to 100% as unit savings are deemed.

Coincidence Factors:
Coincidence factors from C&I Food Service loadshape.

Impact Factors for Calculating Net Savings:

All PAs use Statewide prescriptive net-to-gross results.[3]

Measure	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Conveyor Toaster	CI_EQUIP	All	0.25	0.00	0.09	0.84

Non-Energy Impacts:

NEI values can be found in Appendix B. [4] [5]

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per KWh	Annual $ per Therm	One-time $ per Therm
Conveyor Toaster	CI_EQUIP	All			$0.005			

Endnotes:

1 : Energy Solutions (2023). Conveyor Toaster Impacts Analysis. conveyor_toaster_commercial_lab_testing_data_2020
2 : There is no EUL specifically for an electric toaster, but its method of operation is similar to that of an electric convection oven, so the EUL of a convection oven was assumed for this measure. From CA TRM.
3 : NMR (2021). C&I Omnibus Net-to-Gross Study. 2021_NMR_C&I_Omnibus_NTG
4 : NMR (2021). C&I O&M and Non-O&M NEI Study. 2021_NMR_CIOM and NonOM NEI Study
5 : DNV (2022). C&I Health & Safety NEI Study. 2022_DNV_C&I_Heath_&_Safety_NEIs

3.23 Food Service - Electric Fryer

Measure Code	COM-CE-CF
Market	Commercial
Program Type	Lost Opportunity, New Construction, Time of Sale
Category	Food Service and Cooking Equipment

Measure Description:

Installation of a qualified ENERGY STAR® standard or large vat commercial fryer. ENERGY STAR® commercial fryers save energy during cooking and idle times due to improved cooking efficiency and idle energy rates.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Foodservice - Commercial Fryer, Standard Vat	C&I New & Replacement Equipment (CI_EQUIP)	EC2b046
Midstream - Commercial Fryer, Standard Vat	C&I New & Replacement Equipment (CI_EQUIP)	EC2b082

Algorithms for Calculating Primary Energy Impact:

Unit savings are deemed based on a study[1] :

ΔkWh = ΔkWh
ΔkW = ΔkW / Hours
Where:
ΔkWh = gross annual kWh savings from the measure per table below
ΔkW = gross average kW savings from the measure per table below
Hours = Annual hours of operation. See Hours section below.

Energy Savings for Commercial Fryer[2]

Equipment Type	ΔkW	ΔkWh
Commercial Fryer - Tier 2	0.53	1,585

Baseline Efficiency:

The baseline efficiency case is ENERGY STAR for Commercial Fryers, Version 2.0.

High Efficiency:

The high efficiency case for a Tier 2 $\geq$ 86% cooking efficiency, $\leq$ 0.75 kW idle rate.

Measure Life:

Measure Life is based on the Energy Star Calculator[3]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Commercial Fryer	CI_EQUIP	All	12	n/a	n/a	12

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure	Core Initiative	PA	ISR	SPF	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Commercial Fryer	CI_EQUIP	All	1.00	1.00	1.00	n/a	1.00	1.00	0.90	0.90

<u>**In-Service Rates:**</u>
All installations have 100% in service rate since programs include verification of equipment installations.

<u>**Realization Rates:**</u>
100% realization rates are assumed because savings are based on researched assumptions.

<u>**Coincidence Factors:**</u>
Coincidence factors are 0.9 for both summer and winter seasons to account for the fact that some restaurants close
one day per week and some may not serve both lunch and dinner on weekdays.

Impact Factors for Calculating Net Savings:

All PAs use statewide prescriptive net-to gross results[4]

Measure	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Commercial Fryer	CI_EQUIP	All	0.25	0.085	0.002	0.837

Non-Energy Impacts:

Non-energy impacts are based on study results[5]

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per KWh	Annual $ per Therm	One-time $ per Therm
Commercial Fryer	CI_EQUIP	All	$0.00	$0.00	$0.005	$0.00	$0.00	$0.00

Endnotes:

1 : DNV. (2022). Massachusetts Commercial Food Service Equipment ISP Recommendation. 2022_DNV_MA21C03-B-ISPREP - Kitchen Equipment ISP FINAL MEMO

2 : Appliance standards document signed 3/26/21 starting on page 27 references what the product must meet. MA appliance standards (003)

2 : https://www.energystar.gov/partner_resources/energy_star_training_center/commercial_food_serviceAugust 27, 2021

3 : MA appliance standards (003)

3 : https://www.energystar.gov/partner_resources/energy_star_training_center/commercial_food_service August 27, 2021 ENERGY STAR Calculator - New Baselines and Efficiencies 082721

4 : NMR Group, Inc. (2021). C&I Prescriptive and Custom Net-to-Gross Omnibus Study. 2021_NMR_C&I_Omnibus_NTG

5 : DNV. (2022). C&I Health and Safety Non-Energy Impacts. 2022_DNV_C&I_Heath_&_Safety_NEIs

3.24 Food Service - Electric Griddle

Measure Code	COM-FSE-CEG
Market	Commercial
Program Type	Lost Opportunity, New Construction, Time of Sale
Category	Food Service and Cooking Equipment

Measure Description:

Installation of a qualified ENERGY STAR® griddle. ENERGY STAR® griddles save energy cooking and idle times due to improved cooking efficiency and idle energy rates.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Foodservice - Commerical Electric Griddle	C&I New & Replacement Equipment (CI_EQUIP)	EC2b032
Midstream - Commercial Electric Griddle	C&I New & Replacement Equipment (CI_EQUIP)	EC2b068

Algorithms for Calculating Primary Energy Impact:

Unit savings are deemed based on the Energy Star Savings Calculator[1]

Measure Name	kWh	kW
Commercial Electric Griddle	3,965	0.90

delkWh = SAVE x Width x Hours
delkW = SAVE x Width

Where:
ΔkWh = gross annual kWh savings from the measure. With default Width, average savings are 3,965 kWh.
ΔkW = gross average kW savings from the measure. With default Width, average savings are 0.90 kW.
SAVE = Savings per foot of griddle width: 0.15 kW/ft
Width = Width of griddle in feet. Default of 3 feet.
Hours = Griddles are assumed to operate 313 days per year. The average griddle is assumed to operate 12 hours per day, or 3,756 hours per year.

Baseline Efficiency:

The baseline efficiency case is a typically sized, 6 sq. ft. commercial griddle with a cooking energy efficiency of 65%, production capacity of 35 pounds per hour, and idle energy rate of 400 W/sq. ft.

High Efficiency:

The high efficiency case is a typically sized, 6 sq. ft. commercial griddle with a cooking energy efficiency of 70%, production capacity of 40 pounds per hour, and idle energy rate of 320 W/sq. ft.

Measure Life:

The measure life for a new griddle is 12 years.[2]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Commercial Electric Griddle	CI_EQUIP	All	12	n/a	n/a	12

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Electric Griddle	CI_EQUIP	All	1.00	1.00	1.00	1.00	1.00	0.90	0.90

In-Service Rates:
All installations have 100% in service rate since programs include verification of equipment installations.

Realization Rates:
100% realization rates are assumed because savings are based on researched assumptions.

Coincidence Factors:
Coincidence factors are 0.9 for both summer and winter seasons to account for the fact that some restaurants close one day per week and some may not serve both lunch and dinner on weekdays.

Impact Factors for Calculating Net Savings:

Net-to-gross factors are based on study results.[3]

Measure	Core Initiative	PA	FR	SO_p	SO_{NP}	NTG
Electric Griddle	CI_EQUIP	All	25.0%	0.2%	8.5%	83.7%

Non-Energy Impacts:

Non-energy impacts are based on study results.[4]

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per KWh	Annual $ per Therm	One-time $ per Therm
Electric Griddle	CI_EQUIP	ALL	$0.00	$0.00	$0.005	$0.00	$0.00	$0.00

Endnotes:

1 :
https://www.energystar.gov/partner_resources/energy_star_training_center/commercial_food_serviceAugust 27, 2021 ENERGY STAR Calculator - New Baselines and Efficiencies 082721
2 :
https://www.energystar.gov/partner_resources/energy_star_training_center/commercial_food_serviceAugust 27, 2021 ENERGY STAR Calculator - New Baselines and Efficiencies 082721
3 : NMR Group, Inc. (2018). Massachusetts Sponsors' Commercial and Industrial Free-ridership and Spillover Study. 2018_NMR_CI FR-SO Report
4 : DNV. (2022). C&I Health and Safety Non-Energy Impacts. 2022_DNV_C&I_Heath_&_Safety_NEIs

3.25 Food Service - Electric Oven

Measure Code	COM-FSE-CEO
Market	Commercial
Program Type	Lost Opportunity, New Construction, Time of Sale
Category	Food Service and Cooking Equipment

Measure Description:

Installation of a qualified ENERGY STAR® commercial convection oven or commercial combination oven. ENERGY STAR® commercial ovens save energy during preheat, cooking and idle times due to improved cooking efficiency, and preheat and idle energy rates. Combination ovens can be used either as convection ovens or as steamers.

BCR Measure IDs:

Measure Name	**Core Initiative**	**BCR Measure ID**
Foodservice - Commercial Electric Ovens, Full Size Convection	C&I New & Replacement Equipment (CI_EQUIP)	EC2b029
Foodservice - Commercial Electric Ovens, Combination Oven	C&I New & Replacement Equipment (CI_EQUIP)	EC2b030
Midstream - Commercial Electric Ovens, Full Size Convection	C&I New & Replacement Equipment (CI_EQUIP)	EC2b065
Midstream - Commercial Electric Ovens, Combination Oven	C&I New & Replacement Equipment (CI_EQUIP)	EC2b066

Algorithms for Calculating Primary Energy Impact:

Unit savings are deemed based on a study[1] :
$\Delta kWh = kWh$
$\Delta kW = KWh / hours$

Where:
ΔkWh = gross annual kWh savings from the measure. See table below.
ΔkW = gross average kW savings from the measure. See table below.
Hours = Annual hours of operation. See Hours section below.

Energy Savings for Commercial Ovens[2]

Equipment Type	**ΔkW**	**ΔkWh**

Full Size Convection Oven Tier 2	0.41	1,111
Combination Oven Tier 2 - Mode and Steam Mode	1.90	8,190

Baseline Efficiency:

The baseline efficiency case for electric ovens is a MA-ISP Blended Used/ ENERGY STAR Ovens V2.2. The following are the baseline parameters from a study[3] :

Equipment Type	Cooking Efficiency (%)	Idle Energy Rate (kW)
Full Size Convection Oven	70	1.66
Combination Oven - Convection Mode	74	2.3
Combination Oven - Steam Mode	53	4.6

High Efficiency:

High efficiency case is Tier 2.

Measure Life:

 The measure life for a new commercial electric oven is 12 years.[4]

Other Resource Impacts:

There are no additional resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Electric Ovens	CI_NB&MR, CI_EQUIP	All	1.00	1.00	n/a	1.00	1.00	0.90	0.90

In-Service Rates:
All installations have 100% in service rate since programs include verification of equipment installations.

Realization Rates:
100% realization rates are assumed because savings are based on researched assumptions.

Coincidence Factors:
Coincidence factors are 0.9 for both summer and winter seasons to account for the fact that some restaurants close one day per week and some may not serve both lunch and dinner on weekdays.

Impact Factors for Calculating Net Savings:

Net-to-gross factors are based on study results.[5]

Measure	Initiative	PA	FR	SO$_P$	SO$_{NP}$	NTG
Food Services - Commercial Electric Ovens, Full Size Convection	CI_EQUIP	All	25.0%	0.2%	8.5%	83.7%
Food Services - Commercial Electric Ovens, Combination Oven	CI_EQUIP	All	25.0%	0.2%	8.5%	83.7%

Non-Energy Impacts:

Non-energy impacts are based on study results.[6]

Measure Name	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per kWh	Annual $ per Therm	One-time$ per Therm
Food Services - Commercial Electric Ovens, Full Size Convection	All	$0.00	$0.00	$0.005	$0.00	$0.00	$0.00
Food Services - Commercial Electric Ovens, Combination Oven	All	$0.00	$0.00	$0.005	$0.00	$0.00	$0.00

Endnotes:

1 : DNV. (2022). Massachusetts Commercial Food Service Equipment ISP Recommendation.
2022_DNV_MA21C03-B-ISPREP - Kitchen Equipment ISP FINAL MEMO
2 : DNV. (2022). Massachusetts Commercial Food Service Equipment ISP Recommendation.
2022_DNV_MA21C03-B-ISPREP - Kitchen Equipment ISP FINAL MEMO
3 : DNV. (2022). Massachusetts Commercial Food Service Equipment ISP Recommendation.
2022_DNV_MA21C03-B-ISPREP - Kitchen Equipment ISP FINAL MEMO
4 : https://www.energystar.gov/partner_resources/energy_star_training_center/commercial_food_service
August 27,2021 ENERGY STAR Calculator - New Baselines and Efficiencies 082721
5 : NMR, Group, Inc. (2021). C&I Prescriptive and Custom Net-to-Gross Omnibus Study.
2021_NMR_C&I_Omnibus_NTG
6 : DNV. (2022). C&I Health and Safety Non-Energy Impacts.
2022_DNV_C&I_Heath_&_Safety_NEIs

3.26 Food Service - Electric Steam Cooker

Measure Code	COM-FSE-CESC
Market	Commercial
Program Type	Lost Opportunity, New Construction, Time of Sale
Category	Food Service and Cooking Equipment

Measure Description:

Installation of a qualified ENERGY STAR® commercial steam cooker. ENERGY STAR® steam cookers save energy during cooling and idle times due to improved cooking efficiency and idle energy rates.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Foodservice - Commercial Electric Steam Cooker	C&I New & Replacement Equipment (CI_EQUIP)	EC2b031
Midstream - Commercial Electric Steam Cooker	C&I New & Replacement Equipment (CI_EQUIP)	EC2b067

Algorithms for Calculating Primary Energy Impact:

Unit savings are deemed based on a study[1] :

Measure	kWH	kW
Steam Cooker Tier 2	2,800	1.00

Baseline Efficiency:

The Baseline Efficiency case is ENERGY STAR Commercial Steam Cooker Version 1.2.[2]

High Efficiency:

The High Efficiency case is Tier 2.[3]

Measure Life:

The measure life for a new steamer is 12 years.[4]

Other Resource Impacts:

There are no additional resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Electric Steam Cooker	CI_EQUIP	All	1.00	1.00	n/a	1.00	1.00	0.90	0.90

In-Service Rates:

All installations have 100% in service rate since programs include verification of equipment installations.

Realization Rates:

100% realization rates are assumed because savings are based on researched assumptions.

Coincidence Factors:

Coincidence factors are 0.9 for both summer and winter seasons to account for the fact that some restaurants close
one day per week and some may not serve both lunch and dinner on weekdays

Impact Factors for Calculating Net Savings:

All PAs use Statewide prescriptive net-to-gross results.[5]

Measure	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Commercial Electric Steam Cooker	CI_EQUIP	All	25.0%	0.2%	8.5%	83.7%

Non-Energy Impacts:

Non-energy impacts are based on study results.[6]

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per kWH	Annual $ per Therm	One-time $ per Therm
Commercial Electric Steam Cooker	CI_EQUIP	ALL	$0.00	$0.00	$0.005	$0.00	$0.00	$0.00

Endnotes:

1 : DNV. (2022). Massachusetts Commercial Food Service Equipment ISP Recommendation.
2022_DNV_MA21C03-B-ISPREP - Kitchen Equipment ISP FINAL MEMO
2 : DNV. (2022). Massachusetts Commercial Food Service Equipment ISP Recommendation.

2022_DNV_MA21C03-B-ISPREP - Kitchen Equipment ISP FINAL MEMO
3 : DNV. (2022). Massachusetts Commercial Food Service Equipment ISP Recommendation.
2022_DNV_MA21C03-B-ISPREP - Kitchen Equipment ISP FINAL MEMO
4 : https://www.energystar.gov/partner_resources/energy_star_training_center/commercial_food_service
June 29, 2021 ENERGY STAR Calculator - New Baselines and Efficiencies 082721
5 : NMR Group, Inc. (2021).C&I Prescriptive and Custom Net-to-Gross Omnibus Study.
2021_NMR_C&I_Omnibus_NTG
6 : DNV. (2022). C&I Health and Safety Non-Energy Impacts.
2022_DNV_C&I_Heath_&_Safety_NEIs

3.27 Food Service - Food Holding Cabinet

Measure Code	COM-FSE-FHC
Market	Commercial
Program Type	Lost Opportunity, New Construction, Time of Sale
Category	Food Service and Cooking Equipment

Measure Description:

Installation of a qualified ENERGY STAR® hot food holding cabinet (HFHC). ENERGY STAR® hot food holding cabinets are 70 percent more energy efficient than standard models. Models that meet this requirement incorporate better insulation, reducing heat loss, and may also offer additional energy saving devices such as magnetic door gaskets, auto-door closures, or dutch doors. The insulation of the cabinet also offers better temperature uniformity within the cabinet from top to bottom. Offering full size, 3/4 size, and 1/2 half size HFHC.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Foodservice - Food Holding Cabinet, Full Size	C&I New & Replacement Equipment (CI_EQUIP)	EC2b084
Foodservice - Food Holding Cabinet, 3/4 Size	C&I New & Replacement Equipment (CI_EQUIP)	EC2b085
Foodservice - Food Holding Cabinet, 1/2 Size	C&I New & Replacement Equipment (CI_EQUIP)	EC2b086
Midstream - Food Holding Cabinet, Full Size	C&I New & Replacement Equipment (CI_EQUIP)	EC2b084
Midstream - Food Holding Cabinet, 3/4 Size	C&I New & Replacement Equipment (CI_EQUIP)	EC2b085
Midstream - Food Holding Cabinet, 1/2 Size	C&I New & Replacement Equipment (CI_EQUIP)	EC2b086

Algorithms for Calculating Primary Energy Impact:

Unit savings are deemed based on the Energy Star Commercial Food Service Savings Calculator:

kWh = kWh

kW = kWh / Hours

Where:

kWh = gross annual kWh savings from the measure: See table below.

kW = gross average kW savings from the measure: See table below.

Hours = Annual hours of operation. See Hours section below.

Energy Savings for Commercial Hot Food Holding Cabinets[1]

Equipment Type	kW	kWh
Full Size - Tier 1	0.20	887
3/4 Size - Tier 1	0.19	854
1/2 Size - Tier 1	0.11	493
Full Size - Tier 2	0.33	1,445
3/4 Size - Tier 2	0.28	1,215
1/2 Size - Tier 2	0.15	657

Baseline Efficiency:

The baseline efficiency is the average between 2021 baseline and 2022 Food Service appliance standard baseline. The baseline efficiencies represent the mid-point between the new Massachusetts Appliance Standard minimum threshold (50%) and the current year baseline efficiency (35%).[2] The baseline efficiency idle rate is as follows:

Equipment Type	kW idle rate
Full Size - Tier 1	≤ 0.65
3/4 Size - Tier 1	≤ 0.51
1/2 Size - Tier 1	≤ 0.31
Full Size - Tier 2	≤ 0.65
3/4 Size - Tier 2	≤ 0.51
1/2 Size Tier 2	≤ 0.31

High Efficiency:

The high efficiency idle energy rate for HFHC is as follows:

Equipment Type	kW idle rate
Full Size - Tier 1	≤ 0.30

3/4 Size - Tier 1	≤ 0.29
1/2 Size - Tier 1	≤ 0.2
Full Size - Tier 2	≤ 0.21
3/4 Size - Tier 2	≤ 0.14
1/2 Size Tier 2	≤ 0.11

Measure Life:

The measure life for a new commercial HFHC is 12 years.[3]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Food Holding Cabinet	CI_ EQUIP	All	12	n/a	n/a	12

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Food Holding Cabinet	CI_NB&MR CI_ EQUIP	ALL	1.00	1.00	1.00	1.00	1.00	0.90	0.90

In-Service Rates:
All installations have 100% in service rate since programs include verification of equipment installations.

Realization Rates:
100% realization rates are assumed because savings are based on researched assumptions.

Coincidence Factors:
Coincidence factors are 0.9 for both summer and winter seasons to account for the fact that some restaurants close one day per week and some may not serve both lunch and dinner on weekdays.

Impact Factors for Calculating Net Savings:

All PAs use Statewide prescriptive net-to-gross results.[4]

Measure	Initiative	PA	FR	SO_P	SO_{NP}	NTG
Food Services - Food Holding Cabinet, Full Size	CI_EQUIP	All	25.0%	0.2%	8.5%	83.7%

Food Services - Food Holding Cabinet, 3/4 Size	CI_EQUIP	All	25.0%	0.2%	8.5%	83.7%
Food Services - Food Holding Cabinet, 1/2 Size	CI_EQUIP	All	25.0%	0.2%	8.5%	83.7%

Non-Energy Impacts:

Non-energy impacts are based on study results.[5]

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per kWh	Annual $ per Therm	One-time $ per Therm
Food Services - Food Holding Cabinet	CI EQUIP	ALL	$0.00	$0.00	$0.005	$0.00	$0.00	$0.00

Endnotes:

1 :
https://www.energystar.gov/partner_resources/energy_star_training_center/commercial_food_serviceAugust 27, 2021 ENERGY STAR Calculator - New Baselines and Efficiencies 082721
2 : Appliance standards document signed 3/26/21 starting on page 27 references what the product must meet. MA appliance standards (003)
3 : https://www.energystar.gov/partner_resources/energy_star_training_center/commercial_food_service August 27, 2021 ENERGY STAR Calculator - New Baselines and Efficiencies 082721
4 : NMR Group, Inc. (2018). Massachusetts Sponsors' Commercial and Industrial Free-ridership and Spillover Study. 2018_NMR_CI FR-SO Report
5 : DNV. (2022). C&I Health and Safety Non-Energy Impacts. 2022_DNV_C&I_Heath_&_Safety_NEIs

3.28 Food Service - Gas Fryer

Measure Code	COM-FSE-CF
Market	Commercial
Program Type	Lost Opportunity, New Construction, Time of Sale
Category	Food Service and Cooking Equipment

Measure Description:

The installation of a natural-gas fired fryer that is either ENERGY STAR® rated or has a heavy-load cooking efficiency of at least 50%. Qualified fryers use advanced burner and heat exchanger designs to use fuel more efficiently, as well as increased insulation to reduce standby heat loss.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Foodservice - Fryer, Gas - Midstream	C&I New & Replacement Equipment (CI_EQUIP)	GC2b040

Algorithms for Calculating Primary Energy Impact:

Unit savings are deemed based on the ENERGY STAR Commercial Food Service (CFS) Product Calculator.[1] Savings are calculated based on recommended inputs from an evaluation study and were calculated for both the large and standard fryer types and weighted based on past program activity.[2]

Measure Name	MMBTU
Food Services, Fryer, Gas	13.4

Baseline Efficiency:

The baseline efficiency case for the large vat fryer is an ENERGY STAR V 2.0 with a baseline cooking efficiency of 50% and an idle energy rate of 12,000 Btu/hr. The baseline efficiency case for the standard vat fryer is an ENERGY STAR V 2.0 with a baseline cooking efficiency of 50% and an idle energy rate of 9,000 Btu/hr.

High Efficiency:

High efficiency large vat fryers must have a minimum cooking efficiency of 56% and a maximum idle energy rate of 9,000 Btu/hr. High efficiency standard vat fryers must have a minimum cooking efficiency of 56% and a maximum idle energy rate of 7,100 Btu/hr.

Measure Life:

The measure life is 12 years.[3]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Commercial Fryer	CI_EQUIP	All	12	n/a	n/a	12

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Commercial Fryer	CI_EQUIP	All	1.00	n/a	1.00	n/a	n/a	n/a	n/a

In-Service Rates:

All installations have 100% in service rate since programs include verification of equipment installations.

Realization Rates:

All PAs use 100% energy realization rate. The summer and winter peak realization rates are not applicable for this measure since there are no electric savings claimed.

Coincidence Factors:

Not applicable for this measure since no electric savings are claimed.

Impact Factors for Calculating Net Savings:

All PAs use Statewide prescriptive net-to-gross results. [4]

Measure	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Commercial Fryer	CI_EQUIP	All	0.37	0.02	0.19	0.84

Non-Energy Impacts:

NEI values can be found in Appendix B.[5]

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per KWh	Annual $ per Therm	One-time $ per Therm
Commercial	CI_EQUIP	All					$4.58	

Fryer								

Endnotes:

1 : DNV. (2022). Kitchen Equipment ISP Calculations. 2022_DNV_MA21C03-B-ISPREP - Kitchen Equipment ISP Caclulations

2 : DNV. (2022). Kitchen Equipment ISP Memo. 2022_DNV_MA21C03-B-ISPREP - Kitchen Equipment ISP FINAL MEMO

3 : DNV. (2022). Kitchen Equipment ISP Calculations. 2022_DNV_MA21C03-B-ISPREP - Kitchen Equipment ISP Caclulations

4 : NMR Group, Inc. (2021) Prescriptive and Custom Net-to-Gross Omnibus Study 2021_NMR_Prescriptive and Custom Net-to-Gross Omnibus Study

5 : DNV. (2022). C&I Health & Safety NEI Study. 2022_DNV_C&I_Heath_&_Safety_NEIs

3.29 Food Service - Gas Griddle

Measure Code	COM-FSE-CG
Market	Commercial
Program Type	Lost Opportunity, New Construction, Time of Sale
Category	Food Service and Cooking Equipment

Measure Description:

Installation of a single-sided high efficiency gas griddle that meets ENERGY STAR® specifications or have a tested heavy load cooking efficiency of at least 38% and an idle energy rate <= 2,650 Btu/h per square foot of cooking surface utilizing ASTM Standard F1275.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Foodservice, Griddle, Gas - Midstream	C&I New & Replacement Equipment (CI_EQUIP)	GC2b039

Algorithms for Calculating Primary Energy Impact:

Unit savings are deemed based on the ENERGY STAR Commercial Food Service (CFS) Product Calculator.[1]

Measures	MMBTu
Griddle, Gas	15.3

Baseline Efficiency:

The baseline efficiency case is a non-ENERGY STAR® qualified gas griddle. ENERGY STAR® defines the baseline case as a unit with a tested heavy load cooking efficiency of 32% and an idle energy rate of 3,500 Btu/h per square foot of cooking surface utilizing ASTM Standard F1275.

High Efficiency:

The high efficiency case is an ENERGY STAR® qualified gas griddle with a tested heavy load cooking efficiency of at least 38% and an idle energy rate <= 2,650 Btu/h per square foot of cooking surface utilizing ASTM Standard F1275.

Measure Life:

The measure life is 12 years.[2]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Griddle, Gas	CI_EQUIP	All	12	n/a	n/a	12

Other Resource Impacts:

There are no other resource impacts for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Griddle, Gas	CI_EQUIP	All	1.00	n/a	1.00	n/a	n/a	n/a	n/a

<u>**In-Service Rates:**</u>
All installations have 100% in service rate since programs include verification of equipment installations.

<u>**Realization Rates:**</u>
All PAs use 100% energy realization rate. The summer and winter peak realization rates are not applicable for the
gas measure since there are no electric savings claimed.

<u>**Coincidence Factors:**</u>
Not applicable for gas measure since no electric savings are claimed.

Impact Factors for Calculating Net Savings:

All PAs use Statewide prescriptive net-to-gross results. [3]

Measure	Initiative	PA	FR	SO_P	SO_{np}	NTG
Griddle, Gas	CI_EQUIP	All	0.37	0.02	0.19	0.84

Non-Energy Impacts:

NEI Values can be found in Appendix B.[4]

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per KWh	Annual $ per Therm	One-time $ per Therm
Griddle, Gas	CI_NB&MR	All					$4.58	

Endnotes:

1 : https://www.energystar.gov/partner_resources/energy_star_training_center/commercial_food_service
2 : https://www.energystar.gov/partner_resources/energy_star_training_center/commercial_food_service
3 : NMR Group, Inc. (2021) Prescriptive and Custom Net-to-Gross Omnibus Study.
2021_NMR_Prescriptive and Custom Net-to-Gross Omnibus Study
4 : DNV. (2022). C&I Health & Safety NEI Study. 2022_DNV_C&I_Heath_&_Safety_NEIs

3.30 Food Service - Gas Oven

Measure Code	COM-FS-CO
Market	Commercial
Program Type	Lost Opportunity, New Construction, Time of Sale
Category	Food Service and Cooking Equipment

Measure Description:

Installation of High Efficiency Gas Ovens.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Foodservice, Ovens, Combination Oven, Gas - Midstream	C&I New & Replacement Equipment (CI_EQUIP)	GC2b035
Foodservice, Ovens, Convection Oven, Gas - Midstream	C&I New & Replacement Equipment (CI_EQUIP)	GC2b036
Foodservice, Ovens, Conveyer Oven, Gas - Midstream	C&I New & Replacement Equipment (CI_EQUIP)	GC2b037
Foodservice, Ovens, Rack Oven, Gas - Midstream	C&I New & Replacement Equipment (CI_EQUIP)	GC2b038

Algorithms for Calculating Primary Energy Impact:

Rack Oven, Convection Oven and Combination Oven unit savings are deemed based on the ENERGY STAR Commercial Food Services Product Calculator[1] using the specified baseline and high efficiency inputs as listed below as determined by an evaluation.[2]

Savings for the Conveyor Oven are deemed based on the FSTC Commercial Kitchen Equipment Savings Calculator:[3]

Measure Name	ΔMMBtu
Convection Oven	15.5
Combination Oven	13.2
Conveyer Oven	88.4

Rack Oven (Double Rack)	31.9

Baseline Efficiency:

The baseline efficiencies for the Commercial Ovens are outlined in the table below. Additional baseline parameter for all FSC calculator inputs for Convection, Combination and Rack Ovens can be found in the FSC Calculator Tool .[4]

The baseline efficiencies for the Convection and Combination Ovens are based on ISP research. The baseline efficiencies for the rack ovens are based on ENERGY STAR V2.2. standards.[5]

These performance parameters are drawn from a sample of economy grade equipment tested by the Food Service Technology Center based on ASTM 2093 (Conveyor Ovens).

Measure Name	Baseline Efficiency
Convection Oven	44% Cooking Efficiency; 12,420 Btu/hr idle rate
Combination Oven	Steam Mode: 38% Cooking Efficiency; 11,175 Btu/hr idle rate Convection Mode: 53% Cooking Efficiency; 8,590 Btu/hr idle rate
Conveyer Oven	20% Cooking Efficiency; 70,000 Btu/hr idle rate
Rack Oven (Double Rack)	52% Baking Efficiency; 30,000 Btu/hr idle rate

High Efficiency:

High efficiency case is an oven that meets or exceeds the high efficiency ratings per oven type shown in table below.

Measure Name	Efficiency Requirement
Convection Oven	51% Cooking Efficiency; 7,411 Btu/hr idle rate
Combination Oven	Steam Mode: 48% Cooking Efficiency; 8,700 Btu/hr idle rate Convection Mode: 58% Cooking Efficiency; 6,800 Btu/hr idle rate
Conveyer Oven	>= 42% Cooking Efficiency;<=57,000 Btu/hr idle rate
Rack Oven (Double Rack)	42% Cooking Efficiency; 30,000 Btu/hr idle rate

Measure Life:

The measure life is 12 years for all commercial ovens.[6] [7]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Oven	CI_EQUIP	All	12	n/a	n/a	12

Other Resource Impacts:

There are no other resource impacts for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Convection Oven	CI_EQUIP	All	1.00	n/a	1.00	n/a	n/a	n/a	n/a
Combination Oven	CI_EQUIP	All	1.00	n/a	1.00	n/a	n/a	n/a	n/a
Conveyer Oven	CI_EQUIP	All	1.00	n/a	1.00	n/a	n/a	n/a	n/a
Rack Oven	CI_EQUIP	All	1.00	n/a	1.00	n/a	n/a	n/a	n/a

<u>**In-Service Rates:**</u>
All installations have 100% in service rate since programs include verification of equipment installations.

<u>**Realization Rates:**</u>
All PAs use 100% energy realization rate. The summer and winter peak realization rates are not applicable.

<u>**Coincidence Factors:**</u>
Not applicable for this measure since no electric savings are claimed.

Impact Factors for Calculating Net Savings:

Net-to-gross factors are based on study results. [8]

Measure	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Combination Oven, Gas	CI_EQUIP	All	0.37	0.02	0.19	0.84
Convection Oven, Gas	CI_EQUIP	All	0.37	0.02	0.19	0.84
Conveyor Oven, Gas	CI_EQUIP	All	0.37	0.02	0.19	0.84
Rack Oven, Gas	CI_EQUIP	All	0.37	0.02	0.19	0.84

Non-Energy Impacts:

NEI values can be found in Appendix B. [9]

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per KWh	Annual $ per Therm	One-time $ per Therm
Oven	CI_EQUIP	All					$4.58	

Endnotes:

1 : DNV. (2022). Kitchen Equipment ISP Calculations. 2022_DNV_MA21C03-B-ISPREP - Kitchen Equipment ISP Caclulations

2 : DNV. (2022). Kitchen Equipment ISP Memo. 2022_DNV_MA21C03-B-ISPREP - Kitchen Equipment ISP FINAL MEMO

3 : https://caenergywise.com/calculators/ and http://www.deeresources.net/workpapers

4 : DNV. (2022). Kitchen Equipment ISP Calculations. 2022_DNV_MA21C03-B-ISPREP - Kitchen Equipment ISP Caclulations

5 : DNV. (2022). Kitchen Equipment ISP Memo. 2022_DNV_MA21C03-B-ISPREP - Kitchen Equipment ISP FINAL MEMO

6 : DNV. (2022). Kitchen Equipment ISP Calculations. 2022_DNV_MA21C03-B-ISPREP - Kitchen Equipment ISP Caclulations

7 : https://caenergywise.com/calculators/ and http://www.deeresources.net/workpapers

8 : NMR Group, Inc. (2021) Prescriptive and Custom Net-to-Gross Omnibus Study 2021_NMR_Prescriptive and Custom Net-to-Gross Omnibus Study

9 : DNV. (2022). C&I Health & Safety NEI Study. 2022_DNV_C&I_Heath_&_Safety_NEIs

3.31 Food Service - Gas Steamer

Measure Code	COM-FSE-CS
Market	Commercial
Program Type	Lost Opportunity, New Construction, Time of Sale
Category	Food Service and Cooking Equipment

Measure Description:

The installation of an ENERGY STAR® rated natural-gas fired steamer, either connectionless or steam-generator design, with heavy-load cooking efficiency of at least 38%. Qualified steamers reduce heat loss due to better insulation, improved heat exchange, and more efficient steam delivery systems.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Foodservice, Steam Cooker, Gas - Midstream	C&I New & Replacement Equipment (CI_EQUIP)	GC2b041

Algorithms for Calculating Primary Energy Impact:

Unit savings are deemed based on the ENERGY STAR Commercial Food Service (CFS) Product Calculator and inputs specified by an evaluation. [1] [2]

Measure	MMBtu
Food Service, Steam Cooker, Gas	23.9

Baseline Efficiency:

The baseline efficiency case is a steamer meeting the ENERGY STAR® V1.2 product specification for commercial steam cookers with a 38% cooking efficiency and an idle rate of 12,500 Btu/hr.

High Efficiency:

The high efficiency case is a steamer with a minimum cooking efficiency of 45% and an idle rate of 7,100 Btu/hr.

Measure Life:

The measure life is 12 years.[3]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML

Steam Cooker, Gas	CI_EQUIP	All	12	n/a	n/a	12

Other Resource Impacts:

There are no other resource impacts associated with this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Steam Cooker, Gas	CI_EQUIP	All	1.00	n/a	1.00	1.00	1.00	n/a	n/a

In-Service Rates:

All installations have 100% in service rate since programs include verification of equipment installations.

Realization Rates:

All PAs use 100% energy realization rate. The summer and winter peak realization rates are not applicable for this
measure since there are no electric savings claimed.

Coincidence Factors:

Not applicable for this measure since no electric savings are claimed.

Impact Factors for Calculating Net Savings:

All PAs use Statewide prescriptive net-to-gross results. [4]

Measure	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Steam Cooker, Gas	CI_EQUIP	All	0.37	0.02	0.19	0.84

Non-Energy Impacts:

NEI values can be found in Appendix B. [5]

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per KWh	Annual $ per Therm	One-time $ per Therm
Steam Cooker, Gas	CI_NB&MR	All					$4.58	

Endnotes:

1 : DNV. (2022). Kitchen Equipment ISP Calculations. 2022_DNV_MA21C03-B-ISPREP - Kitchen Equipment ISP Caclulations

2 : DNV. (2022). Kitchen Equipment ISP Memo. 2022_DNV_MA21C03-B-ISPREP - Kitchen Equipment ISP FINAL MEMO

3 : DNV. (2022). Kitchen Equipment ISP Calculations. 2022_DNV_MA21C03-B-ISPREP - Kitchen Equipment ISP Caclulations

4 : NMR Group, Inc. (2021) Prescriptive and Custom Net-to-Gross Omnibus Study 2021_NMR_Prescriptive and Custom Net-to-Gross Omnibus Study

5 : DNV. (2022). C&I Health & Safety NEI Study. 2022_DNV_C&I_Heath_&_Safety_NEIs

3.32 Food Service - Gas Underfired Broiler

Measure Code	COM-FS-UFB
Market	Commercial
Program Type	Lost Opportunity, New Construction, Time of Sale
Category	Food Service and Cooking Equipment

Measure Description:

The installation of a high efficiency natural-gas underfired broiler.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Foodservice - Commercial Underfired Broiler - Midstream	C&I New & Replacement Equipment (CI_EQUIP)	GC2b056

Algorithms for Calculating Primary Energy Impact:

Unit savings are calculated as the difference between the baseline and efficient measures. Savings are deemed based on the following algorithm from the California eTRM entry for Underfired Broilers. [1]

$$Savings = \text{Energy Consumption}_{Base} - \text{Energy Consumption}_{Eff}$$

Where:

$$\text{Energy Consumption}_{Base} = [IER_{Base} \times OHD_{Base} \times OHY_{Base}] / 100{,}000$$

$$\text{Energy Consumption}_{Eff} = [IER_{Eff} \times OHD_{Eff} \times OHY_{Eff}] / 100{,}000$$

IER_{Base} = 25,000 (Btuh) (Broiler Idle Energy Rate)
IER_{Eff} = 20,000 (Btuh) (Broiler Idle Energy Rate)
OHD_{Base} = 12 (Operating Hours/Day in the Baseline Case)
OHD_{Eff} = 12 (Operating Hours/Day in the Efficient Case)
OHY_{Base} = 363 (Operating Hours/Year in the Baseline Case)
OHY_{Eff} = 363 (Operating Hours/Year in the Efficient Case)
100,000 = Btu/Therm

Measure Name	MMBTU
Underfired Broiler	21.8

Baseline Efficiency:

The baseline efficiency case is a unit with an input rate > 22 kBtu/hr/ln-ft at 600 degrees F and an idle and cooking energy rate = 25,000 Btu/hr with a production capacity of 25 lb/hr.

High Efficiency:

The high efficiency case is a unit with an input rate <= 22 kBtu/hr/ln-ft at 600 degrees F and an idle and cooking energy rate <=20,000 Btu/hr with a production capacity of 20 lb/hr.

Measure Life:

The measure life is 12 years.[2]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Underfired Broiler	CI_EQUIP	All	12	n/a	n/a	12

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Underfired Broiler	CI_EQUIP	All	1.00	n/a	1.00	n/a	n/a	n/a	n/a

In-Service Rates:
All installations have 100% in service rate since programs include verification of equipment installations.

Realization Rates:
All PAs use 100% energy realization rate. The summer and winter peak realization rates are not applicable for this measure since there are no electric savings claimed.

Coincidence Factors:
Not applicable for this measure since no electric savings are claimed.

Impact Factors for Calculating Net Savings:

All PAs use Statewide prescriptive net-to-gross results. [3]

Measure	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG

| Underfired Broiler | CI_EQUIP | All | 0.37 | 0.02 | 0.19 | 0.84 |

Non-Energy Impacts:

NEI values can be found in Appendix B.[4]

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per KWh	Annual $ per Therm	One-time $ per Therm
Underfired Broiler	CI_EQUIP	All					$4.58	

Endnotes:

1 : California Technical Reference Manual. https://www.caetrm.com/measure/SWFS019/02/
2 : California Technical Reference Manual. https://www.caetrm.com/measure/SWFS019/02/
3 : NMR Group, Inc. (2021) Prescriptive and Custom Net-to-Gross Omnibus Study
2021_NMR_Prescriptive and Custom Net-to-Gross Omnibus Study
4 : DNV. (2022). C&I Health & Safety NEI Study. 2022_DNV_C&I_Heath_&_Safety_NEIs

3.33 Food Service - High Temperature Commercial Dishwasher

Measure Code	COM-FSE-HTCD
Market	Commercial
Program Type	Lost Opportunity, New Construction, Time of Sale
Category	Food Service and Cooking Equipment

Measure Description:

Installation of a qualified ENERGY STAR® high temperature commercial dishwasher in a building with gas domestic hot water. High temperature dishwashers use a booster heater to raise the rinse water temperature to 180 F – hot enough to sterilize dishes and assist in drying. Electric savings are achieved through savings to the electric booster.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Foodservice - High Temp Under Counter Dishwasher	C&I New & Replacement Equipment (CI_EQUIP)	EC2b037
Foodservice - High Temp Door Type Dishwasher	C&I New & Replacement Equipment (CI_EQUIP)	EC2b038
Foodservice - High Temp Single Tank Conveyer Dishwasher	C&I New & Replacement Equipment (CI_EQUIP)	EC2b039
Foodservice - High Temp Multi Tank Conveyer Dishwasher	C&I New & Replacement Equipment (CI_EQUIP)	EC2b040
Foodservice - High Temp Pots & Pans Dishwasher	C&I New & Replacement Equipment (CI_EQUIP)	EC2b041
Midstream - High Temp Under Counter Dishwasher	C&I New & Replacement Equipment (CI_EQUIP)	EC2b073
Midstream - High Temp Door Type Dishwasher	C&I New & Replacement Equipment (CI_EQUIP)	EC2b074
Midstream - High Temp Single Tank Conveyer Dishwasher	C&I New & Replacement Equipment (CI_EQUIP)	EC2b075
Midstream - High Temp Multi Tank Conveyer Dishwasher	C&I New & Replacement Equipment (CI_EQUIP)	EC2b076

Midstream - High Temp Pots & Pans Dishwasher	C&I New & Replacement Equipment (CI_EQUIP)	EC2b077

Algorithms for Calculating Primary Energy Impact:

Unit savings are deemed based on a study[1] :

kWh = kWh
kW = kWh / hours

Where:
kWh = gross annual kWh savings from the measure. See table below.
kW = gross average kW savings from the measure. See table below.
Hours = Average annual equipment operating hours. See Hours section below.

Energy Savings for High Temperature Commercial Dishwashers[2] :

Equipment Type	kW	kWh
Under Counter - Tier 2	0.17	1,132
Door Type - Tier 2	0.11	730
Single Tank Conveyor - Tier 2	0.27	1,752
Multi Tank Conveyor - Tier 2	0.36	2,336
Pot, Pan, and Utensil - Tier 2	0.007	438

Baseline Efficiency:

The baseline efficiency case is ENERGY STAR Commercial Dishwashers Version 2.0 with the following baseline parameters[3] :

Dishwasher Type	Water Consumption (GPR)	Idle Energy Rate (kW)
Under Counter	0.86	0.5
Door Type	0.89	0.7
Single Tank Conveyor	0.7	1.5
Multi Tank Conveyor	0.54	2.25
Pot, Pan, and Utensil	0.58	1.2

High Efficiency:

The high efficiency case is Tier 2[4] :

Dishwasher Type	Idle Energy Rate (kW) Tier 2
Under Counter	≤ 0.30
Door Type	≤ 0.55
Single Tank Conveyor	≤ 1.20
Multi Tank Conveyor	≤ 1.85
Pot, Pan, and Utensil	≤ 0.90

Measure Life:

The measure life for a new high temperature dishwasher is given by type below[5] :

Dishwasher Type	Life (years)
Under Counter	10
Door Type	15
Single or Multi Tank Conveyor	20
Pot, Pan, and Utensil	10

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
High Temperature Dishwasher	CI_EQUIP	All	1.00	1.00	n/a	1.00	1.00	0.90	0.90

In-Service Rates:
All installations have 100% in service rate since programs include verification of equipment installations.

Realization Rates:
100% realization rates are assumed because savings are based on researched assumptions.

Coincidence Factors:
Coincidence factors are 0.9 for both summer and winter seasons to account for the fact that some restaurants close one day per week and some may not serve both lunch and dinner on weekdays.

Impact Factors for Calculating Net Savings:

All PAs use Statewide prescriptive net-to gross results[6]

Measure	Core Initiative	PA	FR	SO$_P$	SO$_{NP}$	NTG
Food Services - High Temp Dishwasher	CI_EQUIP	All	25.0%	0.2%	8.5%	83.7%

Non-Energy Impacts:

Non-energy impacts are based on study results.[7]

Measure	Core Initiative	Annual $ per unit	One time $ per Unit	Annual $ per kWh	One-time $ per kWH	Annual $ per Therm	One time $ per Therm
Food Services - High Temp Dishwasher	CI_EQUIP	$0.00	$0.00	$0.005	$0.00	$0.00	$0.00

Endnotes:

1 : DNV. (2022). Massachusetts Commercial Food Service Equipment ISP Recommendation. 2022_DNV_MA21C03-B-ISPREP - Kitchen Equipment ISP FINAL MEMO

2 : DNV. (2022). Massachusetts Commercial Food Service Equipment ISP Recommendation. 2022_DNV_MA21C03-B-ISPREP - Kitchen Equipment ISP FINAL MEMO

3 : DNV. (2022). Massachusetts Commercial Food Service Equipment ISP Recommendation. 2022_DNV_MA21C03-B-ISPREP - Kitchen Equipment ISP FINAL MEMO

4 : https://www.energystar.gov/partner_resources/energy_star_training_center/commercial_food_service August 27, 2021 ENERGY STAR Calculator - New Baselines and Efficiencies 082721

5 : https://www.energystar.gov/partner_resources/energy_star_training_center/commercial_food_service August 27, 2021 ENERGY STAR Calculator - New Baselines and Efficiencies 082721

6 : NMR Group, Inc. (2018). Massachusetts Sponsors' Commercial and Industrial Free-ridership and Spillover Study. 2018_NMR_CI FR-SO Report

7 : DNV. (2022). C&I Health and Safety Non-Energy Impacts. 2022_DNV_C&I_Heath_&_Safety_NEIs

3.34 Food Service - Ice Machine

Measure Code	COM-FSE-CIM
Market	Commercial
Program Type	Lost Opportunity, New Construction, Time of Sale
Category	Food Service and Cooking Equipment

Measure Description:

Installation of a qualified ENERGY STAR® commercial ice machine. Commercial ice machines meeting the ENERGY STAR® specifications are on average 15 percent more energy efficient and 10 percent more water-efficient than standard models. ENERGY STAR® qualified equipment includes ice-making head (IMH), self-contained (SCU), and remote condensing units (RCU).

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Foodservice - Commercial Ice Machine, Ice Making Head	C&I New & Replacement Equipment (CI_EQUIP)	EC2b078
Foodservice - Commercial Ice Machine, Self Contained Unit	C&I New & Replacement Equipment (CI_EQUIP)	EC2b079
Foodservice - Commercial Ice Machine, Remote Condensing Unit (Batch)	C&I New & Replacement Equipment (CI_EQUIP)	EC2b080
Foodservice - Commercial Ice Machine, Remote Condensing Unit (Continuous)	C&I New & Replacement Equipment (CI_EQUIP)	EC2b081
Midstream - Commercial Ice Machine, Ice Making Head	C&I New & Replacement Equipment (CI_EQUIP)	EC2b042
Midstream - Commercial Ice Machine, Self Contained Unit	C&I New & Replacement Equipment (CI_EQUIP)	EC2b043
Midstream - Commercial Ice Machine, Remote Condensing Unit (Batch)	C&I New & Replacement Equipment (CI_EQUIP)	EC2b044
Midstream - Commercial Ice Machine, Remote Condensing Unit (Continuous)	C&I New & Replacement Equipment (CI_EQUIP)	EC2b045

Algorithms for Calculating Primary Energy Impact:

Unit savings are deemed based on the Energy Star Commercial Food Service Calculator.

kWh = kWh
kW = kWh / hours

Where:
kWh = gross annual kWh savings from the measure. See table below.
kW = gross average kW savings from the measure. See table below.
Hours = Average annual equipment operating hours, see Hours section below.

Energy Savings for Commercial Ice Machine[1] :

Equipment Type	kW	kWh
Ice Making Head	0.30	1574
Self Contained Unit	0.30	680
Remote Condensing Unit (Batch)	0.30	1322
Remote Condensing Unit (Continuous)	0.30	3235

Baseline Efficiency:

The baseline efficiency case is a Federal Standard Compliant baseline consistent with current federal standards effective 1/28/2018.   https://www.ecfr.gov/current/title-10/chapter-II/subchapter-D/part-431/subpart-H/subject-group-ECFR055e135ff65e6f5/section-431.136

High Efficiency:

The high efficiency case is a commercial ice machine meeting the ENERGY STAR® Specifications V3.0 Efficiency Requirements.[2]

Measure Life:

The measure life for a new ice making machine is assumed to be 8 years.[3]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Ice Making Machine	CI_EQUIP	All	10	n/a	n/a	10

Other Resource Impacts:

There are water savings associated with this measure[4] :

Dishwasher Type	Annual water savings (gal/unit)
Ice Making Head	6,228
Self Contained Unit	4,933

Remote Condensing Unit (Batch)	6,611
Remote Condensing Unit (Continuous)	0

Impact Factors for Calculating Adjusted Gross Savings:

Measure	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Ice Making Machine	CI_EQUIP	All	1.00	1.00	1.00	1.00	1.00	0.90	0.90

In-Service Rates:

All installations have 100% in service rate since programs include verification of equipment installations.

Realization Rates:

100% realization rates are assumed because savings are based on researched assumptions.

Coincidence Factors:

Coincidence factors are 0.9 for both summer and winter seasons to account for the fact that some restaurants close one day per week and some may not serve both lunch and dinner on weekdays.

Impact Factors for Calculating Net Savings:

All PAs use Statewide prescriptive net-to-gross results.[5]

Measure	Core Initiative	PA	FR	SO_p	SO_{NP}	NTG
Ice Making Machine	CI_EQUIP	All	25,.0%	0.2%	8.5%	83.7%

Non-Energy Impacts:

Non-energy impacts are based on study results.[6]

Measure	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One time $ per kWh	Annual $ per Therm	One-time $ per Therm
Ice Making Machine	CI_EQUIP	ALL	$0.00	$0.00	$0.005	$0.00	$0.00	$0.00

Endnotes:

1 : https://www.energystar.gov/partner_resources/energy_star_training_center/commercial_food_service
August 27, 2021 ENERGY STAR Calculator - New Baselines and Efficiencies 082721
2 : https://www.energystar.gov/partner_resources/energy_star_training_center/commercial_food_service

June 29, 2021 ENERGY STAR Calculator - New Baselines and Efficiencies 082721

3 : https://www.energystar.gov/partner_resources/energy_star_training_center/commercial_food_service
August 27, 2021 ENERGY STAR Calculator - New Baselines and Efficiencies 082721

4 : https://www.energystar.gov/partner_resources/energy_star_training_center/commercial_food_service
August 27, 2021 ENERGY STAR Calculator - New Baselines and Efficiencies 082721

5 : NMR Group, Inc. (2018). Massachusetts Sponsors' Commercial and Industrial Free-ridership and Spillover Study. 2018_NMR_CI FR-SO Report

6 : DNV. (2022). C&I Health and Safety Non-Energy Impacts.
2022_DNV_C&I_Heath_&_Safety_NEIs

3.35 Food Service - Induction Cooktop

Measure Code	COM-FSE-CGE
Market	Commercial
Program Type	Time of Sale
Category	Food Service and Cooking Equipment

Measure Description:

Rebate provided for the purchase of an induction heating cooktop in place of traditional electric resistance or natural gas cooking units.

BCR Measure IDs:

Measure	Core Initiative	BCR Measure ID
Midstream - Induction Cooktop Displacing Electric Resistance	C&I New & Replacement Equipment (CI_EQUIP)	EC2b151
Midstream - Induction Cooktop Displacing Natural Gas	C&I New & Replacement Equipment (CI_EQUIP)	GC2b083

Algorithms for Calculating Primary Energy Impact:

Unit kWh savings are deemed.[1] Demand savings are derived from the demand impact model which is developed as part of the Residential Baseline Study.[2]

Measure Name	Core Initiative	ΔkWh	ΔkW	ΔTherm
Midstream - Induction Cooktop Displacing Electric Resistance	CI_EQUIP	2,488	0.43	n/a
Midstream - Induction Cooktop Displacing Natural Gas	CI_EQUIP	-6,522	-1.49	489

Baseline Efficiency:

The baseline efficiency case for the induction cooktop is a traditional electric resistance or natural gas cooktop.

High Efficiency:

The high efficiency case is a cooktop with an induction heating element.

Measure Life:

The measure life is shown below.[3]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Midstream - Induction Cooktop	CI_EQUIP	All	12	n/a	n/a	12

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Midstream - Induction Cooktop	CI_EQUIP	All	1.00	1.00	1.00	1.00	1.00	0.90	0.90

In-Service Rates:
The in-service rate is assumed to be 100% absent evaluation.

Realization Rates:
The realization rate is assumed to be 100% absent evaluation.

Coincidence Factors:

Summer and winter coincidence factors are estimated using the demand allocation methodology described in the Demand Impact Model.[4]

Impact Factors for Calculating Net Savings:

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Midstream - Induction Cooktop Displacing Electric Resistance	CI_EQUIP	All	0.25	0.00	0.09	0.84
Midstream - Induction Cooktop Displacing Natural Gas	CI_EQUIP	All	0.37	0.03	0.19	0.84

Non-Energy Impacts:

The non-energy impacts are below.[5] [6]

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per kWh	Annual $ per Therm	One-time $ per Therm

Midstream - Induction Cooktop	CI_EQUIP	All			$0.005		$4.579	

Endnotes:

1 : Frontier Energy. (2019). Residential Cooktop Performance and Energy Comparison Study.
2019_Frontier_Energy_Residential_Cooktop_Performance_and_Energy_Comparison_Study
2 : Guidehouse. (2020). Residential Baseline Study Phase 4.
2020_Guidehouse_Residential_Baseline_Phase_4
3 : Frontier Energy. (2019). Residential Cooktop Performance and Energy Comparison Study.
2019_Frontier_Energy_Residential_Cooktop_Performance_and_Energy_Comparison_Study
4 : Frontier Energy (2019). Residential Cooktop Performance and Energy Comparison Study.
2019_Frontier_Energy_Residential_Cooktop_Performance_and_Energy_Comparison_Study
4 : Guidehouse. (2020). Residential Baseline Study Phase 4.
2020_Guidehouse_Residential_Baseline_Phase_4
5 : DNV. (2022). C&I Health and Safety Non Energy Impacts.
2022_DNV_C&I_Heath_&_Safety_NEIs
6 : NMR Group, Inc. (2021). O&M and non-O&M NEI Study. 2021_NMR_CIOM and NonOM NEI Study

3.36 Food Service - Low Temperature Commercial Dishwasher

Measure Code	COM-FSE-LTCD
Market	Commercial
Program Type	Lost Opportunity, New Construction, Time of Sale
Category	Food Service and Cooking Equipment

Measure Description:

Installation of a qualified ENERGY STAR® low temperature commercial dishwasher in a facility with electric hot water heating. Low temperature dishwashers use the hot water supplied by the kitchen's existing water heater and use a chemical sanitizing agent in the final rinse cycle and sometimes a drying agent.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Foodservice - Low Temp Under Counter Dishwasher	C&I New & Replacement Equipment (CI_EQUIP)	EC2b033
Foodservice - Low Temp Door Type Dishwasher	C&I New & Replacement Equipment (CI_EQUIP)	EC2b034
Foodservice - Low Temp Single Tank Conveyer Dishwasher	C&I New & Replacement Equipment (CI_EQUIP)	EC2b035
Foodservice - Low Temp Multi Tank Conveyer Dishwasher	C&I New & Replacement Equipment (CI_EQUIP)	EC2b036
Midstream - Low Temp Under Counter Dishwasher	C&I New & Replacement Equipment (CI_EQUIP)	EC2b069
Midstream - Low Temp Door Type Dishwasher	C&I New & Replacement Equipment (CI_EQUIP)	EC2b070
Midstream - Low Temp Single Tank Conveyer Dishwasher	C&I New & Replacement Equipment (CI_EQUIP)	EC2b071
Midstream - Low Temp Multi Tank Conveyer Dishwasher	C&I New & Replacement Equipment (CI_EQUIP)	EC2b072

Algorithms for Calculating Primary Energy Impact:

Unit savings are deemed based on a study[1] :

kWh = kWh
kW = kWh / hours

Where:
kWh = gross annual kWh savings from the measure. See table below.
kW = gross average kW savings from the measure. See table below.
Hours = Average annual equipment operating hours, see Hours section below.

Energy Savings for Low Temperature Commercial Dishwashers:

Equipment Type	kW	kWh
Under Counter - Tier 2	0.22	1,414
Door Type - Tier 2	0.18	1,205
Single Tank Conveyor - Tier 2	0.59	3,854
Multi Tank Conveyor - Tier 2	0.83	5,475

Baseline Efficiency:

The baseline efficiency case is ENERGY STAR Commercial Dishwashers Version 2.0 with iddle energy rates and water consumption as follows[2] :

Dishwasher Type	Gallons per Rack	Idle Energy Rate (kW)
Under Counter	1.19	0.5
Door Type	1.18	0.6
Single Tank Conveyor	0.79	1.5
Multi Tank Conveyor	0.54	2.0

High Efficiency:

The high efficiency case is Tier 2.

Measure Life:

The measure life for a new low temperature dishwasher is given by type below[3] :

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML

Under Counter	CI_EQUIP	All	10	n/a	n/a	10
Door Type	CI_EQUIP	All	15	n/a	n/a	15
Single or Multi Tank Conveyor	CI_EQUIP	All	20	n/a	n/a	20

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Low Temperature Dishwasher	CI_EQUIP	All	1.00	1.00	1.00	1.00	1.00	0.90	0.90

In-Service Rates:
All installations have 100% in service rate since programs include verification of equipment installations.

Realization Rates:
100% realization rates are assumed because savings are based on researched assumptions.

Coincidence Factors:
Coincidence factors are 0.9 for both summer and winter seasons to account for the fact that some restaurants close one day per week and some may not serve both lunch and dinner on weekdays.

Impact Factors for Calculating Net Savings:

All PAs use Statewide prescriptive net-to-gross results.[4]

Measure	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Food Services - Low Temp Dishwasher	CI_EQUIP	All	25.0%	0.2%	8.5%	83.7%

Non-Energy Impacts:

Non-energy impacts are based on study results.[5]

Measure	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per kWh	Annual $ per Therm	One-time $ per Therm
Food Services - Low	CI_EQUIP	ALL	$0.00	$0.00	$0.005	$0.00	$0.00	$0.00

Temp Dishwasher								

Endnotes:

1 : DNV. (2022). Massachusetts Commercial Food Service Equipment ISP Recommendation.
2022_DNV_MA21C03-B-ISPREP - Kitchen Equipment ISP FINAL MEMO

2 : DNV. (2022). Massachusetts Commercial Food Service Equipment ISP Recommendation.
2022_DNV_MA21C03-B-ISPREP - Kitchen Equipment ISP FINAL MEMO

3 :
https://www.energystar.gov/partner_resources/energy_star_training_center/commercial_food_serviceAugust 27, 2021 ENERGY STAR Calculator - New Baselines and Efficiencies 082721

3 :
https://www.energystar.gov/partner_resources/energy_star_training_center/commercial_food_serviceAugust 27, 2021 ENERGY STAR Calculator - New Baselines and Efficiencies 082721

4 : NMR Group, Inc. (2018). Massachusetts Sponsors' Commercial and Industrial Free-ridership and Spillover Study. 2018_NMR_CI FR-SO Report

5 : DNV. (2022). C&I Health and Safety Non-Energy Impacts.
2022_DNV_C&I_Heath_&_Safety_NEIs

3.37 Food Service - Pasta Cooker

Measure Code	COM-FSE-CPC
Market	Commercial
Program Type	Early Retirement, Lost Opportunity, New Construction
Category	Food Service and Cooking Equipment

Measure Description:

A dedicated natural gas fueled pasta cooker with removable strainer.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Midstream - Pasta Cooker	C&I New & Replacement Equipment (CI_EQUIP)	GC2b069

Algorithms for Calculating Primary Energy Impact:

Unit savings are deemed savings.[1]

Measure	Therms
Pasta Cooker, Gas	1,402

Baseline Efficiency:

Baseline case is the standard natural gas stove with stock pot with 27.5% standard efficiency.

High Efficiency:

A dedicated natural high efficiency gas-fueled pasta cooker (equivalent to 50% efficiency) with a removable strainer.

Measure Life:

The measure life for a new conveyor broiler is 12 years.[2]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Pasta Cooker, Gas	CI_EQUIP	All	12	n/a	n/a	12

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure	Core Initiative	PA	ISR	SPF	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Pasta Cooker, Gas	CI_EQUIP	All	1.00	1.00	1.00	n/a	1.00	1.00	1.00	1.00

In-Service Rates:

All installations have a 100% in-service rate since programs include verification of equipment installations.

Realization Rates:

100% realization rates are assumed because savings are based on researched assumptions.

Coincidence Factors:

Not applicable for this measure since no electric savings are claimed.

Impact Factors for Calculating Net Savings:

Net-to-gross factors are based on study results.[3]

Measure	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Pasta Cooker, Gas	CI_EQUIP	All	0.237	0.07	0.00	0.833

Non-Energy Impacts:

This measure does not have any non-resource benefit.

Endnotes:

1 : Frontier Associates, LLC. (2014). Arkansas Technical Reference Manual V4.0 Volume 2.
2014_FrontierAssociates_ArkansasTRMDeemedSavings
2 : Database for Energy Efficient Resources (DEER), EUL Table.
http://www.deeresources.net/workpapers
3 : NMR Group, Inc. (2021). C&I Prescriptive and Custom Net-to-Gross Omnibus Study.
2021_NMR_C&I_Omnibus_NTG

3.38 Food Service - Refrigerator/Freezer

Measure Code	COM-FSE-REFFRE
Market	Commercial
Program Type	Lost Opportunity, New Construction, Time of Sale
Category	Food Service and Cooking Equipment

Measure Description:

Installation of a qualified ENERGY STAR® refrigerator or freezer (glass or solid door).

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Midstream – Refrigerator, Glass Door	C&I New & Replacement Equipment (CI_EQUIP)	EC2b089
Midstream – Refrigerator, Solid Door	C&I New & Replacement Equipment (CI_EQUIP)	EC2b090
Midstream – Freezer, Glass Door	C&I New & Replacement Equipment (CI_EQUIP)	EC2b091
Midstream – Freezer, Solid Door	C&I New & Replacement Equipment (CI_EQUIP)	EC2b092

Algorithms for Calculating Primary Energy Impact:

Unit savings are deemed in accordance with the following table and based on the Energy Star Commercial Kitchen Equipment Calculator [1]

Description	Annual Gross kWh Savings	kW Savings
Refrigerator, Glass Door, <15 ft3, Electric	245	0.03
Refrigerator, Glass Door, 15-29.9 ft3, Electric	307	0.04
Refrigerator, Glass Door, 30-49.9 ft3, Electric	540	0.06
Refrigerator, Glass Door, ≥50 ft3, Electric	610	0.07
Refrigerator, Solid Door, <15 ft3, Electric	170	0.02
Refrigerator, Solid Door, 15-29.9 ft3, Electric	255	0.03
Refrigerator, Solid Door, 30-49.9 ft3, Electric	245	0.03

Description	Annual Gross kWh Savings	kW Savings
Refrigerator, Solid Door, ≥50 ft3, Electric	376	0.04
Freezer, Glass Door, <15 ft3, Electric	427	0.05
Freezer, Glass Door, 15-29.9 ft3, Electric	681	0.08
Freezer, Glass Door, 30-49.9 ft3, Electric	1,062	0.12
Freezer, Glass Door, ≥50 ft3, Electric	1,486	0.17
Freezer, Solid Door, <15 ft3, Electric	212	0.02
Freezer, Solid Door, 15-29.9 ft3, Electric	486	0.06
Freezer, Solid Door, 30-49.9 ft3, Electric	541	0.06
Freezer, Solid Door, ≥50 ft3, Electric	589	0.07
Refrigerator, Glass Door, <15 ft3, Electric	245	0.03
Refrigerator, Glass Door, 15-29.9 ft3, Electric	307	0.04
Refrigerator, Glass Door, 30-49.9 ft3, Electric	540	0.06
Refrigerator, Glass Door, ≥50 ft3, Electric	610	0.07
Refrigerator, Solid Door, <15 ft3, Electric	170	0.02
Refrigerator, Solid Door, 15-29.9 ft3, Electric	255	0.03
Refrigerator, Solid Door, 30-49.9 ft3, Electric	245	0.03
Refrigerator, Solid Door, ≥50 ft3, Electric	376	0.04
Freezer, Glass Door, <15 ft3, Electric	427	0.05
Freezer, Glass Door, 15-29.9 ft3, Electric	681	0.08
Freezer, Glass Door, 30-49.9 ft3, Electric	1,062	0.12
Freezer, Glass Door, ≥50 ft3, Electric	1,486	0.17
Freezer, Solid Door, <15 ft3, Electric	212	0.02
Freezer, Solid Door, 15-29.9 ft3, Electric	486	0.06
Freezer, Solid Door, 30-49.9 ft3, Electric	541	0.06
Freezer, Solid Door, ≥50 ft3, Electric	589	0.07

Baseline Efficiency:

The baseline efficiency case is a refrigerator or freezer with standard energy consumption.

High Efficiency:

The high efficiency case is an Energy Star rated refrigerator or freezer.

Measure Life:

The measure life is 12 years.[2]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Food Services Upstream - Commercial Refrigerator/Freezer (All)	CI_EQUIP	All	12	n/a	n/a	12

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Food Services Upstream - Commercial Refrigerator/Freezer (All)	CI_EQUIP	All	1.00	1.00	1.00	1.00	1.00	0.90	0.90

In-Service Rates:

All installations have 100% in service rate since programs include verification of equipment installations.

Realization Rates:

100% realization rates are assumed because savings are based on researched assumptions.

Coincidence Factors:

Coincidence factors are the default food service factors of 0.90.

Impact Factors for Calculating Net Savings:

Net to gross factors are based on study results.[3]

Measure	Core Initiative	PA	FR	SO_p	SO_{NP}	NTG
Food Services Upstream - Commercial	CI_EQUIP	All	25.0%	0.2%	8.5%	83.7%

Refrigerator/Freezer (All)							

Non-Energy Impacts:

Non-energy impacts are based on study results.[4]

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per kWh	Annual $ per Therm	One-time $ per Therm
Food Services Upstream - Commercial Refrigerator/Freezer (All)	CI_EQUIP	ALL	$0.00	$0.00	$0.005	$0.00	$0.00	$0.00

Endnotes:

1 : https://www.energystar.gov/partner_resources/energy_star_training_center/commercial_food_service
August 27, 2021 ENERGY STAR Calculator - New Baselines and Efficiencies 082721

2 : https://www.energystar.gov/partner_resources/energy_star_training_center/commercial_food_service
August 27, 2021 ENERGY STAR Calculator - New Baselines and Efficiencies 082721

3 : NMR Group, Inc. (2021). C&I Prescriptive and Custom Net-to-Gross Omnibus Study.
2021_NMR_C&I_Omnibus_NTG

4 : NMR Group, Inc. (2021). O&M and NON-O&M NEI Study. 2021_NMR_CIOM and NonOM NEI Study

3.39 HVAC - Boiler Reset Control

Measure Code	COM-HVAC-BSC
Market	Commercial
Program Type	Retrofit
Category	Heating Ventilation and Air Conditioning

Measure Description:

Boiler Reset Controls are devices that automatically control boiler water temperature based on outdoor or return water temperature using a software program

BCR Measure IDs:

Measure Name	**Core Initiative**	**BCR Measure ID**
Boiler Reset Control, Gas	C&I Existing Building Retrofit (CI_RETRO)	GC2a015
Boiler Reset Control (Turnkey)	C&I Existing Building Retrofit (CI_RETRO)	GC2a049

Algorithms for Calculating Primary Energy Impact:

Updates to deemed savings, algorithms, baseline efficiency, and/or high-efficiency edits are suggestions from the C&I Comprehensive TRM Review.[1]

Measure Name	**ΔMMBtu**
Boiler Reset Control	37.3

Annual Electric Energy Savings[2]
ΔkWh=N/A
Summer Peak Coincident Demand Savings
ΔkW=N/A
Annual Fossil Fuel Energy Savings
ΔMMBtu=units x kBtu/hin 1,000x EFLHheating x ESF
ΔMMBtu=1 x k533 Btu/hin 1,000x 1400 hrs x 5%=37.3

Where:

Units   = number of measures installed under the program
$kBTU/h_{in}$ = Fuel input rating (kBTU/h) of the controlled boiler, 533 kBTU/h[3]
$EFLH_{heating}$ = Heating equivalent full-load hours, 1,400 hours[4]
ESF   = Energy Savings Factor, 5%
1,000   = Conversion factor, one MMBtu equals 1,000 kBTU

Baseline Efficiency:

The baseline efficiency case is a boiler without reset controls.

High Efficiency:

The high efficiency case is a boiler with reset controls.

Measure Life:

The measure life is based on an ACEEE study.[2]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Boiler Reset Control	CI_RETRO	All	15	n/a	n/a	15

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR$_E$	RR$_{NE}$	RR$_{SP}$	RR$_{WP}$	CF$_{SP}$	CF$_{WP}$
Boiler Reset Control	CI_RETRO	All	1.00	n/a	1.00	n/a	n/a	n/a	n/a

In-Service Rates:

All installations have 100% in service rate since programs include verification of equipment installations.

Realization Rates:

All PAs use 100% energy realization rate. The summer and winter peak realization rates are not applicable for this measure since there are no electric savings claimed.

Coincidence Factors:

Not applicable for this measure since no electric savings are claimed.

Impact Factors for Calculating Net Savings:

Net to gross factors are based on study results.[3]

Measure Name	Core Initiative	PA	FR	SO$_P$	SO$_{NP}$	NTG
Boiler Reset Control	CI_RETRO	All	0.37	0.00	0.32	0.66

Measure Name	Core Initiative	PA	FR	SO$_P$	SO$_{NP}$	NTG
Boiler Reset Control (Turnkey)	CI_RETRO	All	0.29	0.00	0.00	0.72

Non-Energy Impacts:

NEIs are based on study results.[4]

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per KWh	Annual $ per Therm	One-time $ per Therm
Boiler Reset Control	CI_RETRO	All					$ 0.622	

Endnotes:

1 : Cadeo (2021). Non-Residential TRM Review Study. MA22C01-B_TRM Review_FINAL_31OCT2022

2 : ACEEE (2006). Emerging Technologies Report: Advanced Boiler Controls. ACEEE_2006_Emerging_Technologies_Report_Advanced_Boiler_Controls

3 : NMR Group, Inc. (2018). Massachusetts Sponsor's Commercial and Industrial Free-ridership and Spillover Study. 2018_NMR_CI FR-SO Report

4 : NMR Group Inc (2021). O&M and Non-O&M NEI Study. 2021_NMR_CIOM and NonOM NEI Study

3.40 HVAC - Building Management System

Measure Code	COM-HVAC-BMS
Market	Commercial
Program Type	Retrofit
Category	Heating Ventilation and Air Conditioning

Measure Description:

The measure is the installation of a new building management system (EMS) or the expansion of an existing energy management system for control of non-lighting electric and gas end-uses in an existing building on existing equipment.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Building Management System	C&I Existing Building Retrofit (CI_RETRO)	GC2a080
Building Management System (Turnkey)	C&I Existing Building Retrofit (CI_RETRO)	GC2a081

Algorithms for Calculating Primary Energy Impact:

Gross energy and demand savings for sequences implemented in Building Management Systems (BMS) are estimated using a statewide BMS Calculator. The tool will estimate electric energy and demand savings, gas savings, and delivered fuel savings depending on the project and building characteristics.

Baseline Efficiency:

The baseline for this measure assumes the relevant HVAC equipment has no control.

High Efficiency:

The high-efficiency case is the installation of a new BMS or the expansion of an existing BMS to control additional non-lighting electric or gas equipment. The BMS must be installed in an existing building on existing equipment.

Measure Life:

For retrofit applications, the measure life is 10 years.[2]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Building Management System	CI_RETRO	All	10	n/a	n/a	10

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Building Management System	CI_RETRO	All	1.00	1.00	1.00	1.00	1.00	custom	custom
Building Management System (Turnkey)	CI_RETRO	All	1.00	1.00	1.00	1.00	1.00	custom	custom

In-Service Rates:
All installations have 100% in service rate since all PAs programs include verification of equipment installations.

Realization Rates:
All installations have 100% realization rate since savings are from a new calculator tool.

Coincidence Factors:
Coincidence factors are custom calculated.

Impact Factors for Calculating Net Savings:

Impact factors from 2021 C&I NTG evaluation[7] .

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Building Management System	CI_RETRO	All	37.0%	0.0%	3.0%	66.0%
Building Management System (Turnkey)	CI_RETRO	All	28.5%	0.0%	0.0%	71.5%

Non-Energy Impacts:

Impact factors from MA21X19-B-CIHSNEI C&I H&S NEI study.

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time	Annual $ per kWh	One-time $ per	Annual $ per Therm	One-time $ per

				$ per Unit		KWh		Therm
Building Management System	CI_RETRO	All					$2.80	
Building Management System (Turnkey)	CI_RETRO	All					$2.80	

Endnotes:

1 : Descriptions of the EMS savings calculation tools are included in the TRM Library "C&I Spreadsheet Tools" folder.

2 : Energy & Resource Solutions (2005). Measure Life Study. Prepared for The Massachusetts Joint Utilities; Table 1-1. ERS_2005_Measure_Life_Study

3 : The Fleming Group (1994). Persistence of Commercial/Industrial Non-Lighting Measures, Volume 3, Energy Management Control Systems. Prepared for New England Power Service Company Fleming_Group_1994_Persistence_of_Commercial_Industrial_Non_Lighting_Measures_Volume_3_Energy_Management_Control_Systems

4 : RLW Analytics (2008). Business & Construction Solutions (BS/CS) Programs Measurement & Verification - 2006 Final Report. Prepared for NSTAR Electric and Gas; Table 17 RLW_2008_Business_and_Construction_Solutions_Programs_Measurement_and_Verification_2006_Final_Report

5 : DNV GL (2020). Impact Evaluation of PY 2017 Small Business Initiative Non-Lighting Measures.

6 : MA Common Assumption

7 : NMR Group, Inc. (2021). C&I Prescriptive and Custom NTG Omnibus Study 2021_NMR_C&I_Omnibus_NTG

3.41 HVAC - Circulator Pump

Measure Code	COM-HVAC-CP
Market	Commercial
Program Type	Replace on Burnout
Category	Heating Ventilation and Air Conditioning

Measure Description:

Single-phase circulator pumps up used in C&I buildings used for hydronic heating and system hot water.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Midstream - Circulator Pump	C&I New & Replacement Equipment (CI_EQUIP)	EC2b057
Midstream - PEI-Rated Clean Water Pump	C&I New & Replacement Equipment (CI_EQUIP)	EC2b057

Algorithms for Calculating Primary Energy Impact:

Savings for the Midstream - Circulator Pump depend on application and pump size as described in table below.[1]

Size	Type	kW	kWh
<= 1 HP	Hydronic Heating	$\Delta kW = 0.245 * HP_{rated} + 0.02$	$\Delta kWh = 1{,}325 * HP_{rated} + 111$
<= 1 HP	Service Hot Water	$\Delta kW = 0.245 * HP_{rated} + 0.02$	$\Delta kWh = 2{,}780 * HP_{rated} + 233$
> 1 HP	Hydronic Heating	$\Delta kW = 0.265$	$\Delta kWh = 1{,}436$
> 1 HP	Service Hot Water	$\Delta kW = 0.265$	$\Delta kWh = 3{,}013$

Savings for the Midstream - PEI-Rated Clean Water Pump are based on the prescriptive algorithms[2] below.

$\Delta kWh / HP = (1 - MotorOversizeFactor) * (PEI_{efficient} - PEI_{baseline}) * Load\ Profile\ Adjustment\ Factor * Annual\ Operating\ Hours$

$\Delta kW / HP = RLF * 0.746\ (kW / HP) * (PEI_{efficient} - PEI_{baseline}) * CF$
where:

RLF = ratio of the peak motor load to the maximum connected load

Sector	Annual Operating Hours
Commercial	3,753
Industrial	6,179
Municipal	3,360
Agricultural	2,358

Baseline Efficiency:

The baseline system is a pump without an EC motor. The baseline system may have no control, a timer, aquastat, or be on demand. The baseline system is assumed to run a weighted average of these four control types.

High Efficiency:

The high efficiency case is a pump with an ECM.

Measure Life:

This is a single baseline measure. The baseline is derived from the new construction baseline for motors.[2]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Circulator Pump	CI_EQUIP	All	20	n/a	n/a	20
PEI Pump	CI_EQUIP	All	15	n/a	n/a	15

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Circulator Pump & PEI Pump	CI_EQUIP	All	1.00	1.01	n/a	1.09	1.57	0.82	0.05

In-Service Rates:

All installations have 100% in-service rates since PA programs include verification of equipment installations.

Realization Rates:

RRs are from an impact evaluation 2006 HVAC installations.[4]

Coincidence Factors:

Coincidence factors are based on best information available. [5]

Impact Factors for Calculating Net Savings:

Statewide net impact factors are based on an Upstream HVAC Net-to-Gross study in Massachusetts in 2021.[6]

Measure Name	Core Initiative	PA	FR	SO$_P$	SO$_{NP}$	NTG
HVAC Upstream - Circulator Pump & PEI Pump - 2022	CI_EQUIP	All	0.45	0.00	0.00	0.55
HVAC Upstream - Circulator Pump & PEI Pump - 2023	CI_EQUIP	All	0.45	0.00	0.00	0.55
HVAC Upstream - Circulator Pump & PEI Pump - 2024	CI_EQUIP	All	0.45	0.00	0.00	0.55

Non-Energy Impacts:

Measure Name	Core Initiative	PA	Annual $ per kWh	Annual $ per Therm
HVAC - Circulator Pump & PEI Pump	CI_EQUIP	All	$0.095	

Endnotes:

1 : The Cadmus Group (2017). Circulator Pump Technical Memo.
Cadmus_2017_Circulator_Pump_Technical_Memo
2: Regional Technical Forum, Efficient Pumps v2.0
3 : Energy & Resource Solutions (2005). Measure Life Study. ERS_2005_Measure_Life_Study
4 : RLW Analytics (2008). Business & Construction Solutions (BS/CS) Programs Measurement & Verification 2006 Final Report.
RLW_2008_Business_and_Construction_Solutions_Programs_Measurement_and_Verification_2006_Final_Report
5 : MA Common Assumption
6 : NMR Group, Inc. (2021). C&I Upstream HVAC & Gas Water Heating NTG Study
2021_NMR_C&I_HVAC_NTG
7: 2022_DNV_C&I_Heath_&_Safety_NEIs

3.42 HVAC - Combo Condensing Boiler/Water Heater

Measure Code	COM-HVAC-CWHB
Market	Commercial
Program Type	New Construction, Retrofit
Category	Heating Ventilation and Air Conditioning

Measure Description:

This measure promotes the installation of a combined high-efficiency boiler and water heating unit. Combined boiler and water heating systems are more efficient than separate systems because they eliminate the standby heat losses of an additional tank.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Heating System, Combo Condensing Boiler/Water Heater, Gas 95%	C&I New Buildings & Major Renovations (CI_NB&MR)	GC1a026
Heating System, Combo Condensing Boiler/Water Heater, Gas 95%	C&I New & Replacement Equipment (CI_EQUIP)	GC2b018

Algorithms for Calculating Primary Energy Impact:

Unit savings are deemed based on below calculations[1] .

Measure Name	ΔMMBtu
Combo Condensing Boiler/Water Heater, 95% AFUE	43.8

Annual Electric Energy Savings
$$\Delta kWh = N/A$$

Summer Peak Coincident Demand Savings
$$\Delta kW = N/A$$

Annual Fossil Fuel Energy Savings
$$\Delta MMBtu = \Delta MMBtu_{SH} + \Delta MMBtu_{DHW}$$

$$\Delta MMBtu_{SH} = units \ x \ \frac{kBtu/h_{in}}{unit} \ x \left(\frac{Eff_{ee}}{Eff_{basline}} - 1 \right) x \frac{EFLH_{heating}}{1,000}$$

$$\Delta MMBtu_{DHW} = units \; x \; \left[\frac{GPD \; x \; 365 \; x \; 8.33 \; x \; (T_{set} - T_{main})}{1,000,000} \; x \; \left(\frac{1}{E_{t,basline}} - \frac{1}{E_{t,ee}} \right) \right.$$
$$\left. + \frac{UA_{baseline}}{E_{t,baseline}} \; x \; \frac{(T_{set} - T_{amb})}{1,000,000} \; x \; 8,760 \right]$$

Where:

$\Delta MMBtu_{SH}$ = Annual space heating savings associated with installation of a high-efficiency combi-boiler

$\Delta MMBtu_{DHW}$ = Annual domestic hot water savings associated with installation of a high-efficiency combi-boiler

Units = number of units installed under the program

$kBTU/h_{in}$ = Space heating fuel input rating, 150 $kBTU/h_{in}$[2]

$Eff_{baseline}$ = Boiler space heating baseline condition, 85% AFUE[3]

Eff_{ee} = Boiler space heating energy efficiency condition, 95% AFUE

$E_{t,baseline}$ = Water heating baseline thermal efficiency, 80% Et[4]

$E_{t,ee}$ = Water heating efficient equipment thermal efficiency, 94% Et

$EFLH_{heating}$ = Heating equivalent full-load hours, 1,400 hrs[5]

GPD = Gallons per day, 154 GPD[6]

T_{main} = Average temperature of supply water temperature in water main, 55.7°F[7]

T_{amb} = Average surrounding ambient air temperature, 70°F

T_{set} = Average water heater set point temperature, 140°F[8]

$UA_{baseline}$ = Overall heat loss coefficient (BTU/h-°F) baseline, 15.3 Btu/h-°F[9]

8.33 = Energy required (BTU) to heat one gallon of water by one-degree Fahrenheit

365 = Days in one year

1,000 = Conversion factor, one MMBtu equals 1,000 kBTU

8,760 = Hours per year

1,000,000 = Conversion factor, one MMBtu equals 1,000,000 Btu

Baseline Efficiency:

The baseline efficiency case is a standard efficiency gas-fired storage tank hot water heater with a separate standard efficiency boiler for space heating purposes.

High Efficiency:

The high efficiency case is either a condensing, integrated water heater/boiler with an AFUE of >=90% or AFUE>=95%.

Measure Life:

The measure life is 20 years.[10]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Combo Condensing Boiler/Water Heater	CI_NB&MR	All	20	n/a	n/a	20

	CI_EQUIP					

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Combo Condensing Boiler/Water Heater	CI_NB&MR CI_EQUIP	All	1.00	1.00	1.00	n/a	n/a	n/a	n/a

In-Service Rates:

All installations have 100% in-service rates since programs include verification of equipment installations.

Realization Rates:

All PAs use 100% energy realization rate. The summer and winter peak realization rates are not applicable for this measure since there are no electric savings claimed.

Coincidence Factors:

Not applicable for this measure since no electric savings are claimed.

Impact Factors for Calculating Net Savings:

Impact factors come from the 2021 C&I NTG evaluations.[11]

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Combo Condensing Boiler/Water Heater	CI_NB&MR	All	0.58	0.22	0.00	0.64
Combo Condensing Boiler/Water Heater	CI_Equip	All	0.37	0.026	0.19	0.84

Non-Energy Impacts:

Non-energy impact factors come from the 2022 C&I H&S NEI evaluation.[12]

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per KWh	Annual $ per Therm	One-time $ per Therm
Condensing Boilers	CI_NB&MR	All					$ 0.605	

Endnotes:

1 : Cadeo (2022) Non-Residential TRM Review MA22C01-B_TRM Review_FINAL_31OCT2022

2 : Weighted boiler input capacity based on Eversource program data.

3 : DNVGL,NMR Group, 2017, Gas Boiler Market Characterization DNVGL_2017_Gas_Boiler_Market_Characterization

4 : Title 10, Code of Federal Regulations, Part 430 - Energy Conservation Program for Consumer Products, Subpart C - Energy and Water Conservation Standards and Their Effective Dates. January 1, 2010; Energy Conservation standards for Residential Water Heaters, Direct Heating Equipment, and Pool Heaters: Final Rule, Federal Register, 75 FR 20112, April 16, 2010.

5 : KEMA (2012), Prescriptive Gas Program Final Evaluation Report. Prepared for Massachusetts Energy Efficiency Program Administrators; page 1-2.

6 : DNV GL, Inc (2019) Impact Evaluation of Commercial Water Heaters: Baseline Adjustment Memo Including Consumption Estimates. Table 3. Weighted using 2018 Commercial Buildings Energy Consumption Survey.

7 : 2022-05 Final Determination Technical Support Document Energy Conservation Program for Consumer Products and Certain Commercial and Industrial Equipment: Commercial Prerinse Spray Valves. Table 7.4.1 Weighted Average Annual Main Water Temperature by Census Division and Building Type (Non-education Buildings in New England.) https://downloads.regulations.gov/EERE-2019-BT-STD-0034-0020/content.pdf

8 : OSHA notes that water heater temperatures below 140° F may lead to Legionella bacterial growth (https://www.osha.gov/legionnaires-disease/control-prevention)

9: AHRI Commercial Water Heaters – Average stand by loss for 80 gallon take at 70 degrees ambient temperature.

10 : GDS Associates, Inc. (2009). Natural Gas Energy Efficiency Potential in Massachusetts. GDS_2009_Natural_Gas_Energy_Efficiency_Potential_in_MA

11 : NMR Group, Inc. (2021). Non Residential New Construction NTG Report. 2021_NMR_Non_Residential_New_Construction_NTG_Report

12 : 2022 MA21X19-B-CIHSNEI C&I Health and Safety NEI Study

3.43 HVAC - Combo Furnace/Water Heater

Measure Code	COM-HVAC-CFWH
Market	Commercial
Program Type	Retrofit
Category	Heating Ventilation and Air Conditioning

Measure Description:

Installation of a combination furnace.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Heating System, Combo Condensing Furnace/Water Heater, Gas	C&I New & Replacement Equipment (CI_EQUIP)	GC2b042

Algorithms for Calculating Primary Energy Impact:

The heating load for furnaces is 584 therms. This is based on an evaluation of heating equipment installed through the HEHE program and assumed to be representative of single family homes.[1]

Δ Therms = heating load * (1/AFUEbase – 1/AFUEee) = 584 *(1/0.85 – 1/0.97) = 85 therms.

The water heating load is 139 therms.[2]

Δ Therms = water heating load * (1/UEFbase – 1/UEFee) = 139 *(1/0.63 – 1/0.90) = 66 therms.

Measure Name	ΔMMBtu/Unit
Heating System, Combo Condensing Furnace/Water Heater, Gas	15.1

Baseline Efficiency:

It is assumed that the baseline is an 85% AFUE furnace and a separate high draw gas fired storage water heater with an efficiency rating of 0.63 UEF.[3]

High Efficiency:

A new combination 97% AFUE furnace and 0.90 tankless water heater.

Measure Life:

The measure life is 18 years.[4]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Heating System, Combo Condensing Furnace/Water Heater, Gas	CI_EQUIP	All	18	n/a	n/a	18

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Heating System, Combo Condensing Furnace/Water Heater, Gas	CI_EQUIP	All	1.00	n/a	1.00	n/a	n/a	n/a	n/a

In-Service Rates:

All installations have 100% in service rate since programs include verification of equipment installations.

Realization Rates:

All PAs use 100% energy realization rate. The summer and winter peak realization rates are not applicable for this measure since there are no electric savings claimed.

Coincidence Factors:

Not applicable for this measure since no electric savings are claimed.

Impact Factors for Calculating Net Savings:

2021 C&I NTG study.[5]

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Heating System, Combo Condensing Furnace/Water Heater, Gas	CI_EQUIP	All	0.373	0.026	0.191	0.844

Non-Energy Impacts:

Measure Name	Core Initiative	PA	Annual $ per kWh	Annual $ per Therm

HVAC - Combo Furnace/Water Heater[6]	CI_EQUIP	All		$0.605

Endnotes:

1 : The Cadmus Group (2015). High Efficiency Heating Equipment Impact Evaluation.
CADMUS_2014_HEHE_Impact Evaluation

2 : Navigant Consulting (2018). Water Heater, Boiler, and Furnace Cost Study
2018_Navigant_Water_Heater_Analysis_Memo

3 : Values per Residential baseline assumptions informed by negotiations b/w Residential evaluation stakeholders.

4 : Environmental Protection Agency (2009). Lifecycle Cost Estimate for Energy Star Furnace.
EPA_2009_Lifecycle_Cost_Estimate_for_ENERGY_STAR_Furnace

5 : 2021_NMR_C&I_Omnibus_NTG

6 : 2022 MA21X19-B-CIHSNEI C&I Health and Safety NEI Study
2022_DNV_C&I_Heath_&_Safety_NEIs

3.44 HVAC - Communicating Thermostat

Measure Code	COM-HVAC-WT
Market	Commercial
Program Type	Retrofit
Category	Heating Ventilation and Air Conditioning

Measure Description:

A communicating thermostat which allows remote set point adjustment and control via remote application. System requires an outdoor air temperature algorithm in the control logic to operate heating and cooling systems.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Wi-Fi Thermostat, Electric (Turnkey)	C&I Existing Building Retrofit (CI_RETRO)	EC2a150
Wi-Fi Thermostat, Electric (OMP)	C&I New & Replacement Equipment (CI_EQUIP)	EC2b183
Wi-Fi Thermostat, Oil (Turnkey)	C&I Existing Building Retrofit (CI_RETRO)	EC2a128
Wi-Fi Thermostat, Oil (OMP)	C&I New & Replacement Equipment (CI_EQUIP)	EC2b184
Wi-Fi Thermostat, Propane (Turnkey)	C&I Existing Building Retrofit (CI_RETRO)	EC2a129
Wi-Fi Thermostat, Propane (OMP)	C&I New & Replacement Equipment (CI_EQUIP)	EC2b185
Wi-Fi Thermostat, AC Only (Residential End Use)	C&I Existing Building Retrofit (CI_RETRO)	EC2a085
Wi-Fi Thermostat, Oil (Residential End Use)	C&I Existing Building Retrofit (CI_RETRO)	EC2a086
Wi-Fi Thermostat, Other (Residential End Use)	C&I Existing Building Retrofit (CI_RETRO)	EC2a087
Wi-Fi Thermostat, Gas	C&I Existing Building Retrofit (CI_RETRO)	GC2a017
Wi-Fi Thermostat, Gas (Turnkey)	C&I Existing Building Retrofit (CI_RETRO)	GC2a038

Wi-Fi Thermostat, Gas (Residential End Use)	C&I Existing Building Retrofit (CI_RETRO)	GC2a068
Wi-Fi Thermostat, Gas (OMP)	C&I New and Replacement Equipment (CI_EQUIP)	GC2b082

Algorithms for Calculating Primary Energy Impact:

Unit savings are deemed based on study results.[1] The total cooling savings of 64 kWh were adjusted to reflect the percent of homes that have cooling which based on the Residential Baseline study is 28 percent.

Measure Name	ΔkWh	ΔkW[2]	Δ MMBtu
Wi-Fi Thermostat, Gas			2.79
Wi-Fi Thermostat, Gas (Turnkey)			2.79
Wi-Fi Thermostat, Gas (Residential End Use)	18	0.03	2.79
Wi-Fi Thermostat, AC Only (Residential End Use)	64	0.10	
Wi-Fi Thermostat, Oil (Residential End Use)	18	0.03	2.79
Wi-Fi Thermostat, Other (Residential End Use)	18	0.03	2.79
Wi-Fi Thermostat, Oil (Turnkey)			2.79
Wi-Fi Thermostat, Propane (Turnkey)			2.79

Baseline Efficiency:

The baseline efficiency case is an HVAC system with either a manual or a programmable thermostat.

High Efficiency:

The high efficiency case is an HVAC system that has a Wi-Fi thermostat installed.

Measure Life:

The measure life is 15 years.[3]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Wi-Fi Thermostat	CI_RETRO CI_EQUIP	All	15	n/a	n/a	15

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Wi-Fi Thermostat, Gas	CI_RETRO	All	1.00	n/a	1.00	n/a	n/a	n/a	n/a
Wi-Fi Thermostat, Gas (Turnkey)	CI_RETRO	All	1.00	n/a	1.00	n/a	n/a	n/a	n/a
Wi-Fi Thermostat, AC Only (High Rise)	CI_RETRO	All	1.00	1.00	1.00	1.00	1.00	0.37	0.00
Wi-Fi Thermostat, Oil (High Rise)	CI_RETRO	All	1.00	1.00	1.00	1.00	1.00	n/a	n/a
Wi-Fi Thermostat, Other (High Rise)	CI_RETRO	All	1.00	1.00	1.00	1.00	1.00	0.37	n/a
Wi-Fi Thermostat, Gas (High Rise)	CI_RETRO	All	1.00	1.00	1.00	1.00	1.00	0.37	0.00
Wi-Fi Thermostat, Oil (Turnkey)	CI_RETRO	All	1.00	n/a	1.00	n/a	n/a	n/a	n/a
Wi-Fi Thermostat, Propane (Turnkey)	CI_RETRO	All	1.00	n/a	1.00	n/a	n/a	n/a	n/a

In-Service Rates:
All PAs assume 100% in service rate.

Realization Rates:
Realization rates are set to 100% for deemed measures.

Coincidence Factors:
Summer and winter coincidence factors are estimated using the demand allocation methodology described in the Demand Impact Model which is developed based on the Residential Baseline Study.[4]

Impact Factors for Calculating Net Savings:

Net to gross factors for attached low rise and high rise is based on evaluation results.[5] [6]

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Wi-Fi Thermostat, Gas	CI_RETRO	All	0.369	0.000	0.032	0.663
Wi-Fi Thermostat, Gas (Turnkey)	CI_RETRO	All	0.285	0.000	0.000	0.715
Wi-Fi Thermostat (Residential End Use), Gas	CI_RETRO	All	0.14	0.0	0.0	0.86
Wi-Fi Thermostat (Residential End Use)	CI_RETRO	All	0.14	0.0	0.0	0.86
Wi-Fi Thermostat, Electric/Oil/Propane	CI_RETRO	All	0.077	0.013	0.004	0.940

(Turnkey)						
Wi-Fi Thermostat, Electric/Oil/Propane (OMP)	CI_EQUIP	All	0.25	0.00	0.09	0.84
Wi-Fi Thermostat, Gas (OMP)	CI_EQUIP	All	0.370	0.026	0.190	0.840

Non-Energy Impacts:

C&I values from 2021 C&I NEI study.[7] Residential NEI values are rolled up, component values can be found in Appendix B. The Residential End Use value is per household and is adjusted for number of thermostats per account.

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per KWh	Annual $ per Therm	One-time $ per Therm
Wi-Fi Thermostat, Electric (Turnkey)	CI_RETRO	All			$ 0.246			
Wi-Fi Thermostat, Oil (Turnkey)	CI_RETRO	All			$ 0.246			
Wi-Fi Thermostat, Propane (Turnkey)	CI_RETRO	All			$ 0.246			
Wi-Fi Thermostat, AC Only (Residential End Use)	CI_RETRO	All	$14.35					
Wi-Fi Thermostat, Oil (Residential End Use)	CI_RETRO	All	$14.35					
Wi-Fi Thermostat, Other (Residential End Use)	CI_RETRO	All	$14.35					
Wi-Fi Thermostat, Gas	CI_RETRO	All					$ 2.80	
Wi-Fi Thermostat, Gas (Turnkey)	CI_RETRO	All					$ 2.80	

Wi-Fi Thermostat, Gas (Residential End Use)	CI_RETRO	All					$ 2.80	

Endnotes:

1 : Navigant Consulting (2018). Wi-Fi Thermostat Impact Evaluation--Secondary Research Study Memo. 2018_Navigant_Wi-Fi_Thermostat_Impact_Evaluation_Secondary_Literature_Study
2 : Guidehouse (2020). Residential Baseline Study Phase 4
2020_Guidehouse_Residential_Baseline_Phase_4
3 : Assumed to have the same lifetime as a regular programmable thermostat. Environmental Protection Agency (2010). Life Cycle Cost Estimate for ENERGY STAR Programmable Thermostat.
EPA_2010_Lifecycle_Cost_Estimate_for_ENERGY_STAR_Programmable_Thermostats
4 : Guidehouse (2020). Residential Baseline Study Phase 4
2020_Guidehouse_Residential_Baseline_Phase_4
5 : NMR (2021) Prescriptive and Custom NTG Omnibus Study 2021_NMR_Prescriptive and Custom Net-to-Gross Omnibus Study
6 : Guidehouse (2021). Residential Programs Net-to-Gross Research of RCD and Select Products Measures Workbook 2021_Guidehouse_MA_Res_NTG_Final_Results_Workbook
7 : NMR Group Inc (2021). O&M and Non-O&M NEI Study. 2021_NMR_CIOM and NonOM NEI Study

3.45 HVAC - Condensing Boiler

Measure Code	COM-HVAC-B
Market	Commercial
Program Type	Time of Sale
Category	Heating Ventilation and Air Conditioning

Measure Description:

The installation of a high efficiency natural gas fired condensing hot water boiler.
High-efficiency condensing boilers can take advantage of improved design, sealed combustion and condensing flue gases in a second heat exchanger to achieve improved efficiency.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Heating System, Condensing Boiler, Gas <= 300 mbh (.95 TE)	C&I New & Replacement Equipment (CI_EQUIP)	GC2b011
Heating System, Condensing Boiler, Gas <= 300 mbh (.90 TE)	C&I New & Replacement Equipment (CI_EQUIP)	GC2b012
Heating System, Condensing Boiler, Gas 301-499 mbh (.90 TE)	C&I New & Replacement Equipment (CI_EQUIP)	GC2b013
Heating System, Condensing Boiler, Gas 500-999 mbh (.90 TE)	C&I New & Replacement Equipment (CI_EQUIP)	GC2b014
Heating System, Condensing Boiler, Gas 1000-1700 mbh (.90 TE)	C&I New & Replacement Equipment (CI_EQUIP)	GC2b015
Heating System, Condensing Boiler, Gas 1701+ mbh (.90 TE), Gas	C&I New & Replacement Equipment (CI_EQUIP)	GC2b016
Heating System, Condensing Boiler, Gas < = 300 mbh (0.90 TE) - Upstream	C&I New & Replacement Equipment (CI_EQUIP)	GC2b045
Heating System, Condensing Boiler, Gas 300-499 mbh (0.90 TE) - Upstream	C&I New & Replacement Equipment (CI_EQUIP)	GC2b046
Heating System, Condensing Boiler, Gas 500-999 mbh (0.90 TE) - Upstream	C&I New & Replacement Equipment (CI_EQUIP)	GC2b047
Heating System, Condensing Boiler, Gas 1000-1700 mbh (0.90 TE) - Upstream	C&I New & Replacement Equipment (CI_EQUIP)	GC2b048

Heating System, Condensing Boiler, Gas 1700+ mbh (0.90 TE) - Upstream	C&I New & Replacement Equipment (CI_EQUIP)	GC2b049

Algorithms for Calculating Primary Energy Impact:

Unit savings are deemed based on study results.[1]

Measure Name	ΔMMBtu
<= 300 mbh (0.95 TE)	13.8
<= 300 mbh (0.90 TE)	11.4
301-499 mbh (0.90 TE)	21.8
500-999 mbh (0.90 TE)	39.9
1000-1700 mbh (0.90 TE)	73.4
1701+ mbh (0.90 TE)	128.5

Baseline Efficiency:

Baseline efficiency is an 85% AFUE boiler.[2]

High Efficiency:

High efficiency is per table efficiency thresholds above.

Measure Life:

The measure life is 20 years.[3]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Condensing Boilers	CI_EQUIP	All	20	n/a	n/a	20

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR$_E$	RR$_{NE}$	RR$_{SP}$	RR$_{WP}$	CF$_{SP}$	CF$_{WP}$
Condensing Boilers	CI_EQUIP	All	1.00	n/a	1.00	n/a	n/a	n/a	n/a

In-Service Rates:

All installations have 100% in-service rates since programs include verification of equipment installations.

Realization Rates:

All PAs use 100% energy realization rates. The summer and winter peak realization rates are not applicable for this measure since there are no electric savings claimed.

Coincidence Factors:

Not applicable for this measure since no electric savings are claimed.

Impact Factors for Calculating Net Savings:

Net to Gross factors based on study results.[4]

Measure Name	Core Initiative	PA	FR	SO$_P$	SO$_{NP}$	NTG
Condensing Boilers	CI_EQUIP	All	0.37	0.026	0.19	0.84

Non-Energy Impacts:

Non-Energy Impact factors are deemed from the study results.[5]

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per KWh	Annual $ per Therm	One-time $ per Therm
Condensing Boilers	CI_NB&MR	All					$ 0.846	

Endnotes:

1 : DNV (2021). Prescriptive Measures NRNC and ISP Results. 2021_DNV_Prescriptive Measures NRNC and ISP Results

2 : DNVGL, NMR Group (2017). Gas Boiler Market Characterization. DNVGL_2017_Gas_Boiler_Market_Characterization

3 : DNV GL (2020). C&I Measure Life Study. MA19C02_B_EUL-final-report-03_31_20-v2

4 : NMR Group, Inc. (2018). Massachusetts Sponsors' Commercial and Industrial Free-ridership and Spillover Study. 2018_NMR_CI_FR_SP

5 : 2022 MA21X19-B-CIHSNEI C&I Health and Safety Non-Energy Impacts 2022_DNV_C&I_Heath_&_Safety_NEIs

3.46 HVAC - Condensing Unit Heater

Measure Code	COM-HVAC-CUH
Market	Commercial
Program Type	Retrofit
Category	Heating Ventilation and Air Conditioning

Measure Description:

Installation of a condensing gas-fired unit heater for space heating with capacity up to 300 MBH and minimum combustion efficiency of 90%.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Condensing Unit Heater, Gas <= 300 mbh	C&I New Buildings & Major Renovations (CI_NB&MR)	GC1a023
Condensing Unit Heater, Gas <= 300 mbh	C&I New & Replacement Equipment (CI_EQUIP)	GC2b019

Algorithms for Calculating Primary Energy Impact:

Unit savings for the heaters are deemed based on study results.[1] Updates to endnotes are suggestions from the C&I Comprehensive TRM Review[2]

Measure Name	ΔMMBtu
Condensing Unit Heater (<= 300 mbh)	40.9

Baseline Efficiency:

The baseline efficiency case for the unit heater is a standard efficiency gas fired unit heater with minimum combustion efficiency of 80%, interrupted or intermittent ignition device (IID), and either power venting or an automatic flue damper[2].

High Efficiency:

The high efficiency case is a condensing gas unit heater with 90% AFUE or greater.

Measure Life:

The measure life is 18 years[4] for the unit heater.

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Condensing Unit Heater	CI_NB&MR, CI_EQUIP	All	18	n/a	n/a	18

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Condensing Unit Heater	CI_NB&MR CI_EQUIP	All	1.00	n/a	1.00	n/a	n/a	n/a	n/a

In-Service Rates:

All installations have 100% in-service rates since programs include verification of equipment installations.

Realization Rates:

All PAs use 100% energy realization rates.

Coincidence Factors:

Summer and winter coincidence factors align with the loadshapes used to capture the coincident peak demand savings associated with the scroll compressor and the floating head pressure control components of the measure, as used in the VT TRM methodology.

Impact Factors for Calculating Net Savings:

Net savings factors for Condensing Boilers within CI_NB&MR initiative are from the 2021 NRNC NTG study (paths 3&4)[5] . Condensing Boilers within CI_EQUIP initiative are based on evaluated freeridership and spillover factors for Massachusetts prescriptive C&I New and Replacement Equipment (2021 Omnibus NTG Study)[6] .

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Condensing Boilers	CI_NB&MR	All	0.583	0.227		0.644
Condensing Boilers	CI_EQUIP	All	0.373	0.026	0.191	0.844

Non-Energy Impacts:

Impact factors are deemed based on study results.[7]

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per KWh	Annual $ per Therm	One-time $ per Therm
Condensing Unit Heater	CI_NB&MR, CI_EQUIP	All					$0.605	

Endnotes:

1 : NYSERDA Deemed Savings Database (Rev 11); Measure Name: A.UNIT-HEATER-COND.

2 : 2012 International Energy Conservation Code.

4 : Ecotrope, Inc. (2003). Natural Gas Efficiency and Conservation Measure Resource Assessment for the Residential and Commercial Sectors. Prepared for the Energy Trust of Oregon.
Ecotrope_2003_Natural_Gas_Efficiency_and_Conservation_Measure_Resource_Assessment

5 : NMR Group. Inc. (2021). Non Residential New Construction NTG Report.
2021_NMR_Non_Residential_New_Construction_NTG_Report

6 : NMR Group, Inc. (2021). C&I Prescriptive and Custom NTG Omnibus Study
2021_NMR_Prescriptive and Custom Net-to-Gross Omnibus Study

6 : KEMA (2012). Commercial and Industrial Non-Energy impacts Study.
TETRATECH_2012_MA_CI_NEI_REPORT

3.47 HVAC - Cooler Night Cover

Measure Code	COM-R-CNC
Market	Commercial
Program Type	Retrofit
Category	Refrigeration

Measure Description:

Installation of retractable aluminum woven fabric covers for open-type refrigerated display cases, where the covers are deployed during the facility unoccupied hours in order to reduce refrigeration energy consumption.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Cooler Night Covers	C&I Existing Building Retrofit (CI_RETRO)	EC2a038
Cooler Night Covers (Turnkey)	C&I Existing Building Retrofit (CI_RETRO)	EC2a157

Algorithms for Calculating Primary Energy Impact:

$$\Delta kWh = (Width) \times (Save) \times (Hours)$$

$$\Delta kW = (Width) \times (Save)$$

Where:
ΔkWh = Energy Savings
ΔkW = Connected load reduction
Width = Width of the opening that the night covers protect (ft)
Save = Savings factor based on the temperature of the case (kW/ft). See table below[1]
Hours = Annual hours that the night covers are in use

Savings Factors:

Cooler Case Temperature	Savings Factor
Low Temperature (-35 F to -5 F)	0.03 kW/ft
Medium Temperature (0 F to 30 F)	0.02 kW/ft
High Temperature (35 F to 55 F)	0.01 kW/ft

Baseline Efficiency:

The baseline efficiency case is the annual operation of open-display cooler cases.

High Efficiency:

The high efficiency case is the use of night covers to protect the exposed area of display cooler cases during unoccupied hours.

Measure Life:

The measure is determined to be an add on single baseline measure.[2] [3]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Cooler Night Covers	CI_RETRO	All	10	1	n/a	10

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E[6]	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Cooler Night Covers	CI_RETRO	All	1.00	0.91	n/a	0.92	0.92	0.90	0.90
Cooler Night Covers (turnkey)	CI_RETRO	All	1.00	0.95	n/a	1.27	1.42	0.90	0.90

In-Service Rates:

All installations have 100% in service rate since all PAs' programs include verification of equipment installations.

Realization Rates:

Values based on small business non-lighting study (2019)

Coincidence Factors:

Coincidence factors are representative of C&I Refrigeration

Impact Factors for Calculating Net Savings:

All PAs use statewide prescriptive net-to-gross results.[5]

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Cooler Night Covers	CI_RETRO	All	0.18	0.00	0.05	0.88

Cooler Night Covers (Turnkey)	CI_RETRO	All	0.14	0.05	0.02	0.94

Non-Energy Impacts:

Prescriptive refrigeration measures in retrofit applications have an annual $/kWh NEI.[6]

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per kWh	Annual $ per Therm	One-time $ per Therm
Refrigeration - Cooler Night Covers	CI_RETRO	All			$0.001			

Endnotes:

1 : CL&P Program Savings Documentation for 2011 Program Year (2010). Factors based on Southern California Edison (1997). Effects of the Low Emissive Shields on Performance and Power Use of a Refrigerated Display Case.
SoCalEdison_1997_Effects_of_the_Low_Emissive_Shields_on_Performance_and_Power_Use_of_a_R efrigerated_Display_Case

2 : Baseline Categories and preliminary Out Year Factors are described at a high level in DNV GL, ERS (2018). Portfolio Model Companion Sheet. Additional background on the baseline categorization given in DNV GL, ERS (2018). Portfolio Model Methods and Assumptions – Electric and Natural Gas Memo.
2018_DNVGL_ERS_Portfolio_Model_Companion_Sheet

3 : Energy & Resource Solutions (2005). Measure Life Study. Prepared for The Massachusetts Joint Utilities; Page 4-5 to 4-6. ERS_2005_Measure_Life_Study

6 : DNV GL. (2019). Impact Evaluation of PY 2017 Small Business Initiative Non-lighting measures.
Final Report MA19C03-E-SBIMPCT 03202020

5 : NMR Group, Inc. (2021). Prescriptive and Custom NTG Omnibus Study.
2021_NMR_C&I_Omnibus_NTG

6 : NMR Group Inc (2021). O&M and Non-O&M NEI Study. 2021_NMR_CIOM and NonOM NEI Study

3.48 HVAC - Dual Enthalpy Economizer Controls (DEEC)

Measure Code	COM-HVAC-DEEC
Market	Commercial
Program Type	Retrofit
Category	Heating Ventilation and Air Conditioning

Measure Description:

The measure is to upgrade the outside-air dry-bulb economizer to a dual enthalpy economizer. The system will continuously monitor the enthalpy of both the outside air and return air. The system will control the system dampers adjust the outside quantity based on the two readings.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Midstream - Dual Enthalpy Economizer Controls (DEEC)	C&I New & Replacement Equipment (CI_EQUIP)	EC2b054

Algorithms for Calculating Primary Energy Impact:

$\Delta kWh = (kBtu/h)(1\ Ton/12\ kBtu\ /\ h)(SAVEkWh)$
$\Delta kWh = (kBtu/h)(1\ Ton/12\ kBtu\ /\ h)(SAVEkW)$

Where:
kBtu/h = Capacity of the cooling equipment in kBtu per hour (1 ton of cooling capacity equals 12kBtu/h).
SAVEkWh = Average annual kWh reduction per ton of cooling capacity: 38.2 kWh/ton[1]
SAVEkW = Average kW reduction per ton of cooling capacity: 0.0 kW/ton[2]

(deemed kWh/ton and kW/ton savings from NY TRM modeled savings mapped to MA climate zones)

Baseline Efficiency:

The baseline efficiency case for this measure assumes the relevant HVAC equipment is operating with a fixed dry-bulb economizer.

High Efficiency:

The high efficiency case is the installation of an outside air economizer utilizing two enthalpy sensors, one for outdoor air and one for return air.

Measure Life:

The measure life is 10 years.[3]

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
DEEC	CI_EQUIP	National Grid	1.00	1.00	n/a	1.00	1.00	0.40	0.00
DEEC	CI_EQUIP	Eversource (NSTAR)	1.00	1.01	n/a	1.09	1.57	0.45	0.00
DEEC	CI_EQUIP	CLC	1.00	1.01	n/a	1.09	1.57	0.44	0.00
DEEC	CI_EQUIP	Unitil	1.00	1.00	n/a	1.00	1.00	0.332	0.00

In-Service Rates:

All installations have 100% in-service rates since PA programs include verification of equipment installations.

Realization Rates:
- National Grid RRs are 1.0 since there have been no impact evaluations of the prescriptive savings calculations.
- Eversource (NSTAR) & CLC energy and demand RRs from impact evaluation of NSTAR 2006 HVAC installations.[4]
- Unitil realization rates same as Unitary AC.

Coincidence Factors:

All PAs on-peak CFs based 2011 NEEP C&I Unitary AC Loadshape Project[5]

Impact Factors for Calculating Net Savings:

Measure	Initiative	PA	FR	SO_P	SO_{NP}	NTG
HVAC Upstream - Dual Enthalpy Economizer Controls	CI_EQUIP	All	0.45	0.00	0.00	0.55

NTG rates are based on the Massachusetts Commercial and Industrial Upstream HVAC/Heat Pump and Hot Water NTG and Market Effects Indicator Study. Dual Enthalpy Economizer Controls (DEEC) were not studied specifically, but the value from HVAC Upstream Unitary Air Conditioners was applied to this equipment.[6]

Non-Energy Impacts:

NEIs are based on study results.[4] [5]

Measure Name	Core Initiative	PA	Annual $ per kWh	Annual $ per Therm
Dual Enthalpy Economizer Controls (DEES)	CI_EQUIP	All	$0.095	

Endnotes:

1 : Patel, Dinesh (2001). Energy Analysis: Dual Enthalpy Control. Prepared for Eversource (NSTAR). Patel_2001_Energy_Analysis_Dual_Enthalpy_Controls

2 : Patel, Dinesh (2001). Energy Analysis: Dual Enthalpy Control. Prepared for Eversource (NSTAR). Patel_2001_Energy_Analysis_Dual_Enthalpy_Controls

3 : Energy & Resource Solutions (2005). Measure Life Study. Prepared for The Massachusetts Joint Utilities; Table 1-1 ERS_2005_Measure_Life_Study

4 : KEMA (2011). C&I Unitary HVAC Loadshape Project - Final Report. Prepared for the Regional Evaluation, Measurement & Verification Forum. KEMA_2011_CIUnitaryHVACLoadShapeProject

5 : KEMA (2011). C&I Unitary HVAC Loadshape Project - Final Report. Prepared for the Regional Evaluation, Measurement & Verification Forum. KEMA_2011_CIUnitaryHVACLoadShapeProject

6 : NMR Group, Inc. (2021). C&I Upstream HVAC & Gas Water Heating NTG Study 2021_NMR_C&I_HVAC_NTG

3.49 HVAC - Duct Insulation

Measure Code	COM-HVAC-DI
Market	Commercial
Program Type	Retrofit
Category	Heating Ventilation and Air Conditioning

Measure Description:

For existing ductwork in non-conditioned spaces, insulate ductwork. This could include replacing un-insulated flexible duct with rigid insulated ductwork and installing 1" - 2" of duct-wrap insulation.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Duct Insulation, Electric (Turnkey)	C&I Existing Building Retrofit (CI_RETRO)	EC2a130
Duct Insulation, Oil (Turnkey)	C&I Existing Building Retrofit (CI_RETRO)	EC2a131
Duct Insulation, Propane (Turnkey)	C&I Existing Building Retrofit (CI_RETRO)	EC2a132
Duct Insulation, Gas	C&I Existing Building Retrofit (CI_RETRO)	GC2a019
Duct Insulation, Gas (Turnkey)	C&I Existing Building Retrofit (CI_RETRO)	GC2a041

Algorithms for Calculating Primary Energy Impact:

Per sq ft savings based on PA internal calculations.[1]

Measure Name	ΔkWh/sq ft	ΔkW/sq ft	ΔMMBtu/sq ft
Duct Insulation, Gas			0.035
Duct Insulation, Electric	13	0.01	
Duct Insulation, Oil			0.035
Duct Insulation, Propane			0.035

Baseline Efficiency:

The baseline efficiency case is existing, uninsulated ductwork in unconditioned spaces (e.g. attic or basement).

High Efficiency:

The high efficiency condition is insulated ductwork in unconditioned spaces.

Measure Life:

The measure life is 20 years.[2]

Measure Name	Core Initiative	EUL	OYF	RUL	AML
Duct Insulation	CI_RETRO	20	n/a	n/a	20

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Duct Insulation, Gas	CI_RETRO	1.00	n/a	1.00	n/a	n/a	n/a	n/a
Duct Insulation, Electric	CI_RETRO	1.00	1.00	n/a	1.00	1.00	0.31	0.81
Duct Insulation, Oil	CI_RETRO	1.00	n/a	1.00	n/a	n/a	n/a	n/a
Duct Insulation, Propane	CI_RETRO	1.00	n/a	1.00	n/a	n/a	n/a	n/a

In-Service Rates:
All installations have 100% in service rate since programs include verification of equipment installations.

Realization Rates:
All PAs use 100% energy, demand, and non-energy realization rates.

Coincidence Factors:
Summer and winter coincidence factors are estimated using the demand allocation methodology described in the Demand Impact Model which is developed based on the Residential Baseline Study.[3]

Impact Factors for Calculating Net Savings:

Impact factors are from the 2021 C&I NTG evaluation.[4]

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Duct Insulation, Gas	CI_Retro	All	0.285	0.000	0.000	0.715
Duct Insulation, Gas (Turnkey)	CI_RETRO	All	0.369	0.00	0.032	0.663
Duct Insulation, Electric (Turnkey)	CI_Retro	All	0.077	0.013	0.004	0.940

Duct Insulation, Oil (Turnkey)	CI_Retro	All	0.077	0.013	0.004	0.940
Duct Insulation, Propane (Turnkey)	CI_Retro	All	0.077	0.013	0.004	0.940

Non-Energy Impacts:

Non-energy impact factors come from the 2021 C&I NEI evaluation.[5] NEIs for Turnkey Electric, Oil and Propane measures are referencing 2022 C&I Health and Safety NEI Study[6]

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per kWh	Annual $ per Therm	One-time $ per Therm
Duct Insulation, Gas	CI_RETRO	All					$ 0.593	
Duct Insulation, Gas (Turnkey)	CI_RETRO	All					$ 0.593	
Duct Insulation, Electric (Turnkey)	CI_RETRO	All			0.095			
Duct Insulation, Oil (Turnkey)	CI_RETRO	All			0.095			
Duct Insulation, Propane (Turnkey)	CI_RETRO	All			0.095			

Endnotes:

1 : National Grid Staff Estimate (2010). MA SBS-DI Duct Sealing and Insulation Scenario and Deemed Savings. NGrid_MA_SBS-DI_Duct_Sealing_and_Insulation_Scenario_and_Deemed_Savings_6-22-10
2 : National Grid Staff Estimate (2010). MA SBS-DI Duct Sealing and Insulation Scenario and Deemed Savings. NGrid_MA_SBS-DI_Duct_Sealing_and_Insulation_Scenario_and_Deemed_Savings_6-22-10
3 : Guidehouse (2020). Residential Baseline Study Phase 4.
2020_Guidehouse_Residential_Baseline_Phase_4
4 : NMR Group, Inc. (2018). Massachusetts Sponsor's Commercial and Industrial Free-ridership and Spillover Study. 2018_NMR_CI_FR_SP
5 : NMR Group Inc (2021). O&M and Non-O&M NEI Study. 2021_NMR_CIOM and NonOM NEI Study
6 : 2022 MA21X19-B-CIHSNEI C&I Health and Safety Non-Energy Impacts
2022_DNV_C&I_Heath_&_Safety_NEIs

3.50 HVAC - Duct Insulation - C&I Metered Multi-Family

Measure Code	COM-HVAC-DIREU
Market	Commercial
Program Type	Retrofit
Category	Heating Ventilation and Air Conditioning

Measure Description:

For existing ductwork in non-conditioned spaces, seal and insulate ductwork. This could include replacing un-insulated flexible duct with rigid insulated ductwork or sealing leaky fixed ductwork with mastic or aerosol and installing 1" – 2" of duct-wrap insulation.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Duct Insulation, Elec (Residential End Use)	C&I Existing Building Retrofit (CI_RETRO)	EC2a065
Duct Insulation, Gas (Residential End Use)	C&I Existing Building Retrofit (CI_RETRO)	GC2a059

Algorithms for Calculating Primary Energy Impact:

Deemed average annual MMBtu savings of 0.035 are assumed per unit.[1] Units are based on square feet of duct surface area.

Baseline Efficiency:

The baseline efficiency case is existing, uninsulated ductwork in unconditioned spaces (e.g. attic or basement).

High Efficiency:

The high efficiency condition is insulated ductwork in unconditioned spaces.

Measure Life:

The measure life is 20 years.[2]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Duct Insulation (Residential End Use)	CI_RETRO	All	20	n/a	n/a	20

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Duct Insulation, Gas (Residential End Use)	CI_RETRO	All	1.00	0.86	0.86	0.86	0.86	n/a	n/a
Duct Insulation, Elec (Residential End Use)	CI_RETRO	All	1.00	0.86	0.86	0.86	0.86	0.37	0.22

In-Service Rates:

All installations have 100% in-service rates since programs include verification of equipment installations.

Realization Rates:

Realization rates are based on evaluation results.[3]

Coincidence Factors:

Summer and winter coincidence factors are estimated using the demand allocation methodology described in the Demand Impact Model which is developed based on the Residential Baseline Study.[4]

Impact Factors for Calculating Net Savings:

Net-to-gross factors are from evaluation results.[5]

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Duct Insulation, Gas (Residential End Use)	CI_RETRO	All	0.14	0.0	0.0	0.86
Duct Insulation, Elec (Residential End Use)	CI_RETRO	All	0.14	0.0	0.0	0.86

Non-Energy Impacts:

There are no non-energy impacts identified for this measure.

Endnotes:

1 : National Grid Staff Estimate (2010) MA SBS-DI Duct Sealing and Insulation Scenario and Deemed Savings. NGrid_MA_SBS-DI_Duct_Sealing_and_Insulation_Scenario_and_Deemed_Savings_6-22-10
2 : National Grid Staff Estimate (2010) MA SBS-DI Duct Sealing and Insulation Scenario and Deemed Savings. NGrid_MA_SBS-DI_Duct_Sealing_and_Insulation_Scenario_and_Deemed_Savings_6-22-10
3 : Navigant Consulting (2018). Multi-Family Program Impact and Net-to-Gross Evaluation. 2018_Navigant_Multifamily_Program_Impact_Evaluation
4 : Guidehouse (2020). Residential Baseline Study Phase 4

2020_Guidehouse_Residential_Baseline_Phase_4

5 : Guidehouse (2021). Residential Programs Net-to-Gross Research of RCD and Select Products.

2021_Guidehouse_MA_Res_NTG_Final_Report

3.51 HVAC - Duct Sealing

Measure Code	COM-HVAC-DS
Market	Commercial
Program Type	Retrofit
Category	Heating Ventilation and Air Conditioning

Measure Description:

For existing ductwork in non-conditioned spaces, seal ductwork. This could include sealing leaky fixed ductwork with mastic or aerosol.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Duct Sealing, Gas	C&I Existing Building Retrofit (CI_RETRO)	GC2a020
Duct Sealing, Gas (Turnkey)	C&I Existing Building Retrofit (CI_RETRO)	GC2a040

Algorithms for Calculating Primary Energy Impact:

Unit savings are deemed based on study results:
ΔMMBtu = MMBtu x Units

Where:
Unit = Number of square feet of ductwork treated
MMBtu = Average annual MMBtu savings per unit: 0.094[1]

Baseline Efficiency:

The baseline efficiency case is existing, non-sealed (leaky) in unconditioned spaces (e.g. attic or basement).

High Efficiency:

The high efficiency condition is air sealed ductwork in unconditioned spaces.

Measure Life:

The measure life is 20 years.[2]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML

Duct Sealing	CI_RETRO	All	20	n/a	n/a	20

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Duct Sealing	CI_RETRO	All	1.00	1.00	1.00	n/a	n/a	n/a	n/a

In-Service Rates :

All installations have 100% in service rate since programs include verification of equipment installations.

Realization Rates :

All PAs use 100% energy realization rate. The summer and winter peak realization rates are not applicable for this measure since there are no electric savings claimed.

Coincidence Factors:

Not applicable for this measure since no electric savings are claimed.

Impact Factors for Calculating Net Savings:

Net-to-Gross values are based on evaluation results.[3]

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Duct Sealing	CI_RETRO	All	0.221	0.025	0.00	0.660
Duct Sealing (Turnkey)	CI_RETRO	All	0.369	0.000	0.032	0.720

Non-Energy Impacts:

Non-energy impact factors come from the 2021 C&I NEI evaluation [4]

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per kWh	Annual $ per Therm	One-time $ per Therm
Duct Sealing	CI_RETRO	All					$ 0.593	

Endnotes:

1 : National Grid Staff Estimate (2010). MA SBS-DI Duct Sealing and Insulation Scenario and Deemed Savings. NGrid_MA_SBS-DI_Duct_Sealing_and_Insulation_Scenario_and_Deemed_Savings_6-22-10
2 : National Grid Staff Estimate (2010). MA SBS-DI Duct Sealing and Insulation Scenario and Deemed Savings. NGrid_MA_SBS-DI_Duct_Sealing_and_Insulation_Scenario_and_Deemed_Savings_6-22-10

3.52 HVAC - Duct Sealing - C&I Metered Multi-Family

Measure Code	COM-HVAC-DS-REU
Market	Commercial
Program Type	Retrofit
Category	Heating Ventilation and Air Conditioning

Measure Description:

Ducts are sealed by reconnecting disconnected duct joints and sealing gaps or seams with mastic and fiber-mesh tape as appropriate.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Duct Sealing, Elec (Residential End Use)	C&I Existing Building Retrofit (CI_RETRO)	EC2a064
Duct Sealing, Gas (Residential End Use)	C&I Existing Building Retrofit (CI_RETRO)	GC2a058

Algorithms for Calculating Primary Energy Impact:

MMBtu = Annual Heating Consumption x % SAVE x 1/1,000,000

Where:
AnnualHeatingConsumption = The total annual heating consumption for the facility (Btu)
%SAVE = Average reduction in energy consumption.
1/1,000,000 = Conversion from Btu to MMBtu.

Savings Factors for Multifamily Duct Sealing[1]:

Measure Type	%SAVE
Surface Area < 50 SQFT	7%
Surface Area > 50 SQFT and < 200 SQFT	3%
Surface Area > 200 SQFT	1%

Baseline Efficiency:

The baseline efficiency case is the existing facility or equipment prior to the implementation of duct sealing.

High Efficiency:

The baseline efficiency case is the existing facility or equipment after the implementation of duct sealing.

Measure Life:

The measure life is 20 years.[2]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Duct Sealing	CI_RETRO	All	20	n/a	n/a	20

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Duct Sealing	CI_RETRO	All	1.00	0.86	0.86	0.86	0.86	0.37	0.22

In-Service Rates:

In-service rates are set to 100% for direct install measures.

Realization Rates:

The energy realization rate is based on evaluation results.[3]

Coincidence Factors:

Summer and winter coincidence factors are estimated using the demand allocation methodology described in the Demand Impact Model which is developed based on the Residential Baseline Study.[4]

Impact Factors for Calculating Net Savings:

Net to gross factors based on evaluation results.[5]

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Duct Sealing	CI_RETRO	All	0.14	0.0	0.0	0.86

Non-Energy Impacts:

NEI values are rolled up, component values can be found in Appendix B.[6]

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per	Annual $ per kWh	One-time $ per	Annual $ per	One-time $ per

				Unit		**KWh**	**Therm**	**Therm**
Duct Sealing	CI_RETRO	All	0.23	0.00	0.00	0.00	0.00	0.00

Endnotes:

1 : Savings assumptions from National Grid program vendor.

2 : GDS Associates, Inc. (2007). Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures.

GDS_2007_Measure_Life_Report_Residential_and_CI_Lighting_and_HVAC_Measures

3 : Navigant Consulting (2018). Multi-Family Program Impact and Net-to-Gross Evaluation

2018_Navigant_Multifamily_Program_Impact_Evaluation

4 : Guidehouse (2020). Residential Baseline Study Phase 4

2020_Guidehouse_Residential_Baseline_Phase_4

5 : Guidehouse (2021). Residential Programs Net-to-Gross Research of RCD and Select Products.

2021_Guidehouse_MA_Res_NTG_Final_Report

6 : NMR Group, Inc., Tetra Tech (2011). Massachusetts Special and Cross-Sector Studies Area, Residential and Low-Income Non-Energy Impacts (NEI) Evaluation.

Tetra_Tech_and_NMR_2011_MA_Res_and_LI_NEI_Evaluation

3.53 HVAC - Energy Management System

Measure Code	COM-HVAC-EMS
Market	Commercial
Program Type	Retrofit
Category	Heating Ventilation and Air Conditioning

Measure Description:

The measure is the installation of a new building energy management system (EMS) or the expansion of an existing energy management system for control of non-lighting electric and gas end-uses in an existing building on existing equipment.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Energy Management System	C&I Existing Building Retrofit (CI_RETRO)	EC2a006
Energy Management System (Turnkey)	C&I Existing Building Retrofit (CI_RETRO)	EC2a045

Algorithms for Calculating Primary Energy Impact:

Gross energy and demand savings for sequences implemented in Energy Management Systems (EMS) are estimated using a statewide BMS Calculator. The tool will estimate electric energy and demand savings, gas savings, and delivered fuel savings depending on the project and building characteristics.

Baseline Efficiency:

The baseline for this measure assumes the relevant HVAC equipment has no control. Refer to the EMS Baseline Framework in the EMS ISP study[1] for details by building type and event type.

High Efficiency:

The high efficiency case is the installation of a new EMS or the expansion of an existing EMS to control additional non-lighting electric or gas equipment. The EMS must be installed in an existing building on existing equipment.

Measure Life:

For retrofit applications, the measure life is 10 years.[2]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Energy Management System	CI_RETRO	All	10	n/a	n/a	10

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Energy Management System	CI_RETRO	All	1.00	1.00	1.00	1.00	1.00	custom	custom

In-Service Rates:
All installations have 100% in service rate since all PAs programs include verification of equipment installations.

Realization Rates:
All installations have 100% realization rate since savings are from a new calculator tool.

Coincidence Factors:
Coincidence factors are custom calculated.

Impact Factors for Calculating Net Savings:

Impact factors from 2021 C&I NTG evaluation[7].

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Energy Management System	CI_RETRO	All	17.9%	0.3%	5.4%	87.8%
Energy Management System (turnkey)	CI_RETRO	All	7.7%	1.3%	0.4%	94%

Non-Energy Impacts:

Impact factors from MA21X19-B-CIHSNEI C&I H&S NEI study

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per KWh	Annual $ per Therm	One-time $ per Therm
Energy Management System	CI_RETRO	All			$0.239			
Energy Management	CI_RETR	All			$0.239			

System (turnkey)	O							

Endnotes:

1 : Descriptions of the EMS savings calculation tools are included in the TRM Library "C&I Spreadsheet Tools" folder.

2 : Energy & Resource Solutions (2005). Measure Life Study. Prepared for The Massachusetts Joint Utilities; Table 1-1. ERS_2005_Measure_Life_Study

3 : The Fleming Group (1994). Persistence of Commercial/Industrial Non-Lighting Measures, Volume 3, Energy Management Control Systems. Prepared for New England Power Service Company
Fleming_Group_1994_Persistence_of_Commercial_Industrial_Non_Lighting_Measures_Volume_3_Energy_Management_Control_Systems

4 : RLW Analytics (2008). Business & Construction Solutions (BS/CS) Programs Measurement & Verification - 2006 Final Report. Prepared for NSTAR Electric and Gas; Table 17
RLW_2008_Business_and_Construction_Solutions_Programs_Measurement_and_Verification_2006_Final_Report

5 : DNV GL (2020). Impact Evaluation of PY 2017 Small Business Initiative Non-Lighting Measures.

6 : MA Common Assumption

7 : NMR Group, Inc. (2021). C&I Prescriptive and Custom NTG Omnibus Study
2021_NMR_C&I_Omnibus_NTG

3.54 HVAC - Furnace, Gas

Measure Code	COM-HVAC-F
Market	Commercial
Program Type	Time of Sale
Category	Heating Ventilation and Air Conditioning

Measure Description:

The installation of a high efficiency natural gas warm air furnace with an electronically commutated motor (ECM) for the fan. High efficiency furnaces are better at converting fuel into direct heat and better insulated to reduce heat loss. ECM fan motors significantly reduce fan motor electric consumption as compared to both shaped-pole and permanent split capacitor motors.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Heating System, Furnace, Gas 95% Muni	C&I New & Replacement Equipment (CI_EQUIP)	GC2b008
Heating System, Furnace, Gas 97% Muni	C&I New & Replacement Equipment (CI_EQUIP)	GC2b010

Algorithms for Calculating Primary Energy Impact:

Unit savings are deemed based on study results.[1] Updates to deemed savings, algorithms, baseline efficiency and/or high-efficiency edits are suggestions from the C&I Comprehensive TRM Review.[1]

Measure Name	ΔMMBtu
Furnace, 95%	6.7
Furnace, 97%	7.7

Baseline Efficiency:

The baseline efficiency is a blend of 82% AFUE (New Construction) and 85% AFUE (Replace on Failure).

High Efficiency:

The high efficiency scenario assumes either a gas-fired furnace equal or higher than 95% AFUE or 97% AFUE.

Measure Life:

The measure life is 18 years.[3]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Furnaces	CI_EQUIP	All	18	n/a	n/a	18

Other Resource Impacts:

There are no other resource impacts for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Furnaces	CI_EQUIP	All	1.00	1.00	1.00	n/a	n/a	0.00	0.16

In-Service Rates:

All installations have 100% in service rate since programs include verification of equipment installations.

Realization Rates:

All PAs use 100% energy realization rate.

Coincidence Factors:

Values pertain to other resource impacts for the EC motors.

Impact Factors for Calculating Net Savings:

Values are based on an evaluation study.[4]

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Furnaces	CI_EQUIP	All	37.3%	2.6%	19.1%	84.4%

Non-Energy Impacts:

Impact factors are deemed from the study results.[5] [6]

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per KWh	Annual $ per Therm	One-time $ per Therm
Furnaces	CI_EQUIP	All					$ 2.80	

Endnotes:

1 : DNV (2021). Prescriptive Measures NRNC and ISP Results. 2021_DNV_Prescriptive Measures NRNC and ISP Results

2 : ERS (2011), Pilot Evaluation of BFM DRAFT. Results as of 9/29/2011. The savings values for the BFM come from Page 1, Table 1 of the BFM impact evaluation filed with the Annual Report. While this report was only to provide savings for the BFM - -the original savings used by the PA's 600 kWh and .116 kW were used for both the BFM and ECM. When the BFM study was almost complete we asked the evaluation team if it were possible to come up with savings for the ECM motor; they calculated the 168 kWh using data from the BFM onsites, after several discussions the evaluation team determined the ECM motor was a different measure than the BFM so the calculations were not 100% accurate. They note that while the 600 kWh was too high, the 168 may be on the low side but could not confirm without an evaluation of the ECM. PA's determined while we did not have an evaluation for the 168 it was probably a more realistic number than the 600.

3 : ASHRAE Applications Handbook (2003); Page 36.3

4 : NMR Group, Inc. (2018). Massachusetts Sponsor's Commercial and Industrial Free-ridership and Spillover Study. 2018_NMR_CI FR-SO Report

5 : DNVGL (2016). Commercial and Industrial New Construction Non-Energy Impacts Study DNVGL_2016_CI_NC_NEI

6 : NMR Group Inc (2021). O&M and Non-O&M NEI Study. 2021_NMR_CIOM and NonOM NEI Study

3.55 HVAC - Heat Pump - C&I Multi-Family

Measure Code	COM-HVAC-HP-C
Market	Commercial
Program Type	Retrofit
Category	Heating Ventilation and Air Conditioning

Measure Description:

Installation of a custom heat pump to displace electric heat.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Custom - Heat Pumps displacing Electric Heat (Residential End Use)	C&I Existing Building Retrofit (CI_RETRO)	EC2a108

Algorithms for Calculating Primary Energy Impact:

Savings will be calculated by the vendor based on existing site conditions.

Baseline Efficiency:

The baseline efficiency case is the existing site conditions.

High Efficiency:

The high efficiency case will vary by site.

Measure Life:

The measure life will vary depending on the type of equipment installed.

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Custom Heat Pumps, Displacing Electric Heat (Residential End	CI_RETRO	All	1.00	1.00	1.00	1.00	1.00	0.00	0.43

Use)									

In-Service Rates:

All installations have 100% in service rate since all PAs programs include verification of equipment installations.

Realization Rates:

Realization rates are set to 100% because the measure is new and has not been evaluated.

Coincidence Factors:

Summer and winter coincidence factors are estimated using the demand allocation methodology described in the Demand Impact Model which is developed based on the Residential Baseline Study.[1]

Impact Factors for Calculating Net Savings:

Net-to-Gross rates are set to 100% because the measure is new and has not been evaluated.

Measure Name	Core Initiative	PA	FR	SO$_P$	SO$_{NP}$	NTG
Custom Heat Pumps, Displacing Electric Heat (Residential End Use)	CI_RETRO	All	0.00	0.00	0.00	1.00

Non-Energy Impacts:

NEI values are rolled up, component values can be found in Appendix B.[2]

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per kWh	Annual $ per Therm	One-time $ per Therm
Custom Heat Pumps, Displacing Electric Heat (Residential End Use)	CI_RETRO	All			$0.05			

Endnotes:

1 : Guidehouse (2020). Residential Baseline Study Phase 4.
2020_Guidehouse_Residential_Baseline_Phase_4
2 : NMR Group, Inc. (2021). C&I O&M and Non-O&M Non-Energy Impacts Study 2021_NMR_CIOM and NonOM NEI Study

3.56 HVAC - Heat Pump System

Measure Code	COM-HVAC-HPS
Market	Commercial
Program Type	Replace on Burnout
Category	Heating Ventilation and Air Conditioning

Measure Description:

This measure applies to the installation of high-efficiency heat pumps used for space cooling in C&I applications. This includes air cooled, water source, ground water source, ground source, variable refrigerant flow, and mini-split heat pumps.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Midstream - Heat Pump Systems	C&I New & Replacement Equipment (CI_EQUIP)	EC2b052
Midstream - VRF	C&I New & Replacement Equipment (CI_EQUIP)	EC2b087

Algorithms for Calculating Primary Energy Impact:

Unit savings are deemed based on a model1 developed to estimate the savings associated with the displacement of existing heating (and cooling) systems by CBECS building type.

Measure	Core Initiative	Electric Savings (kWh/ton)
Midstream - Heat Pump Systems	C&I New & Replacement Equipment (CI_EQUIP)	286
Midstream - VRF	C&I New & Replacement Equipment (CI_EQUIP)	72

Baseline Efficiency:

Baseline efficiencies are equal to code for VRF, while ISP is used in place of code for the other heat pump systems. To determine ISP, a factor of 1.03 was applied for cooling to IECC specified efficiencies.

A comprehensive table of baseline equipment types and efficiencies can be found starting on page 22 of the Energy Optimization Model Update study report[1].

High Efficiency:

The actual installed equipment/program data for 2022-Q1 2023 was used to set the high efficiency case in the model[1].

Measure Life:

The measure life is 12 years.[2]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Midstream Heat Pumps	CI_EQUIP	All	12	n/a	n/a	12

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Midstream - Heat Pump Systems	CI_EQUIP	All	1.00	1.00	1.00	1.00	1.00	0.00	1.00
Midstream - VRF	CI_EQUIP	All	1.00	1.00	1.00	1.00	1.00	0.00	1.00

In-Service Rates:

All installations have 100% in-service rates since all PAs programs include verification of equipment installations.

Realization Rates:

Realization rates are assumed 100% as impacts are based on evaluated results.

Coincidence Factors:

Coincidence factors are calculated to reflect blend of heating and cooling.

Impact Factors for Calculating Net Savings:

Midstream Heat Pump Systems and VRFs are based on a HVAC Upstream study which developed statewide net-to-gross results.[3] Midstream PTHP, which is a newer measure, reflects a NTG from the Omnibus NTG study[4]

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Midstream - Heat Pump Systems	CI_EQUIP	All	45.0%	0.0%	0.0%	55.0%
Midstream - VRF	CI_EQUIP	All	70.0%	0.0%	0.0%	30.0%

Non-Energy Impacts:

Non-energy impacts are based on MA21X19-B-CIHSNEI C&I H&S NEI study results.[5]

Measure Name	Core Initiative	PA	Annual $ per kWh
Midstream - Heat Pump Systems	CI_EQUIP	All	0.095
Midstream - VRF	CI_EQUIP	All	0.095

Endnotes:

1 : For equipment with cooling capacities less than 65 kBtu/h, it is assumed that the heating capacity and cooling capacity are equal.

2 : For Air Source HPs: Heating Capacity = Cooling Capacity * 13,900/12,000 (ratio of heat produced in heating mode to cooling produced in cooling mode). For Water/Ground Source HPs: Heating Capacity = Cooling Capacity * COP/EER (converts the rated cooling output to the rated heating output.

3 : The capacity adjustment factor is used only when IEER is used to determine energy savings. Since IEER takes into account performance at different loading points, the capacity adjustment factor helps to account for the fact that more load occurs at lower temperatures and capacities. The adjustment factor is greater than 1 for climate zones with lower full load hours and runtime, and the factor is less than 1 for zones with more full load hours and runtime.

4 : KEMA (2011). C&I Unitary AC Loadshape Project - Final Report. KEMA_2011_CIUnitaryHVACLoadShapeProject

5 : DNV GL (2014). Memo – Develop Modified Runtime from NEEP HVAC Loadshape Study. Capacity Factors are weighted using information about PA specific load zones. DNVGL_2014_Memo_Modified_Hours_NEEP_HVAC_Loadshape_Study

6 : DNV GL (2018). Expected Useful Life (EUL) Estimation for Air-Conditioning Equipment from Current Age Distribution Memo. 2018_DNVGL_P73_EUL_Estimation_Results_to_Date

7 : The Fleming Group (1994). Persistence of Commercial/Industrial Non-Lighting Measures, Volume 2, Energy Efficient HVAC and Process Cooling Equipment. Fleming_Group_1994_Persistence_of_Commercial_Industrial_Non_Lighting_Measures_Volume_2_Energy_Efficiency_HVAC_and_Process

8 : RLW Analytics (2008). Business & Construction Solutions (BS/CS) Programs Measurement & Verification - 2006 Final Report. Prepared for NSTAR Electric and Gas; Table 17. RLW_2008_Business_and_Construction_Solutions_Programs_Measurement_and_Verification_2006_Final_Report

9 : KEMA (2011). C&I Unitary HVAC LoadShape Project – Final Report. Prepared for the Regional Evaluation, Measurement & Verification Forum. KEMA_2011_CIUnitaryHVACLoadShapeProject

4 : NMR Group Inc. (2021). C&I Upstream HVAC Net-to-Gross Study. 2021_NMR_C&I_HVAC_NTG

4 : NMR Group Inc. (2021). C&I Upstream HVAC Net-to-Gross Study. 2021_NMR_C&I_HVAC_NTG

5 : DNV (2022). C&I Health & Safety NEIs. 2022_DNV_C&I_Heath_&_Safety_NEIs

6 : NMR Group, Inc. (2021). C&I O&M and Non-O&M NEIs. 2021_NMR_CIOM and NonOM NEI Study

3.57 HVAC - Heat Pump Water Heater

Measure Code	COM-HVAC-HPWH
Market	Commercial
Program Type	Retrofit
Category	Water Heating

Measure Description:

Midstream heat pump water heater (displacing elec/oil/propane)

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Midstream - Heat Pump Water Heater displacing Electric Resistance	C&I New & Replacement Equipment (CI_EQUIP)	EC2b148
Midstream - Heat Pump Water Heater displacing Oil	C&I New & Replacement Equipment (CI_EQUIP)	EC2b149
Midstream - Heat Pump Water Heater displacing Propane	C&I New & Replacement Equipment (CI_EQUIP)	EC2b150

Algorithms for Calculating Primary Energy Impact:

Annual Electric Energy Savings
$$\Delta kWh = units \times GPD \times 365 \times 8.33 \times \frac{\Delta Tmain}{3{,}412} \times \left(\frac{FeDHW}{UEFbaseline} - \frac{1}{UEFee \times Fderate} \right) + \Delta kWhcooling - \Delta kWhheating$$
$$\Delta kWhcooling = units \times GPD \times 365 \times 8.33 \times \frac{\Delta Tmain}{3{,}412} \times \frac{1}{UEFee} \times FLoc \times \frac{FCool}{SEER/3.412}$$
$$\Delta kWhheating = units \times GPD \times 365 \times 8.33 \times \frac{\Delta Tmain}{3{,}412} \times \frac{1}{UEFee} \times FLoc \times FElecHeat \times \frac{FHeat}{HSPF/3.412}$$

Peak Coincident Demand Savings
$$\Delta kW = units \times (\Delta kW/unit)$$

MMBtu savings

ΔMMBtu=(GPD $\times$ D days/year $\times$ 8.33 lb/gal $\times$ ΔT $\times$ (1/COPb - 1/COPh) $\div$1,000,000 Btu/MMBtu) - Q_(net.space)

ΔT=Th – Tm

Term	Definition
GPD	Gallons per Day
ΔkWh	Annual electricity savings
ΔT	Temperature difference of water main and hot water temperatures
Tm	Water main temperature
Th	Hot water set temperature
COPb	Baseline water heater efficiency
COPh	High efficiency water heater efficiency
D	Days per year

The calculation methodology utilizes the standard energy calculation for water heating and accounts for heat pump water heater effects on space conditioning using the net thermal impact on the space. Since heat pump water heaters utilize heat from within a conditioned space equal to the amount of heat required for heating the water, the estimated hot water load was utilized to calculate the amount of heat removed from the building by the heat pump water heater. Section 4.6 of the NREL study listed in the sources provides further explanation to this methodology. Run hours from the MA eTRM commercial HVAC entries were used to determine % of time a building is heating and cooling based on effective full load hours (HVAC effects tab). Water use assumptions are based on the 2019 water heating evaluation and utilize the five categories defined (low, medium, high, multifamily, manufacturing).

Savings Summary / Examples:

PA	Baseline COP	Measure COP	Cold Water Temp	Warm Water Temp	Delta T	Weighted Average Annual Use (Gallons)	lbs/Gal	Total Annual Water Heating Load (MMBtu)	Baseline Electric Annual Energy Use (kWh)	Heating Penalty (kWh)	Cooling Bonus (kWh)	Proposed Electric HPWH Annual Energy Use (kWh)	Annual Water Heating kWh Savings	Peak Demand Savings (kW)	Total Electric Savings (kWh)
120 Gal Commercial Heat Pump Water Heater, Electric Resistance Replacement															
All	1.94	4.2	55	140	85	36,302	8.33	25.7	3,875.2	0.0*	0.0	1,793.7	2,082	0.19	2,082
<55 Gal Heat Pump Water Heater, Electric Resistance Replacement															
NGRID	0.95	3.2	55	140	85	29,444	8.33	20.8	6,465.8	-156.0	0.0	1,909.4	4,556	0.41	4,400

PA	Baseline COP	Measure COP	Cold Water Temp	Warm Water Temp	Delta T	Weighted Average Annual Use (Gallons)	lbs/Gal	Total Annual Water Heating Load (MMBtu)	Baseline Electric Annual Energy Use (kWh)	Heating Penalty (kWh)	Cooling Bonus (kWh)	Proposed Electric HPWH Annual Energy Use (kWh)	Annual Water Heating kWh Savings	Peak Demand Savings (kW)	Total Electric Savings (kWh)
CLC	0.95	3.2	55	140	85	29,444	8.33	20.8	6,465.8	0.0	2,304.1	1,909.4	4,556	0.41	6,861
Unitil	0.95	3.2	55	140	85	29,444	8.33	20.8	6,465.8	-1,682.5	0.0	1,909.4	4,556	0.41	2,874
ES West	0.95	3.2	55	140	85	29,444	8.33	20.8	6,465.8	-1,682.5	0.0	1,909.4	4,556	0.41	2,874
ES East	0.95	3.2	55	140	85	29,444	8.33	20.8	6,465.8	0.0	2,304.1	1,909.4	4,556	0.41	6,861
55-80 Gal Heat Pump Water Heater, Electric Resistance Replacement															
All	1.98	3.2	55	140	85	29,444	8.33	20.8	3,080.4	0.0*	0.0	1,909.4	1,171	0.11	1,171

* Assumed no interactive HVAC effects since baseline equipment is a heat pump.

PA	Baseline COP	Measure COP	Cold Water Temp	Warm Water Temp	Delta T	Weighted Average Annual Use (Gallons)	lbs/Gal	Total Annual Water Heating Load (MMBtu)	Baseline Natural Gas Consumption (Therms)	Heating Penalty (Therms)	Cooling Bonus (kWh)	Annual Water Heating MMBtu Savings	Peak Demand Increase (kW)	Total Natural Gas Savings (Therms)	Proposed Electric HPWH Annual Energy Use (kWh)
120 Gal Commercial Heat Pump Water Heater, Gas Storage WH Replacement															
NGRID	0.80	4.2	55	140	85	36,302	8.33	25.7	321.3	-6.6	0.0	26.01	-15.6	327.9	1,793.7
CLC	0.80	4.2	55	140	85	36,302	8.33	25.7	321.3	0.0	2,840.8	26.01	-15.6	321.3	1,793.7
Unitil	0.80	4.2	55	140	85	36,302	8.33	25.7	321.3	-70.8	0.0	26.01	-15.6	392.1	1,793.7
ES West	0.80	4.2	55	140	85	36,302	8.33	25.7	321.3	-70.8	0.0	26.01	-15.6	392.1	1,793.7
ES East	0.80	4.2	55	140	85	36,302	8.33	25.7	321.3	0.0	2,840.8	26.01	-15.6	321.3	1,793.7
50-80 Gal Commercial Heat Pump Water Heater, Gas Storage WH Replacement															

PA															
NGRID	0.80	3.2	55	140	85	29,444	8.33	20.8	260.6	-5.3	0.0	19.55	-5.7	265.9	1,909.4
CLC	0.80	3.2	55	140	85	29,444	8.33	20.8	260.6	0.0	2,304.1	19.55	-5.7	260.6	1,909.4
Unitil	0.80	3.2	55	140	85	29,444	8.33	20.8	260.6	-57.4	0.0	19.55	-5.7	318.0	1,909.4
ES West	0.80	3.2	55	140	85	29,444	8.33	20.8	260.6	-57.4	0.0	19.55	-5.7	318.0	1,909.4
ES East	0.80	3.2	55	140	85	29,444	8.33	20.8	260.6	0.0	2,304.1	19.55	-5.7	260.6	1,909.4

PA	Baseline COP	Measure COP	Cold Water Temp	Warm Water Temp	Delta T	Weighted Average Annual Use (Gallons)	lbs/Gal	Total Annual Water Heating Load (MMBtu)	Baseline Propane Consumption (MMBtu)	Heating Penalty (MMBtu)	Cooling Bonus (kWh)	Annual Water Heating MMBtu Savings	Peak Demand Increase (kW)	Total Propane Savings (MMBtu)	Proposed Electric HPWH Annual Energy Use (kWh)
120 Gal Commercial Heat Pump Water Heater, Propane Storage WH Replacement															
NGRID	0.8	4.2	55	140	85	36,302	8.33	25.7	32.1	-0.7	0.0	26.01	-15.6	32.8	1,793.7
CLC	0.8	4.2	55	140	85	36,302	8.33	25.7	32.1	0.0	2,840.8	26.01	-15.6	32.1	1,793.7
Unitil	0.8	4.2	55	140	85	36,302	8.33	25.7	32.1	-7.1	0.0	26.01	-15.6	39.2	1,793.7
ES West	0.8	4.2	55	140	85	36,302	8.33	25.7	32.1	-7.1	0.0	26.01	-15.6	39.2	1,793.7
ES East	0.8	4.2	55	140	85	36,302	8.33	25.7	32.1	0.0	2,840.8	26.01	-15.6	32.1	1,793.7
50-80 Gal Commercial Heat Pump Water Heater, Propane Storage WH Replacement															
NGRID	0.8	3.2	55	140	85	29,444	8.33	20.8	26.1	-0.5	0.0	19.55	-5.7	26.6	1,909.4
CLC	0.8	3.2	55	140	85	29,444	8.33	20.8	26.1	0.0	2,304.1	19.55	-5.7	26.1	1,909.4
Unitil	0.8	3.2	55	140	85	29,444	8.33	20.8	26.1	-5.7	0.0	19.55	-5.7	31.8	1,909.4
ES West	0.8	3.2	55	140	85	29,444	8.33	20.8	26.1	-5.7	0.0	19.55	-5.7	31.8	1,909.4
ES East	0.8	3.2	55	140	85	29,444	8.33	20.8	26.1	0.0	2,304.1	19.55	-5.7	26.1	1,909.4

PA	Baseline COP	Measure COP	Cold Water Temp	Warm Water Temp	Delta T	Weighted Average Annual Use (Gallons)	lbs/Gal	Total Annual Water Heating Load (MMBtu)	Baseline Fuel Oil Consumption (MMBtu)	Heating Penalty (MMBtu)	Cooling Bonus (kWh)	Annual Water Heating MMBtu Savings	Peak Demand Increase (kW)	Total Fuel Oil Savings (MMBtu)	Proposed Electric HPWH Annual Energy Use (kWh)
120 Gal Commercial Heat Pump Water Heater, Oil Storage WH Replacement															
NGRID	0.8	4.2	55	140	85	36,302	8.33	25.7	32.1	-0.7	0.0	26.01	-15.6	32.8	1,793.7
CLC	0.8	4.2	55	140	85	36,302	8.33	25.7	32.1	0.0	2,840.8	26.01	-15.6	32.1	1,793.7
Unitil	0.8	4.2	55	140	85	36,302	8.33	25.7	32.1	-7.1	0.0	26.01	-15.6	39.2	1,793.7
ES West	0.8	4.2	55	140	85	36,302	8.33	25.7	32.1	-7.1	0.0	26.01	-15.6	39.2	1,793.7
ES East	0.8	4.2	55	140	85	36,302	8.33	25.7	32.1	0.0	2,840.8	26.01	-15.6	32.1	1,793.7
50-80 Gal Commercial Heat Pump Water Heater, Oil Storage WH Replacement															
NGRID	0.80	3.20	55.0	140.0	85.0	29,444	8.33	20.8	26.1	-0.5	0.0	19.55	-5.7	26.6	1,909.4
CLC	0.80	3.20	55.0	140.0	85.0	29,444	8.33	20.8	26.1	0.0	2,304.1	19.55	-5.7	26.1	1,909.4

Sources: 2018 Navigant Water Heater Analysis Memo, NY TRM, and NREL Field Performance of Heat Pump Water Heaters in the Northeast

Baseline Efficiency:

Code baseline is IECC 2018 (Minimum Performance of Water-Heating Equipment).

Equipment Type	**Baseline** (from 2018 IECC)	**Measure Eligibility / Qualifications**
Commercial <55 Gallon Electric Heat Pump Water Heater, Electric Baseline	0.95 UEF	UEF of 3.2 or greater
Commercial 55-80 Gallon Electric Heat Pump Water Heater, Electric Baseline	1.98 UEF	UEF of 3.2 or greater
Commercial 120 Gallon Electric Heat Pump Water Heater, Electric Baseline	1.94 UEF	Electric heat pump water heater with 120 gallon storage tank and minimum COP of 3.6

Equipment Type	Baseline (from 2018 IECC)	Measure Eligibility / Qualifications
Commercial 55-80 Gallon Electric Heat Pump Water Heater, Natural Gas Water Heater Replacement	80% Thermal Efficiency	UEF of 3.2 or greater
Commercial 120 Gallon Electric Heat Pump Water Heater, Natural Gas Water Heater Replacement	80% Thermal Efficiency	Electric heat pump water heater with 120 gallon storage tank and minimum COP of 3.6
Commercial 55-80 Gallon Electric Heat Pump Water Heater, Propane Water Heater Replacement	80% Thermal Efficiency	UEF of 3.2 or greater
Commercial 120 Gallon Electric Heat Pump Water Heater, Propane Water Heater Replacement	80% Thermal Efficiency	Electric heat pump water heater with 120 gallon storage tank and minimum COP of 3.6
Commercial 55-80 Gallon Electric Heat Pump Water Heater, Fuel Oil Water Heater Replacement	80% Thermal Efficiency	UEF of 3.2 or greater
Commercial 120 Gallon Electric Heat Pump Water Heater, Fuel Oil Water Heater Replacement	80% Thermal Efficiency	Electric heat pump water heater with 120 gallon storage tank and minimum COP of 3.6

Measure Life:

The measure life is 13 years (same as MA eTRM residential heat pump water heater measure)

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Midstream - Heat Pump Water Heater	CI_EQUIP	All	13	n/a	n/a	13

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Midstream - Heat Pump Water Heater	CI_EQUIP	All	1.00	1.00	1.00	1.00	1.00	n/a	n/a

Impact Factors for Calculating Net Savings:

Net savings impact factors from 2021 C&I HVAC & Water Heater NTG study (storage water heater)

Measure Name	Core Initiative	PA	FR	SO$_P$	SO$_{NP}$	NTG
Midstream - Heat Pump Water Heater	CI_EQUIP	All	0.71	0.00	0.09	0.29

Non-Energy Impacts:

NEIs are based on study results.[5] [6]

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per KWh	Annual $ per Therm	One-time $ per Therm
Midstream - Heat Pump Water Heater displacing Electric Resistance	CI_EQUIP	All			$0.095			
Midstream - Heat Pump Water Heater displacing Oil	CI_EQUIP	All			$0.095			
Midstream - Heat Pump Water Heater displacing Propane	CI_EQUIP	All			$0.095			

3.58 HVAC - High Efficiency Chiller

Measure Code	COM-HVAC-HEC
Market	Commercial
Program Type	Retrofit
Category	Heating Ventilation and Air Conditioning

Measure Description:

This measure promotes the installation of efficient water-cooled and air-cooled water chilling packages for comfort cooling applications. Eligible chillers include air-cooled, water cooled rotary screw and scroll, and water cooled centrifugal chillers for single chiller systems or for the lead chiller only in multi-chiller systems.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
High Efficiency Chiller -- IPLV	C&I New Buildings & Major Renovations (CI_NB&MR)	EC1a011
High Efficiency Chiller -- FL	C&I New Buildings & Major Renovations (CI_NB&MR)	EC1a012
High Efficiency Chiller -- IPLV	C&I New & Replacement Equipment (CI_EQUIP)	EC2b010
High Efficiency Chiller -- FL	C&I New & Replacement Equipment (CI_EQUIP)	EC2b011

Algorithms for Calculating Primary Energy Impact:

Gross energy and demand savings for chiller installations may be custom calculated using the PA's chillers savings calculation tool as is the case for Eversource who uses their own tool to custom calculate savings. These tools are used to calculated energy and demand savings based on site-specific chiller plant details including specific chiller plan equipment, operational staging, operating load profile and load profile.

Alternatively, the energy and demand savings may be calculated using the following algorithms and inputs. Please note that consistent efficiency types (FL or IPLV) must be used between the baseline and high efficiency cases. It is recommended that IPLV be used over FL efficiency types when possible.

Air-Cooled Chillers:
$$kWh = Tons * (12/EER_{base} - 12/EER_{ee}) * Hours$$
$$kW = Tons * (12/EER_{base} - 12/EER_{ee})$$

Water-Cooled Chillers:

kWh = Tons * (kWtonbase - kWtonee) * Hours

kW = Tons * (kWtonbase - kWtonee) * (LF/100)

Where:

Tons = Rated capacity of the cooling equipment

EERBASE = Energy Efficiency Ratio of the baseline equipment. See table below for values.

EEREE = Energy Efficiency Ratio of the efficient equipment. Site-specific.

kW/tonBASE = Energy efficiency rating of the baseline equipment. See table below for values.

kW/tonEE = Energy efficiency rating of the efficient equipment. Site-specific.

Hours = Equivalent full load hours for chiller operation

Baseline Efficiency:

The baseline efficiency case assumes compliance with the efficiency requirements as mandated by Massachusetts State Building Code. As described in Chapter 13 of the aforementioned document, energy efficiency must be met via compliance with the International Energy Conservation Code (IECC) 2015.

The table below details the specific efficiency requirements by equipment type and capacity.

Chiller - Minimum Efficiency Requirements[1]:

Equipment Type	Size Category (Tons)	Units	Path A	Path A	Path B	Path B
			Full Load	IPLV	Full Load	IPLV
Air-cooled chillers	<150	EER (Btu/W)	10.16	13.78	9.76	15.89
Air-cooled chillers	≥150	EER (Btu/W)	10.16	14.08	9.76	16.20
Water cooled, electrically operated positive displacement	<75	kW/ton	0.746	0.596	0.775	0.497
Water cooled, electrically operated positive displacement	≥75 and <150	kW/ton	0.716	0.557	0.746	0.487
Water cooled, electrically operated positive displacement	≥150 and <300	kW/ton	0.656	0.537	0.676	0.437
Water cooled, electrically operated positive displacement	≥300 and <600	kW/ton	0.606	0.517	0.621	0.408
Water cooled, electrically operated positive displacement	≥600	kW/ton	0.557	0.497	0.581	0.378

Equipment Type	Size Category (Tons)	Units	Path A	Path A	Path B	Path B
			Full Load	IPLV	Full Load	IPLV
Water cooled, electrically operated centrifugal	<150	kW/ton	0.606	0.547	0.691	0.437
Water cooled, electrically operated centrifugal	≥150 and <300	kW/ton	0.606	0.547	0.631	0.398
Water cooled, electrically operated centrifugal	≥300 and <400	kW/ton	0.557	0.517	0.591	0.388
Water cooled, electrically operated centrifugal	≥400 and <600	kW/ton	0.557	0.497	0.581	0.378
Water cooled, electrically operated centrifugal	≥600	kW/ton	0.557	0.497	0.581	0.378

Note: Compliance with this standard may be obtained by meeting the minimum requirements of Path A or B, however, both the Full Load and IPLV must be met to fulfill the requirements of Path A or B.

High Efficiency:

The high efficiency scenario assumes water chilling packages that exceed the efficiency levels required by Massachusetts State Building Code and meet the minimum efficiency requirements as stated in the New Construction HVAC energy efficiency rebate forms.

Measure Life:

The measure life is 23 years[2] .

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Chillers – IPLV used	CI_NB&MR CI_EQUIP	All	1.00	1.00	1.00	1.00	1.00	0.49	0.06
Chillers – FL used	CI_NB&MR CI EQUIP	All	1.00	2.63	2.63	1.00	1.00	0.86	0.10

In-Service Rates:

All installations have 100% in service rate since all PAs programs include verification of equipment installations.

Realization Rates:
RRs based on statewide prospective results from 2015 prescriptive chiller study[3] . Realization rates assume PA use of the prescriptive algorithms detailed above.

Coincidence Factors:
CFs based on prospective statewide results from 2015 prescriptive chiller study4 . Coincidence factors assume PA use of the prescriptive algorithms detailed above.

Impact Factors for Calculating Net Savings:

All PAs use Statewide net-to-gross results[5] . Net savings factors for CI_NB&MR initiative are based on 2021 NRNC Study (paths 3&4)[6] . Net savings factors for CI_EQUIP initiative are based on 2021 Omnibus NTG Study (prescriptive).

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
High Efficiency Chiller - IPLV	CI_NB&MR	All	58.3%	22.7%		64.4%
High Efficiency Chiller - FL	CI_NB&MR	All	58.3%	22.7%		64.4%
High Efficiency Chiller - IPLV	CI_EQUIP	All	25.0%	0.2%	8.5%	84.0%
High Efficiency Chiller - FL	CI_EQUIP	All	25.0%	0.2%	8.5%	84.0%

Non-Energy Impacts:

Measure Name	Core Initiative	PA	Annual $ per kWh	Annual $ per Therm
High Efficiency Chiller - IPLV	CI_NB&MR, CI_EQUIP	All	$0.135	
High Efficiency Chiller - FL	CI_NB&MR, CI_EQUIP	All	$0.135	

Endnotes:

1 : DNV (2021). HVAC Chiller Industry Standard Practice Memo 2021_DNV_Chiller_ISP_Memo
2 : GDS Associates, Inc. (2007). Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures.
GDS_2007_Measure_Life_Report_Residential_and_CI_Lighting_and_HVAC_Measures
3 : DNV GL (2015). Impact Evaluation of Prescriptive Chiller and Compressed Air Installations.

Prepared for the MA PAs and EEAC. DNVGL_2015_Impact_Eval_Prescriptive_Chiller_CAIR_FINAL

4 : DNV GL (2015). Impact Evaluation of Prescriptive Chiller and Compressed Air Installations. Prepared for the MA PAs and EEAC. DNVGL_2015_Impact_Eval_Prescriptive_Chiller_CAIR_FINAL

5 : NMR Group, Inc. (2021). C&I Prescriptive and Custom NTG Omnibus Study 2021_NMR_C&I_Omnibus_NTG

6 : NMR Group, Inc. (2021). Non Residential New Construction NTG Report. 2021_NMR_Non_Residential_New_Construction_NTG_Report

3.59 HVAC - High-Efficiency Condensing Unit

Measure Code	COM-HVAC-HECU
Market	Commercial
Program Type	Retrofit
Category	Heating Ventilation and Air Conditioning

Measure Description:

Upstream high efficiency condensing unit (HECU) captures the savings attributed to an upstream commercial refrigeration condensing unit. Applicable to condensing units serving Low (0°F) and Medium (32°F) conditioned environments, an efficient condensing unit is defined by units incorporating three requisite attributes: an efficient scroll compressor, floating head pressure controls, and modulating compressor fan speed capabilities (for analysis purposes low/high speed capabilities are assumed, however some units are equipped with variable speed drives that would realize additional savings). The collective effect of these three features results in the refrigeration load requirements being met while using less power as compared to the baseline unit. Units with compressor horsepower ratings in the range of 1-5hp are eligible to participate in the upstream initiative. Eligibility is limited to outdoor units. Savings claimed assume the efficient unit replaces a baseline outdoor unit, however it's worth noting that a customer replacing an indoor unit with an outdoor unit would likely realize additional savings.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Midstream - High-Efficiency Condensing Unit	C&I New & Replacement Equipment (CI_EQUIP)	EC2b095

Algorithms for Calculating Primary Energy Impact:

For the upstream HECU measure, prescriptive deemed savings are claimed based on a unit's temperature appliation, power phase requirements and compressor horsepower rating. For the purposes of the TRM, horsepower ratings are specified in 1/2 horsepower increments. In the event a qualifying unit falls somewhere in the middle of an established category, it will be assigned to the closest category with the most conservative total kWh savings.

HECU Electric Demand Savings

The tabulated energy savings values for each of the three components of the HECU (scroll compressor, compressor fans, floating head pressure controls) were divided by their respective annual full load operation hours, as described in the following table[x]:

Component	Annual Full Operating Hours	Source

Component	Annual Full Operating Hours	Source
Scroll Compressor	2913 (w/ Economizer), 3910 (w/o Economizer)	EVT Refrigeration Analysis Tool (CATInput worksheet)
Compressor Fan(s)	6087	As derived in HECU Compressor Fan Loadshape F
Floating Head Pressure Controls	7221	EVT Refrigeration Analysis Tool (CATInput worksheet)

The resulting connected load savings is shown in the following table. Units are in kW. For the purposes of coincident peak demand savings claims, the savings for each component will be treated separately against its respective loadshape, as described in the load shape section.

Temp	Phase	HP	Scroll Compressor	Condenser Fan(s)	Floating Head Pressure Controls	Total
Medium	1	1	0.21997	0.07605	0.12982	0.42585
		1.5	0.16477	0.08149	0.15421	0.40047
		2	0.19216	0.09504	0.17984	0.46704
		2.5	0.22508	0.11132	0.21065	0.54705
		3	0.21755	0.14153	0.28241	0.64149
		3.5	0.30964	0.16165	0.30956	0.78086
		4	0.34246	0.17879	0.34237	0.86362
		4.5	0.34856	0.18197	0.34847	0.87901
		5	0.22508	0.18197	0.38505	0.82928
	3	1	0.15623	0.06806	0.11695	0.34125
		1.5	0.13245	0.07799	0.14330	0.35374
		2	0.15447	0.09095	0.16712	0.41255
		2.5	0.18093	0.10654	0.19576	0.48323
		3	0.18620	0.13028	0.24637	0.56284
		3.5	0.27717	0.14907	0.26912	0.69535
		4	0.30654	0.16487	0.29764	0.76905
		4.5	0.31200	0.16780	0.30294	0.78275

Temp	Phase	HP	Scroll Compressor	Condenser Fan(s)	Floating Head Pressure Controls	Total
		5	0.27084	0.18512	0.34883	0.80478
Low	1	2	0.12604	0.09116	0.16728	0.38449
		2.5	0.11317	0.10645	0.20257	0.42219
		3	0.12627	0.11877	0.22601	0.47105
		3.5	0.15284	0.14376	0.27357	0.57016
		4.5	0.15564	0.15828	0.30390	0.61783
	3	2	0.09065	0.08296	0.15547	0.32908
		2.5	0.09374	0.09918	0.18896	0.38187
		3	0.10458	0.11065	0.21082	0.42606
		3.5	0.12659	0.13394	0.25518	0.51571
		4.5	0.16792	0.15403	0.28875	0.61070

HECU Electric Energy Savings

The following table outlines the energy savings associated with each specified unit. Units are in kWh. For the purposes of screening, the savings for each component will be treated separately against its respective loadshape, as described in the Load Shape section.

Temp	Phase	HP	Scroll Compressor	Condenser Fan(s)	Floating Head Pressure Controls	Total
Medium	1	1	838.1	462.9	937.5	2238.5
		1.5	627.8	496.0	1113.5	2237.4
		2	732.2	578.5	1298.6	2609.3
		2.5	857.6	677.6	1521.1	3056.3
		3	828.9	861.5	2039.3	3729.7
		3.5	1179.8	984.0	2235.4	4399.1
		4	1304.9	1088.3	2472.3	4865.4
		4.5	1328.1	1107.7	2516.3	4952.1
		5	971.9	1151.4	2780.5	4903.8

Temp	Phase	HP	Scroll Compressor	Condenser Fan(s)	Floating Head Pressure Controls	Total
	3	1	595.3	414.3	844.5	1854.1
		1.5	504.7	474.7	1034.8	2014.2
		2	588.6	553.6	1206.8	2349.0
		2.5	689.4	648.5	1413.6	2751.4
		3	709.4	793.0	1779.0	3281.5
		3.5	1056.0	90.4	1943.3	3906.7
		4	1168.0	1003.5	2149.3	4320.8
		4.5	1188.8	1021.4	2187.6	4397.8
		5	1032.0	1126.8	2518.9	4677.6
Low	1	2	521.7	554.9	1208.0	2284.5
		2.5	468.4	648.0	1462.8	2579.2
		3	522.6	722.9	1632.0	2877.6
		3.5	632.6	875.1	1975.4	3483.1
		4.5	644.2	963.5	2194.5	3802.2
	3	2	375.2	505.0	1122.7	2002.8
		2.5	388.0	603.7	1364.5	2356.1
		3	432.9	673.5	1522.3	2628.7
		3.5	523.9	815.3	1842.7	3181.9
		4.5	695.0	937.6	2085.1	3717.7

Baseline Efficiency:

The baseline efficiency case for the HECU measure is a condensing unit with a standard compressor efficiency rating, no floating head pressure controls, and single speed compressor fan motors.

High Efficiency:

The high efficiency case for the HECU measure must have scroll compressor technology, incorporate floating head pressure controls, and have the ability to modulate compressor fan speed.

Measure Life:

The measure life is 11 years for the HECU.[x]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
High Efficiency Condensing Unit	CI_EQUIP	All	11	n/a	n/a	11

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
High Efficiency Condensing Unit- Scroll compressor	CI_EQUIP	All	1.00	1.00	n/a	1.00	1.00	0.9	0.9

In-Service Rates:

All installations have 100% in-service rates since programs include verification of equipment installations.

Realization Rates:

All PAs use 100% energy realization rates.

Coincidence Factors:

Summer and winter coincidence factors align with the loadshapes used to capture the coincident peak demand savings associated with the scroll compressor and the floating head pressure control components of the measure, as used in the VT TRM methodology.

Impact Factors for Calculating Net Savings:

HECU net savings factors are based on evaluated freeridership and spillover factors for Massachusetts prescriptive C&I New and Replacement Equipment (2021 Omnibus NTG Study)[1].

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
High Effciency Condensing Units	CI_EQUIP	All	0.250	0.002	0.085	0.837

Non-Energy Impacts:

There are no non-energy impacts identified for this measure.

Endnotes:

1 : NMR Group, Inc. (2021). C&I Prescriptive and Custom NTG Omnibus Study
2021_NMR_C&I_Omnibus_NTG

3.60 HVAC - Hotel Occupancy Sensor

Measure Code	COM-HVAC-HOS
Market	Commercial
Program Type	Retrofit
Category	Heating Ventilation and Air Conditioning

Measure Description:

The installation of hotel occupancy sensors (HOS) to control packaged terminal AC units (PTACs) with electric heat, heat pump units, and/or fan coil units in hotels that operate all 12 months of the year.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Hotel Occupancy Sensor	C&I Existing Building Retrofit (CI_RETRO)	EC2a029

Algorithms for Calculating Primary Energy Impact:

Unit savings are deemed based on evaluation results:
$delkWh = SAVE_{kWh}$
$delkW = SAVE_{kW}$

Where:
Unit = Installed hotel room occupancy sensor
$SAVE_{kWh}$ = Average annual kWh reduction per unit: 438 kWh[1]
$SAVE_{kW}$ = Average annual kWh reduction per unit: 0.09 kW[2]

Baseline Efficiency:

The baseline efficiency case assumes the equipment has no occupancy based controls.

High Efficiency:

The high efficiency case is the installation of controls that include (a) occupancy sensors, (b) window/door switches for rooms that have operable window or patio doors, and (c) set back to 65 F in the heating mode and set forward to 78º F in the cooling mode when occupancy detector is in the unoccupied mode. Sensors controlled by a front desk system are not eligible.

Measure Life:

This measure was determined to be an add on single baseline.[3]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML

HVAC - Hotel Occupancy Sensors	CI_RETRO	All	10	1.00	n/a	10

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
HVAC - Hotel Occupancy Sensors	CI_RETRO	National Grid	1.00	1.00	n/a	1.00	1.00	0.30	0.70
HVAC - Hotel Occupancy Sensors	CI_RETRO	Eversource CLC	1.00	1.01	n/a	1.09	1.57	0.82	0.05
HVAC - Hotel Occupancy Sensors	CI_RETRO	Unitil	1.00	1.00	n/a	1.00	1.00	0.82	0.05

In-Service Rates:
All installations have 100% in service rate since all PAs programs include verification of equipment installations.

Realization Rates:

- National Grid: RRs based on engineering estimates.
- Eversource (NSTAR), CLC energy and demand RRs from impact evaluation of NSTAR 2006 HVAC installations.[4]
- Unitil: Energy and demand RRs are set to 100% due to no formal evaluations have been completed.[5]

Coincidence Factors:

- National Grid: CFs based on engineering estimates.[6]
- Eversource, CLC, Unitil: on-peak CFs based on standard assumptions. [7]

Impact Factors for Calculating Net Savings:

All PAs use statewide prescriptive net-to-gross results.[8]

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
HVAC - Hotel Occupancy Sensors	CI_RETRO	All	17.9%	0.3%	5.4%	87.8%

Non-Energy Impacts:

Prescriptive HVAC measures in retrofit applications have an annual $/kWh NEI.[9]

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per KWh	Annual $ per Therm	One-time $ per Therm
HVAC - Hotel Occupancy Sensors	CI_RETRO	All			$0.222			

Endnotes:

1 : MassSave (2010). Energy Analysis: Hotel Guest Occupancy Sensors. Prepared for National Grid and Eversource (NSTAR). NGRID_and_NSTAR_EnergyAnalysis_Hotel_Guest_Occupancy_Sensors
2 : MassSave (2010). Energy Analysis: Hotel Guest Occupancy Sensors. Prepared for National Grid and Eversource (NSTAR). NGRID_and_NSTAR_EnergyAnalysis_Hotel_Guest_Occupancy_Sensors
3 : Baseline Categories and preliminary Out Year Factors are described at a high level in DNV GL, ERS (2018). Portfolio Model Companion Sheet.. Additional background on the baseline categorization given in DNV GL, ERS (2018). Portfolio Model Methods and Assumptions – Electric and Natural Gas Memo. 2018_DNVGL_ERS_Portfolio_Model_Companion_Sheet
4 : RLW Analytics (2008). Business & Construction Solutions (BS/CS) Programs Measurement & Verification - 2006 Final Report. Prepared for NSTAR Electric and Gas; Table 17
RLW_2008_Business_and_Construction_Solutions_Programs_Measurement_and_Verification_2006_Final_Report
5 : MA Common Assumption
6 : Common Assumption
7 : Common Assumption
8 : NMR Group, Inc. (2021). C&I Prescriptive and Custom NTG Omnibus Study
2021_NMR_C&I_Omnibus_NTG
9 : KEMA, Inc. (2012). Commercial and Industrial Non-Energy Impacts Study.
TETRATECH_2012_MA_CI_NEI_REPORT

3.61 HVAC - Infrared Heater

Measure Code	COM-HVAC-IH
Market	Commercial
Program Type	Time of Sale
Category	Heating Ventilation and Air Conditioning

Measure Description:

The installation of a gas-fired low intensity infrared heating system in place of unit heater, furnace, or other standard efficiency equipment. Infrared heating uses radiant heat as opposed to warm air to heat buildings. In commercial environments with high air exchange rates, heat loss is minimal because the space's heat comes from surfaces rather than air.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Infrared Heaters, Gas	C&I New Buildings & Major Renovations (CI_NB&MR)	GC1a024
Infrared Heaters, Gas	C&I New & Replacement Equipment (CI_EQUIP)	GC2b020

Algorithms for Calculating Primary Energy Impact:

Unit savings are deemed based on study results.[1]

Measure Name	ΔMMBtu
Infrared Heaters	12.0

Baseline Efficiency:

The baseline efficiency case is a standard efficiency gas-fired unit heater with combustion efficiency of 80%.

High Efficiency:

The high efficiency case is a gas-fired low-intensity infrared heating unit.

Measure Life:

The measure life is 17 years.[2]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML

| Infrared Heaters | CI_NB&MR CI_EQUIP | All | 17 | n/a | n/a | 17 |

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Infrared Heaters	CI_NB&MR CI_EQUIP	All	1.00	1.00	1.00	n/a	n/a	n/a	n/a

In-Service Rates:
All installations have 100% in service rate since programs include verification of equipment installations.

Realization Rates:
All PAs use 100% energy realization rate. The summer and winter peak realization rates are not applicable for this measure since there are no electric savings claimed.

Coincidence Factors:
Not applicable for this measure since no electric savings are claimed.

Impact Factors for Calculating Net Savings:

Values from 2021 C&I NTG Omnibus study.[3]

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Infrared Heaters	CI_NB&MR	All	0.58	0.22	0.00	0.64
Infrared Heaters	CI_EQUIP	All	0.373	0.026	0.191	0.84

Non-Energy Impacts:

Values sourced for 2022 NEI Study.[4]

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per KWh	Annual $ per Therm	One-time $ per Therm
Infrared Heaters	CI_NB&MR	All					$ 2.80	

Endnotes:

1 : KEMA (2013). Impact Evaluation of 2011 Prescriptive Gas Measures; Page 1-5.
KEMA_2013_Prescriptive_Gas_Impact_Eval_PY2011
2 : Nexant (2006). DSM Market Characterization Report. Prepared for Questar Gas.
Nexant_2006_DSM_Market_Characterization_Report
3 : NMR Group, Inc. (2021). Non Residential New Construction NTG Report.
2021_NMR_Non_Residential_New_Construction_NTG_Report
4 : 2022 MA21X19-B-CIHSNEI C&I Health and Safety Non-Energy Impacts
2022_DNV_C&I_Heath_&_Safety_NEIs

3.62 HVAC - Large ASHP

Measure Code	COM-HVAC-LASHP
Market	Commercial
Program Type	Retrofit
Category	Heating Ventilation and Air Conditioning

Measure Description:

Full or partial displacement of electric resistance, oil, propane, or gas heat with a high efficiency heat pump with a cooling capacity >65,000 kBtu/h.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Large ASHP partially displacing Electric Heat	C&I New & Replacement Equipment (CI_EQUIP)	EC2b126
Large ASHP fully displacing Electric Heat	C&I New & Replacement Equipment (CI_EQUIP)	EC2b129
Large ASHP partially displacing Oil Heat (weatherized)	C&I New & Replacement Equipment (CI_EQUIP)	EC2b132
Large ASHP partially displacing Propane Heat (weatherized)	C&I New & Replacement Equipment (CI_EQUIP)	EC2b133
Large ASHP fully displacing Oil Heat (weatherized)	C&I New & Replacement Equipment (CI_EQUIP)	EC2b136
Large ASHP fully displacing Propane Heat (weatherized)	C&I New & Replacement Equipment (CI_EQUIP)	EC2b137
Large ASHP partially displacing Oil Heat (weatherization unverified)	C&I New & Replacement Equipment (CI_EQUIP)	EC2b144
Large ASHP partially displacing Propane Heat (weatherization unverified)	C&I New & Replacement Equipment (CI_EQUIP)	EC2b145
Large ASHP fully displacing Oil Heat (weatherization unverified)	C&I New & Replacement Equipment (CI_EQUIP)	EC2b154
Large ASHP fully displacing Propane Heat (weatherization unverified)	C&I New & Replacement Equipment (CI_EQUIP)	EC2b155
Large ASHP partially displacing Gas	C&I New & Replacement	GC2b062

Measure Name	Core Initiative	BCR Measure ID
Heating (verified Wx)	Equipment (CI_EQUIP)	
Large ASHP partially displacing Gas Heating (unverified Wx)	C&I New & Replacement Equipment (CI_EQUIP)	GC2b063
Large ASHP fully displacing Gas Heating (Verified Wx)	C&I New & Replacement Equipment (CI_EQUIP)	GC2b064
Large ASHP fully displacing Gas Heating (Unverified Wx)	C&I New & Replacement Equipment (CI_EQUIP)	GC2b086

Algorithms for Calculating Primary Energy Impact:

Unit savings are demed on a per system-ton basis based on a model[1] developed to estimate the savings associated with the displacement of existing heating (and cooling) systems

Measure Name	Core Initiative	Annual kWh/ton	kW/ton	MMBTu/ton
Large ASHP partially displacing Electric Heat	CI_EQUIP	1,681	0.0	n/a
Large ASHP fully displacing Electric Heat	CI_EQUIP	2,275	0.0	n/a
Large ASHP partially displacing Oil Heat	CI_EQUIP	-644	-0.621	8.7
Large ASHP fully displacing Oil Heat	CI_EQUIP	-1,034	-1.286	11.1
Large ASHP partially displacing Propane Heat	CI_EQUIP	-664	-0.621	8.8
Large ASHP fully displacing Propane Heat	CI_EQUIP	-1,045	-1.286	11
Large ASHP partially displacing Gas Heat	CI_EQUIP	-472	-0.621	8.3
Large ASHP fully displacing Gas Heat	CI_EQUIP	-928	1.286	12.5

Baseline Efficiency:

A list of baseline HVAC system types was developed based on prevalence in the commercial HVAC market according to available data sources, including the MA Baseline Studies, the 2018 Commercial Building Energy Consumption Survey (CBECS), and a participant survey fielded as part of the 2023 C&I Energy Optimization Model Update study. The technologies modeled were identified as likely candidates for program participation based on their floor area (<75,000 sf) and represented non-heat pump-based technologies utilizing any fuel type other than district steam or hot water.

The efficiency of the baseline systems were derived from multiple sources including MA Baseline Studies and the MA Baseline Repository. Efficiencies of modeled scenarios that were not available in other data sources were used as a lever for calibrating the models as part of the Energy Optimization Model Update. The model used equipment capacities based on typical design conditions and account for

typical commercial building geometries and the building characteristics (envelope, internal gains, and ventilation requirements) developed through the study's calibration process.

A comprehensive table of baseline equipment types and efficiencies can be found on page 22 of the Energy Optimization Model Update study report.

High Efficiency:

The high efficiency case for these measures is derived from the MA Baseline Repository as part of the Energy Optimization Model Update.

System Type	Heating Efficiency	Cooling Efficiency	Efficiency Approach	Efficiency Details
Heat Pumps	8.5 HSPF	14.4 SEER	ISP in place of code requirement	Apply a factor of 1.06 for heating and 1.03 for cooling to IECC specified efficiencies
Mini-/Multi Split-Single-Zone	8.2 HSPF	14.0 SEER	ISP in place of code requirement	Apply a factor of 1.06 for heating and 1.03 for cooling to IECC specified efficiencies
Mini-/Multi Split-Multi-Zone	8.7 HSPF	14.4 SEER	ISP in place of code requirement	Apply a factor of 1.06 for heating and 1.03 for cooling to IECC specified efficiencies

Measure Life:

Measure Name	Core Initiative	PA	EUL[2]	OYF	RUL	AML
Large ASHP	CI_EQUIP	All	17	n/a	n/a	17

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Large ASHP	CI_EQUIP	All	1.00	1.00	n/a	n/a	n/a	0.00	1.00

In-Service Rates:
Installation rates are assumed to be 100% until evaluated.

Realization Rates:
Realization rates are set to 100% since deemed savings are based on evaluation results.

Coincidence Factors:

Coincidence factors are calculated to reflect blend of heating and cooling.

Impact Factors for Calculating Net Savings:

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG[3]
Large ASHP (displacing electric resistance, oil, propane)	CI_EQUIP	All	0.25	0.00	0.09	0.84
Large ASHP (displacing gas)	CI_EQUIP	All	0.37	0.03	0.19	0.84

Non-Energy Impacts:

Non-energy impacts are based on study results.[4] [5]

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per kWh	Annual $ per Therm	One-time $ per Therm
Large ASHP displacing electric resistance	CI_EQUIP	All			$0.095			
Large ASHP displacing oil, propane, gas	CI_EQUIP	All			$0.149			

Endnotes:

1 : Cadeo (2023). Energy Optimization Model Update. 2023_Cadeo_MA22C10_Energy Optimization Model Update

2 : GDS Associates, Inc. (2007). Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures.
GDS_2007_Measure_Life_Report_Residential_and_CI_Lighting_and_HVAC_Measures

3 : NMR Group, Inc. (2021). Prescriptive and Custom NTG Omnibus Study.
2021_NMR_C&I_Omnibus_NTG

4 : NMR Group, Inc. (2021). C&I O&M and Non O&M NEI Study. 2021_NMR_CIOM and NonOM NEI Study

5 : DNV (2022). C&I Health & Safety NEIs. 2022_DNV_C&I_Heath_&_Safety_NEIs

3.63 HVAC - PTHP

Measure Code	COM-HVAC-PTHP
Market	Commercial
Program Type	Early Replacement, Lost Opportunity
Category	Heating Ventilation and Air Conditioning

Measure Description:

A package terminal heat pump (PTHP) is purchased to replace either a functional or end of life package terminal air conditioner (PTAC) with electric resistance heat.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Midstream - PTHP	C&I New & Replacement Equipment (CI_EQUIP)	EC2b195

Algorithms for Calculating Primary Energy Impact:

Unit savings are deemed based on a model[1] developed to estimate the savings associated with the displacement of existing heating (and cooling) systems.

Measure	Core Initiative	PA	Electric Savings (kWh/ton)
Midstream - PTHP	C&I New & Replacement Equipment (CI_EQUIP)	All	1,126

Baseline Efficiency:

For PTHPs, savings are calculated as a 50/50 average between a baseline package terminal air conditioner (PTAC) with electric resistance heat and a standard efficiency PTHP.

High Efficiency:

Assumed to be 24 kBtu/hr in the model[1] used to develop impacts.

Measure Life:

The unadjusted measure life is 12 years.[2] The measure life is adjusted to reflect a blend of equipment replaced on failure and replaced early.

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Midstream - PTHP	CI_EQUIP	All	12	0.95	n/a	11.4

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Midstream - PTHP	CI_EQUIP	All	1.00	1.00	n/a	1.00	1.00	0.34	0.42

In-Service Rates:
Assumed 100% until evaluated.

Realization Rates:
Realization rates are assumed 100% as impacts are based on evaluated results.

Coincidence Factors:
Coincidence factors from Vermont TRM LS_114a for PTHP, Hotel.

Impact Factors for Calculating Net Savings:

From the HVAC Upstream study which developed statewide net-to-gross results.[3]

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Midstream - PTHP	CI_EQUIP	All	45.0%	0.0%	0.0%	55.0%

Non-Energy Impacts:

Non-energy impacts are based on study results.[4]

Measure Name	Core Initiative	PA	Annual $ per kWh
Midstream - PTHP	CI_EQUIP	All	0.095

Endnotes:

1 : Cadeo(2023). Energy Optimization Model Update. 2023_Cadeo_MA22C10_Energy Optimization Model Update
2 : DNV GL (2018). Expected Useful Life (EUL) Estimation for Air-Conditioning Equipment from Current Age Distribution Memo. 2018_DNVGL_P73_EUL_Estimation_Results_to_Date
3 : NMR Group Inc. (2021). C&I Upstream HVAC Net-to-Gross Study.

2021_NMR_C&I_HVAC_NTG

4 : NMR (2021). C&I O&M and Non-O&M NEI Study. 2021_NMR_CIOM and NonOM NEI Study

3.64 HVAC - Pipe Wrap (Heating)

Measure Code	COM-HVAC-PWS
Market	Commercial
Program Type	Retrofit
Category	Heating Ventilation and Air Conditioning

Measure Description:

Install insulation on steam pipes located in non-conditioned spaces.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Pipe Wrap, Steam, Oil (Turnkey)	C&I Existing Building Retrofit (CI_RETRO)	EC2a133
Pipe Wrap, Steam, Propane (Turnkey)	C&I Existing Building Retrofit (CI_RETRO)	EC2a134
Pipe Wrap Steam, Gas, <=1.5"	C&I Existing Building Retrofit (CI_RETRO)	GC2a026
Pipe Wrap Steam, Gas, 3"	C&I Existing Building Retrofit (CI_RETRO)	GC2a027
Pipe Wrap Steam, Gas , <=1.5" (Turnkey)	C&I Existing Building Retrofit (CI_RETRO)	GC2a047
Pipe Wrap Steam, Gas , 3" (Turnkey)	C&I Existing Building Retrofit (CI_RETRO)	GC2a048
Pipe Wrap, Gas, <=1.5' (OMP)	C&I New and Replacement Equipment (CI_EQUIP)	GC2b080

Algorithms for Calculating Primary Energy Impact:

Unit savings are deemed based on PA calculations.[1]

Measure Name	ΔMMBtu per linear foot
Pipe Wrap Steam, <= 1.5"	0.21
Pipe Wrap Steam, 3"	0.37

Baseline Efficiency:

The baseline efficiency case is un-insulated steam piping in unconditioned space.

High Efficiency:

The high efficiency condition is steam piping in unconditioned space with insulation installed.

Measure Life:

The measure life is 15 years.[2]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Pipe Wrap Steam	CI_RETRO	All	15	n/a	n/a	15

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Pipe Wrap Steam	CI_RETRO	All	1.00	n/a	1.00	n/a	n/a	n/a	n/a

In-Service Rates:

All installations have 100% in service rate since programs include verification of equipment installations.

Realization Rates:

All PAs use 100% non-energy realization rate. The summer and winter peak realization rates are not applicable for this measure since there are no electric savings claimed.

Coincidence Factors:

Not applicable for this measure since no electric savings are claimed.

Impact Factors for Calculating Net Savings:

Values are based on an evaluation study.[3]

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Pipe Wrap Steam, Gas	CI_RETRO	All	0.369	0.00	0.032	0.663
Pipe Wrap Steam, Gas (Turnkey)	CI_RETRO	All	0.285	0.00	0.00	0.715
Pipe Wrap Steam, Oil	CI_RETRO	All	0.077	0.013	0.040	0.940
Pipe Wrap Steam, Propane	CI_RETRO	All	0.077	0.013	0.040	0.940
Pipe Wrap, Gas (OMP)	CI_EQUIP	All	0.370	0.026	0.190	0.840

Non-Energy Impacts:

Pipe Wrap, Gas NEIs are from the 2021 Study.[4] Pipe Wrap Oil and Propane NEIs are updated based on the C&I H&S Study.[5]

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per KWh	Annual $ per Therm	One-time $ per Therm
Pipe Wrap, Gas	CI_RETRO	All					$ 0.622	
Pipe Wrap, Steam, Oil (Turnkey)	CI_RETRO	All					$0.095	
Pipe Wrap, Steam, Propane (Turnkey)	CI_RETRO	All					$0.095	

Endnotes:

1 : National Grid Staff Calculations (2010). Pipe insulation for SBS DI measures 2010 Workbook. NGrid_Pipe_insulation_for_SBS_DImeasures_2010
2 : GDS Associates, Inc (2009). Natural Gas Energy Efficiency Potential in Massachusetts. GDS_2009_Natural_Gas_Energy_Efficiency_Potential_in_MA
3 : NMR Group, Inc. (2018). Massachusetts Sponsor's Commercial and Industrial Free-ridership and Spillover Study. 2018_NMR_CI_FR_SP
4 : NMR Group Inc (2021). O&M and Non-O&M NEI Study. 2021_NMR_CIOM and NonOM NEI Study

3.65 HVAC - Pipe Wrap (Heating) - C&I Metered Multi-Family

Measure Code	COM-HVAC-PWREU
Market	Commercial
Program Type	Retrofit
Category	Heating Ventilation and Air Conditioning

Measure Description:

Install insulation on steam piping located in non-conditioned spaces.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Pipe Wrap (Heating), Gas (Residential End Use)	C&I Existing Building Retrofit (CI_RETRO)	GC2a061

Algorithms for Calculating Primary Energy Impact:

Unit savings are deemed per linear foot of pipe insulation based on calculation assumptions.[1]

Measure Name	Δ MMBtu
Pipe Wrap (Heating), Gas (Residential End Use)	0.16

Baseline Efficiency:

The baseline efficiency case is un-insulated heating piping in unconditioned space.

High Efficiency:

The high efficiency condition is heating piping in unconditioned space with insulation installed.

Measure Life:

The measure life is 15 years.[2]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Pipe Wrap (Heating), Gas (Residential End Use)	CI_RETRO	All	15	n/a	n/a	15

Other Resource Impacts:

There are no other resource impacts for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Pipe Wrap (Heating), Gas (Residential End Use)	CI_RETRO	All	1.00	1.00	1.00	n/a	n/a	n/a	n/a

In-Service Rates:

All installations have 100% in service rate since programs include verification of equipment installations.

Realization Rates:

All PAs use 100% energy realization rate. The summer and winter peak realization rates are not applicable for this measure since there are no electric savings claimed.

Coincidence Factors:

Not applicable for this measure since no electric savings are claimed.

Impact Factors for Calculating Net Savings:

Net to gross factors are from evaluation results.[3]

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Pipe Wrap (Heating), Gas (Residential End Use)	CI_RETRO	All	0.14	0.0	0.0	0.86

Non-Energy Impacts:

There are no non-energy impacts for this measure.

Endnotes:

1 : National Grid Staff Calculation (2010). Pipe insulation for SBS DI measures 2010 Excel Workbook Savings assumptions from National Grid program vendor for High Rise.
NGrid_Pipe_insulation_for_SBS_DImeasures_2010
2 : GDS Associates, Inc (2009). Natural Gas Energy Efficiency Potential in Massachusetts.
GDS_2007_Measure_Life_Report_Residential_and_CI_Lighting_and_HVAC_Measures
3 : Guidehouse (2021). Residential Programs Net-to-Gross Research of RCD and Select Products.
2021_Guidehouse_MA_Res_NTG_Final_Report

3.66 HVAC - Programmable Thermostat

Measure Code	COM-HVAC-PT
Market	Commercial
Program Type	Retrofit
Category	Heating Ventilation and Air Conditioning

Measure Description:

This measure involves the installation of a programmable thermostat for cooling and/or heating systems in spaces with either no or erratic existing control.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Programmable Thermostat, Electric	C&I Existing Building Retrofit (CI_RETRO)	EC2a023
Programmable Thermostat, Electric (OMP)	C&I New & Replacement Equipment (CI_EQUIP)	EC2b180
Programmable Thermostat, Electric (Turnkey)	C&I Existing Building Retrofit (CI_RETRO)	EC2a047
Programmable Thermostat, Oil	C&I New & Replacement Equipment (CI_EQUIP)	EC2b181
Programmable Thermostat, Oil (Turnkey)	C&I Existing Building Retrofit (CI_RETRO)	EC2a126
Programmable Thermostat, Propane	C&I New & Replacement Equipment (CI_EQUIP)	EC2b182
Programmable Thermostat, Propane (Turnkey)	C&I Existing Building Retrofit (CI_RETRO)	EC2a127
Programmable Thermostat, Gas	C&I Existing Building Retrofit (CI_RETRO)	GC2a016
Programmable Thermostat, Gas (Turnkey)	C&I Existing Building Retrofit (CI_RETRO)	GC2a037
Programmable Thermostat, Gas	C&I New & Replacement Equipment (CI_EQUIP)	GC2b081

Algorithms for Calculating Primary Energy Impact:

Electric Savings:

$kWh = (SQFT)(SAVE_{kWh})$

$kW = (SQFT)(SAVE_{kW})$

Where:

SQFT = square feet of controlled space

$SAVE_{kWh}$ = average annual kWh reduction per SQFT of controlled (see below)

$SAVE_{kW}$ = average kW reduction per SQFT of controlled space (see below)

Measure Name	SAVEkWh (kWh/SqFt)[1]	SAVEkW (kW/SqFt)
PT - Cool Only No Existing Control	0.539	0.000
PT - Cool Only Erratic Existing Control	0.154	0.000
PT - Heat Only No Existing Control	0.418	0.000
PT - Heat Only Erratic Existing Control	0.119	0.000
PT - Cool and Heat No Existing Control	0.957	0.000
PT - Cool and Heat Erratic Existing Control	0.273	0.000
PT - Heat Pump No Existing Control	0.848	0.000
PT - Heat Pump Erratic Existing Control	0.242	0.000

Gas & Delivered Fuel (Propane & Oil) Savings:

Unit savings are deemed based on study results.[1]

Measure Name	ΔMMBtu
Programmable Thermostat	2.07

Deemed savings for the gas programmable thermostat is 20.7 therms.[2]

Baseline Efficiency:

The baseline efficiency case includes spaces with either no or erratic heating and/or cooling control as indicated in the equipment type selection.

High Efficiency:

The high efficiency case includes control of the space cooling and/or heating system as indicated in the

equipment type selection.

Measure Life:

Measure Name	Core Initiative	PA	EUL[3]	OYF	RUL	AML
Programmable Thermostat	CI_RETRO	All	10	n/a	n/a	10
Programmable Thermostat (turnkey)	CI_RETRO	All	15	n/a	n/a	15
Programmable Thermostat (OMP)	CI_EQUIP	All	13	n/a	n/a	13

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR$_E$	RR$_{NE}$	RR$_{SP}$	RR$_{WP}$	CF$_{SP}$	CF$_{WP}$
Programmable Thermostat	CI_RETRO	National Grid	1.00	1.00	n/a	1.00	1.00	0.00	0.00
Programmable Thermostat	CI_RETRO	Eversource	1.00	1.00	n/a	1.00	1.00	0.00	0.00
Programmable Thermostat	CI_RETRO	CLC	1.00	1.00	n/a	1.00	1.00	0.00	0.00
Programmable Thermostat	CI_RETRO	Unitil	1.00	1.00	n/a	1.00	1.00	0.00	0.00
Programmable Thermostat (Turnkey)	CI_RETRO	Eversource	1.00	0.95	n/a	1.26	1.41	0.00	0.00
Programmable Thermostat (Turnkey)	CI_RETRO	Unitil	1.00	0.95	n/a	1.26	1.41	0.00	0.00
Programmable Thermostat (Turnkey)	CI_RETRO	CLC	1.00	1.05	n/a	0.94	1.17	0.00	0.00
Programmable Thermostat (Turnkey)	CI_RETRO	National Grid	1.00	1.05	n/a	0.94	1.17	0.00	0.00

In-Service Rates

All installations have 100% in service rate since PA programs include verification of equipment installations.

Realization Rates
Retrofit
- RRs set to 100% based on no evaluations.

Retrofit (Turnkey)
- Realizations Rates come from the Small Business Impact Evaluation[4]

Coincidence Factors
All PAs CFs set to zero since no savings are expected during peak periods.

Impact Factors for Calculating Net Savings:

Values from 2021 C&I NTG study.[4]

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Programmable Thermostat, Gas	CI_RETRO	All	0.369	0.000	0.032	0.663
Programmable Thermostat, Gas (Turnkey)	CI_RETRO	All	0.285	0.000	0.000	0.715
Programmable Thermostat, Electric	CI_RETRO	All	0.18	0.00	0.05	0.880
Programmable Thermostat, Electric (OMP)	CI_EQUIP	All	0.25	0.00	0.09	0.84
Programmable Thermostat, Electric (Turnkey)	CI_RETRO	All	0.080	0.010	0.000	0.940
Programmable Thermostat, Oil (Turnkey)	CI_RETRO	All	0.080	0.010	0.000	0.940
Programmable Thermostat, Propane (Turnkey)	CI_RETRO	All	0.080	0.010	0.000	0.940

Non-Energy Impacts:

Non-energy impacts are from the MA21X19-B-CIHSNEI C&I H&S NEI study.[5]

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per KWh	Annual $ per Therm	One-time $ per Therm
Programmable Thermostat	CI_RETRO	All			$ 0.246			
Programmable Thermostat, Electric (Turnkey)	CI_RETRO	All			$ 0.246			
Programmable Thermostat, Oil (Turnkey)	CI_RETRO	All			$ 0.246			

Programmable Thermostat, Propane (Turnkey)	CI_RETRO	All			$ 0.246			
Programmable Thermostat, Gas	CI_RETRO	All					$ 2.80	
Programmable Thermostat, Gas (Turnkey)	CI_RETRO	All					$ 2.80	

Endnotes:

1 : All deemed savings values based on Massachusetts common assumptions.
2 : Guidehouse (2021). WiFi and Programmable Thermostat Impacts.
2021_Guidehouse_Thermostat_Impact_Study
3 : Energy & Resource Solutions (2005). Measure Life Study. ERS_2005_Measure_Life_Study
4 : DNV GL (2020). Impact Evaluation of PY 2017 Small Business Initiative Non-Lighting Measures.
5 : NMR Group Inc (2021). O&M and Non-O&M NEI Study. 2021_NMR_CIOM and NonOM NEI Study

3.67 HVAC - Programmable Thermostat - C&I Multi-Family

Measure Code	COM-HVAC-PTREU
Market	Commercial
Program Type	Retrofit
Category	Heating Ventilation and Air Conditioning

Measure Description:

Installation of a programmable thermostat, which gives the ability to adjust heating or air-conditioning operating times according to a pre-set schedule.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Programmable Thermostat, Gas (Residential End Use)	C&I Existing Building Retrofit (CI_RETRO)	GC2a066
Programmable Thermostat, Electric Resistance, No AC (Residential End Use)	C&I Existing Building Retrofit (CI_RETRO)	EC2a081
Programmable Thermostat, Electric Resistance, With AC (Residential End Use)	C&I Existing Building Retrofit (CI_RETRO)	EC2a082
Programmable Thermostat, AC Only (Residential End Use)	C&I Existing Building Retrofit (CI_RETRO)	EC2a083
Programmable Thermostat, Heat Pump (Residential End Use)	C&I Existing Building Retrofit (CI_RETRO)	EC2a084

Algorithms for Calculating Primary Energy Impact:

Unit savings are deemed based on study results[1]

Measure Name	ΔkWh	ΔkW[2]	ΔMMBtu
Programmable Thermostat, Gas (Residential End Use)			2.07
Programmable Thermostat, Electric Resistance, No AC (Residential End Use)	257	0.19	
Programmable Thermostat, Electric Resistance, With AC (Residential End Use)	281	0.13	
Programmable Thermostat, AC Only (Residential End Use)	25	0.04	

Programmable Thermostat, Heat Pump (Residential End Use)	241	0.28	
Programmable Thermostat, Oil (Residential End Use)			2.1

Baseline Efficiency:

The baseline efficiency case is an HVAC system without a programmable thermostat.

High Efficiency:

The high efficiency case is an HVAC system that has a programmable thermostat installed.

Measure Life:

The measure life is 19 years.[3] The measure persistence was estimated to be 69%[4] so the effective measure life is 13 years (19 years * 69%).

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Programmable Thermostat (Residential End Use)	CI_RETRO	All	19	n/a	n/a	13

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Programmable Thermostat, Gas (Residential End Use)	CI_RETRO	All	1.00	1.00	1.00	1.00	1.00	0.35	0.00

In-Service Rates:
All installations have 100% in service rate since all PAs programs include verification of equipment installations.

Realization Rates:
Realization rates are set to 100% since savings are deemed

Coincidence Factors:
Summer and winter coincidence factors are estimated using the demand allocation methodology described in the Demand Impact Model which is developed based on the Residential Baseline Study.[5]

Impact Factors for Calculating Net Savings:

Net to gross factors are based on evaluation results.[6]

Measure Name	Core Initiative	PA	FR	SO$_P$	SO$_{NP}$	NTG
Programmable Thermostat (Residential End Use)	CI_RETRO	All	0.14	0.0	0.0	0.86

Non-Energy Impacts:

NEI values are rolled up, component values can be found in Appendix B. The thermostat NEI values are per household and the PAs adjust the total value by the average number of thermostats per account depending on the initiative.

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per KWh	Annual $ per Therm	One-time $ per Therm
Programmable Thermostat (Residential End Use)	CI_RETRO	All	$14.35					

Endnotes:

1 : Guidehouse (2021). Residential Wi-Fi and Programmable Thermostat Impacts.
2021_Guidehouse_Thermostat_Impact_Study
2 : Guidehouse (2020) Residential Baseline Phase 4 2020_Guidehouse_Residential_Baseline_Phase_4
3 : Guidehouse (2021). Comprehensive TRM Review Report. 2021_Guidehouse_TRM_Final_Report
4 : The Cadmus Group, Inc. (2012). Massachusetts 2011 Residential Retrofit Multifamily Program
Analysis. CADMUS_2012_Multifamily_Impacts_Analysis_Report
5 : Guidehouse (2020). Residential Baseline Study Phase 4
2020_Guidehouse_Residential_Baseline_Phase_4
6 : Guidehouse (2021). Residential Programs Net-to-Gross Research of RCD and Select Products.
2021_Guidehouse_MA_Res_NTG_Final_Report

3.68 HVAC - Small ASHP

Measure Code	COM-HVAC-SASHP
Market	Commercial
Program Type	Retrofit
Category	Heating Ventilation and Air Conditioning

Measure Description:

Full or partial displacement of electric resistance, oil, propane, or gas heat with a high efficiency heat pump with a cooling capacity <65,000 kBtu/h.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Small ASHP partially displacing Electric Heat	C&I New & Replacement Equipment (CI_EQUIP)	EC2b103
Small ASHP fully displacing Electric Heat	C&I New & Replacement Equipment (CI_EQUIP)	EC2b128
Small ASHP partially displacing Oil Heat (weatherized)	C&I New & Replacement Equipment (CI_EQUIP)	EC2b104
Small ASHP partially displacing Oil Heat (weatherization unverified)	C&I New & Replacement Equipment (CI_EQUIP)	EC2b142
Small ASHP partially displacing Propane Heat (weatherized)	C&I New & Replacement Equipment (CI_EQUIP)	EC2b106
Small ASHP partially displacing Oil Heat (weatherization unverified)	C&I New & Replacement Equipment (CI_EQUIP)	EC2b143
Small ASHP fully displacing Oil Heat (weatherized)	C&I New & Replacement Equipment (CI_EQUIP)	EC2b115
Small ASHP fully displacing Propane Heat (weatherized)	C&I New & Replacement Equipment (CI_EQUIP)	EC2b117
Small ASHP fully displacing Oil Heat (weatherization unverified)	C&I New & Replacement Equipment (CI_EQUIP)	EC2b152
Small ASHP fully displacing Propane Heat (weatherization unverified)	C&I New & Replacement Equipment (CI_EQUIP)	EC2b153

Measure Name	Core Initiative	BCR Measure ID
Small ASHP partially displacing Gas Heating (Verified Wx)	C&I New & Replacement Equipment (CI_EQUIP)	GC2b059
Small ASHP partially displacing Gas Heating (Unverified Wx)	C&I New & Replacement Equipment (CI_EQUIP)	GC2b060
Small ASHP fully displacing Gas Heating (Verified Wx)	C&I New & Replacement Equipment (CI_EQUIP)	GC2b061
Small ASHP fully displacing Gas Heating (Unverified Wx)	C&I New & Replacement Equipment (CI_EQUIP)	GC2b085

Algorithms for Calculating Primary Energy Impact:

Unit savings are deemed on a per system-ton basis based on a model[1] developed to estimate the savings associated with the displacement of existing heating (and cooling) systems

Measure Name	Core Initiative	Annual kWh/ton	kW/ton	MMBtu/ton
Small ASHP partially displacing Electric Heat	CI_EQUIP	1,681	0.0	n/a
Small ASHP fully displacing Electric Heat	CI_EQUIP	2,275	0.0	n/a
Small ASHP partially displacing Oil Heat	CI_EQUIP	-644	-0.621	8.7
Small ASHP fully displacing Oil Heat	CI_EQUIP	-1,034	-1.286	11.1
Small ASHP partially displacing Propane Heat	CI_EQUIP	-664	-0.621	8.8
Small ASHP fully displacing Propane Heat	CI_EQUIP	-1,045	-1.286	11
Small ASHP partially displacing Gas Heating	CI_EQUIP	-472	-0.621	8.3
Small ASHP fully displacing Gas Heating	CI_EQUIP	-928	-1.286	12.5

Baseline Efficiency:

A list of baseline HVAC system types was developed based on prevalence in the commercial HVAC market according to available data sources, including the MA Baseline Studies, the 2018 Commercial Building Energy Consumption Survey (CBECS), and a participant survey fielded as part of the 2023 C&I Energy Optimization Model Update study. The technologies modeled were identified as likely candidates for program participation based on their floor area (<75,000 sf) and represented non-heat pump-based technologies utilizing any fuel type other than district steam or hot water.

The efficiency of the baseline systems were derived from multiple sources inlcuding MA Baseline Studies and the MA Baseline Repository. Efficiencies of modeled scenarios that were not available in other data sources were used as a lever for calibrating the models as part of the Energy Optimization Model Update. The model uses equipment capacities based on typical design conditions and account for typical commercial building geometries and the building characteristics (envelope, internal gains, and ventilation requirements) developed through the study's calibration process.

A comprehensive table of baseline equipment types and efficiencies can be found on page 22 of the Energy Optimization Model Update study report.

High Efficiency:

The high efficiency case for these measures are derived from the MA Baseline Repository as part of the Energy Optimization Model Update.

System Type	Heating Efficiency	Cooling Efficiency	Efficiency Approach	Efficiency Details
Heat Pumps	8.5 HSPF	14.4 SEER	ISP in place of code requirement	Apply a factor of 1.06 for heating and 1.03 for cooling to IECC specified efficiencies
Mini-/Multi Split-Single-Zone	8.2 HSPF	14.0 SEER	ISP in place of code requirement	Apply a factor of 1.06 for heating and 1.03 for cooling to IECC specified efficiencies
Mini-/Multi Split-Multi-Zone	8.7 HSPF	14.4 SEER	ISP in place of code requirement	Apply a factor of 1.06 for heating and 1.03 for cooling to IECC specified efficiencies

Measure Life:

The measure life is based on evaluation results.[2]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Small ASHP	CI_EQUIP	All	17	n/a	n/a	17

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}

Small ASHP	CI_EQUIP	All	1.00	1.00	1.00	1.00	1.00	0.00	1.00

In-Service Rates:

All installations have 100% in-service rates since all PAs programs include verification of equipment installations.

Realization Rates:

Realization rates are set to 100% since deemed savings are based on evaluation results.

Coincidence Factors:

Coincidence factors are calculated to reflect blend of heating and cooling.

Impact Factors for Calculating Net Savings:

Measure Name	Core Initiative	PA	FR	SO$_P$	SO$_{NP}$	NTG[3]
Small ASHP (displacing electric resistance, oil, propane)	CI_EQUIP	All	0.25	0.00	0.09	0.84
Small ASHP (displacing gas)	CI_EQUIP	All	0.37	0.03	0.19	0.84

Non-Energy Impacts:

Non-energy impacts are based on study results. [4] [5]

Measure Name	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per kWh	Annual $ per Therm	One-time $ per Therm
Small ASHP (displacing electric)	All	$0.00	$0.00	$0.095	$0.00	$0.00	$0.00
Small ASHP (displacing oil, propane, gas)	All	$0.00	$0.00	$0.149	$0.00	$0.00	$0.00

Endnotes:

1 : Cadeo (2023). Energy Optimization Model Update. 2023_Cadeo_MA22C10_Energy Optimization Model Update

6 : Navigant Consulting (2018). Baseline Study Saturation Result 2018_Navigant_Baseline_Loadshape_Comprehensive_Report

2 : GDS Associates, Inc. (2007). Measure Life Report: Residential and Commercial/Industrial Lighting

and HVAC Measures.

GDS_2007_Measure_Life_Report_Residential_and_CI_Lighting_and_HVAC_Measures

3 : NMR Group, Inc. (2021). Prescriptive and Custom NTG Omnibus Study. 2021_NMR_Prescriptive and Custom Net-to-Gross Omnibus Study

4 : NMR Group Inc (2021). O&M and Non-O&M NEI Study. 2021_NMR_CIOM and NonOM NEI Study

5 : DNV (2022). C&I Health & Safety NEIs. 2022_DNV_C&I_Heath_&_Safety_NEIs

3.69 HVAC - Unitary Air Conditioner

Measure Code	COM-HVAC-UAC
Market	Commercial
Program Type	New Construction
Category	Heating Ventilation and Air Conditioning

Measure Description:

This measure promotes the installation of high efficiency unitary air conditioning equipment in lost opportunity applications. Air conditioning (AC) systems are a major consumer of electricity and systems that exceed baseline efficiencies can save considerable amounts of energy. This measure applies to air, water, and evaporatively-cooled unitary AC systems, both single-package and split systems.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Midstream - Unitary Air Conditioners	C&I New & Replacement Equipment (CI_EQUIP)	EC2b051

Algorithms for Calculating Primary Energy Impact:

For units with cooling capacities less than 65 kBtu/h:
$\Delta kWh = (kBtu/h)\ (1/SEER_{base} - 1/SEER_{ee})\ (EFLH_{cool})$
$\Delta kW = (kBtu/h)\ (1/EER_{base} - 1/EER_{ee})$

For units with cooling capacities equal to or greater than 65 kBtu/h and EER available:
$\Delta kWh = (kBtu/h)\ (1/EER_{base} - 1/EER_{ee})\ (EFLH_{cool})$
$\Delta kW = (kBtu/h)\ (1/EER_{base} - 1/EER_{ee})$

For units with cooling capacities equal to or greater than 65 kBtu/h and IEER available:

$\Delta kWh = (kBtu/h)\ (1/IEER_{base} - 1/IEER_{ee})\ (EFLH_{cool})$
$\Delta kW = (kBtu/h)\ (1/EER_{base} - 1/EER_{ee})$

Where;
ΔkWh = Gross annual kWh savings from the measure.
ΔkW = Gross connected kW savings from the measure.
kBtu/h = Capacity of the cooling equipment in kBtu per hour (1 ton of cooling capacity equals 12 kBtu/h)
SEERBASE = Seasonal Energy Efficiency Ratio of the baseline equipment.
SEEREE = Seasonal Energy Efficiency Ratio of the energy efficient equipment.

EFLHCool = Cooling equivalent full load hours.

EERBASE = Energy Efficiency Ratio of the baseline equipment.

EEREE = Energy Efficiency Ratio of the energy efficient equipment.

IEERBASE = Integrated Energy Efficiency Ratio of the baseline equipment.

IEEREE = Integrated Energy Efficiency Ratio of the energy efficient equipment.

HoursCool = Annual Cooling Hours

Capadj = Capacity Adjustment Factor[1]

PA specific Capacity Adjustment Factors for IEER

PA	Capacity Adjustment Factor
National Grid	1.009
Eversource CLC	0.927
Unitil	1.104

Baseline Efficiency:

The baseline efficiency case for new installations assumes compliance with the efficiency requirements as mandated by IECC 2018.

A/C Baseline Efficiency Requirements

EQUIPMENT TYPE	SIZE CATEGORY	HEATING SECTION TYPE	SUBCATEGORY OR RATING CONDITION	MINIMUM EFFICIENCY	TEST PROCEDURE
Air conditioners, air cooled	< 65,000 Btu/h	All	Split System	13.0 SEER	AHRI 210/240
			Single Package	14.0 SEER	
Through-the-wall (air cooled)	≤ 30,000 Btu/h	All	Split system	12.0 SEER	
			Single Package	12.0 SEER	
Small duct high velocity, air cooled	≤ 65,000 Btu/h	All	Split system	11.0 SEER	
Air conditioners, air cooled	≥ 65,000 Btu/h and < 135,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	11.2 EER 12.9 IEER	AHRI 340/360
		All other	Split System and Single Package	11.0 EER 12.7 IEER	

EQUIPMENT TYPE	SIZE CATEGORY	HEATING SECTION TYPE	SUBCATEGORY OR RATING CONDITION	MINIMUM EFFICIENCY	TEST PROCEDURE
	≥ 135,000 Btu/h and < 240,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	11.0 EER 12.4 IEER	
		All other	Split System and Single Package	10.8 EER 12.2 IEER	
	≥ 240,000 Btu/h and < 760,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	10.0 EER 11.6 IEER	
		All other	Split System and Single Package	9.8 EER 11.4 IEER	
	≥ 760,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	9.7 EER 11.2 IEER	
		All other	Split System and Single Package	9.5 EER 11.0 IEER	
Air conditioners, water cooled	< 65,000 Btu/h	All	Split System and Single Package	12.1 EER 12.3 IEER	AHRI 210/240
	≥ 65,000 Btu/h and < 135,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	12.1 EER 13.9 IEER	AHRI 340/360
		All other	Split System and Single Package	11.9 EER 13.7 IEER	
	≥ 135,000 Btu/h and < 240,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	12.5 EER 13.9 IEER	
		All other	Split System and Single Package	12.3 EER 13.7 IEER	
	≥ 240,000 Btu/h and < 760,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	12.4 EER 13.6 IEER	
		All other	Split System and Single Package	12.2 EER 13.4 IEER	

EQUIPMENT TYPE	SIZE CATEGORY	HEATING SECTION TYPE	SUBCATEGORY OR RATING CONDITION	MINIMUM EFFICIENCY	TEST PROCEDURE
	≥ 760,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	12.2 EER 13.5 IEER	
		All other	Split System and Single Package	12.0 EER 13.3 IEER	
Air conditioners, evaporatively cooled	< 65,000 Btu/h	All	Split System and Single Package	12.1 EER 12.3 IEER	AHRI 210/240
	≥ 65,000 Btu/h and < 135,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	12.1 EER 12.3 IEER	AHRI 340/360
		All other	Split System and Single Package	11.9 EER 12.1 IEER	
	≥ 135,000 Btu/h and < 240,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	12.0 EER 12.2 IEER	
		All other	Split System and Single Package	11.8 EER 12.0 IEER	
	≥ 240,000 Btu/h and < 760,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	11.9 EER 12.1 IEER	
		All other	Split System and Single Package	11.7 EER 11.9 IEER	
	≥ 760,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	11.7 EER 11.9 IEER	
		All other	Split System and Single Package	11.5 EER 11.7 IEER	
Condensing units, air cooled	≥ 135,000 Btu/h			10.5 EER 11.8 IEER	AHRI 365
Condensing units,	≥ 135,000 Btu/h			13.5 EER 14.0 IEER	

EQUIPMENT TYPE	SIZE CATEGORY	HEATING SECTION TYPE	SUBCATEGORY OR RATING CONDITION	MINIMUM EFFICIENCY	TEST PROCEDURE
water cooled					
Condensing units, evaporatively cooled	≥ 135,000 Btu/h			13.5 EER 14.0 IEER	

High Efficiency:

The high efficiency case assumes the HVAC equipment meets or exceeds the Consortium for Energy Efficiency's (CEE) specification. This specification results in cost-effective energy savings by specifying higher efficiency HVAC equipment while ensuring that several manufacturers produce compliant equipment. The CEE specification is reviewed and updated annually to reflect changes to the ASHRAE and IECC energy code baseline as well as improvements in the HVAC equipment technology. Equipment efficiency is the rated efficiency of the installed equipment for each project.

Measure Life:

The measure life is 12 years.

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Unitary AC	CI_EQUIP	All	12	n/a	n/a	12

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure	Core Initiative	PA	ISR	RR$_E$	RR$_{NE}$	RR$_{SP}$	RR$_{WP}$	CF$_{SP}$	CF$_{WP}$
Unitary AC	CI_EQUIP	CLC	1.00	1.00	1.00	0.74	0.00	0.45	0.00
Unitary AC	CI_EQUIP	National Grid	1.00	1.00	1.00	1.00	1.00	0.40	0.00
Unitary AC	CI_EQUIP	Eversource	1.00	1.00	1.00	0.74	0.00	0.45	0.00
Unitary AC	CI_EQUIP	Unitil	1.00	1.00	1.00	1.00	1.00	0.33	0.00

In-Service Rates:
All installations have 100% in service rate since all programs include verification of equipment installations.

Realization Rates:
Energy RRs set to 1.00 based 2011 NEEP C&I Unitary HVAC Loadshape Project.[2]

Coincidence Factors:
CFs based 2011 NEEP C&I Unitary HVAC Loadshape Project.[3]

Impact Factors for Calculating Net Savings:

NTG values were developed as part of an upstream HVAC NTG study in 2021 in Massachusetts.[5]

Measure	Initiative	PA	FR	SO$_P$	SO$_{NP}$	NTG
HVAC - Upstream - Unitary Air Conditioner - 2022	CI_EQUIP	All	0.45	0.00	0.00	0.55
HVAC - Upstream - Unitary Air Conditioner - 2023	CI_EQUIP	All	0.45	0.00	0.00	0.55
HVAC - Upstream - Unitary Air Conditioner - 2024	CI_EQUIP	All	0.45	0.00	0.00	0.55

Non-Energy Impacts:

Measure Name	Core Initiative	PA	Annual $ per kWh	Annual $ per Therm
HVAC - Unitary Air Conditioner	CI_EQUIP	All	$0.135	

Endnotes:

1 : The capacity adjustment factor is used only when IEER is used to determine energy savings. Since IEER takes into account performance at different loading points, the capacity adjustment factor helps to account for the fact that more load occurs at lower temperatures and capacities. The adjustment factor is greater than 1 for climate zones with lower full load hours and runtime, and the factor is less than 1 for zones with more full load hours and runtime.
2 : KEMA (2011). C&I Unitary HVAC Loadshape Project.
KEMA_2011_CIUnitaryHVACLoadShapeProject
3 : KEMA (2011). C&I Unitary HVAC Loadshape Project.
KEMA_2011_CIUnitaryHVACLoadShapeProject
4 : NMR Group, Inc. (2021). C&I Upstream HVAC & Gas Water Heating NTG Study
2021_NMR_C&I_HVAC_NTG

3.70 HVAC - VRF, GSHP Displacing Electric Heat

Measure Code	COM-HVAC-HPE
Market	Commercial
Program Type	Lost Opportunity, Retrofit
Category	Heating Ventilation and Air Conditioning

Measure Description:

Installation of a heat pump displacing electric heat

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
VRFHP partially displacing electric heat	C&I New & Replacement Equipment (CI_EQUIP)	EC2b127
VRFHP fully displacing electric heat	C&I New & Replacement Equipment (CI_EQUIP)	EC2b130
GSHP fully displacing electric heat	C&I New & Replacement Equipment (CI_EQUIP)	EC2b131

Algorithms for Calculating Primary Energy Impact:

Unit savings are deemed based on a model[1] developed to estimate the savings associated with the displacement of existing heating (and cooling) systems.

Measure	kWh/ton
VRFHP partially displacing electric heat	1,644
VRFHP fully displacing electric heat	2,129
GSHP fully displacing electric heat	4,161

Baseline Efficiency:

A list of baseline HVAC system types was developed based on prevalence in the commercial HVAC market according to available data sources, including the MA Baseline Studies, the 2018 Commercial Building Energy Consumption Survey (CBECS), and a participant survey fielded as part of the 2023 C&I Energy Optimization Model Update study. The technologies modeled were identified as likely candidates for program participation based on their floor area (<75,000 sf) and represented non-heat pump-based technologies utilizing any fuel type other than district steam or hot water.

The efficiency of the baseline systems were derived from multiple sources including MA Baseline Studies and the MA Baseline Repository. Efficiencies of modeled scenarios that were not avialable in other data sources were used as a lever for calibrating the models as part of the Energy Optimization Model Update. The model used equipment capacities based on typical design conditions and account for typical commercial building geometries and the building characteristics (envelope, internal gains, and ventilation requirements) developed through the study's calibration process.

A comprehensive table of baseline equipment types and efficiencies can be found on page 22 of the Energy Optimization Model Update study report.

High Efficiency:

The high efficiency case is equal to code, using ASHRAE 90.1-2022 Table 6.8.9-1 or equivalent.

Measure Life:

The measure life is based on evaluation results[3] .

Measure Name	Core Initiative	PA	EUL[4]	OYF	RUL	AML
VRFHP partially displacing electric heat	CI_EQUIP	All	17	n/a	n/a	17
VRFHP fully displacing electric heat	CI_EQUIP	All	17	n/a	n/a	17
GSHP fully displacing electric heat	CI_EQUIP	All	25	n/a	n/a	25

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
VRFHP partially displacing electric heat	CI_EQUIP	All	1.00	1.00	1.00	1.00	1.00	0.00	1.00
VRFHP fully displacing electric heat	CI_EQUIP	All	1.00	1.00	1.00	1.00	1.00	1.00	1.00
GSHP fully displacing electric heat	CI_EQUIP	All	1.00	1.00	1.00	1.00	1.00	1.00	1.00

In-Service Rates:

All installations have 100% in-service rates since all PAs programs include verification of equipment installations.

Realization Rates:

Realization rates are set to 100% since deemed savings are based on evaluation results.

Coincidence Factors:

Coincidence factors are calculated to reflect blend of heating and cooling.

Impact Factors for Calculating Net Savings:

Measure Name	Core Initiative	PA	FR	SO$_P$	SO$_{NP}$	NTG[4]
VRFHP partially displacing electric heat	CI_EQUIP	All	0.25	0.00	0.09	0.84
VRFHP fully displacing electric heat	CI_EQUIP	All	0.25	0.00	0.09	0.84
GSHP fully displacing electric heat	CI_EQUIP	All	0.25	0.00	0.09	0.84

Non-Energy Impacts:

Non-energy impacts are based on MA21X19-B-CIHSNEI C&I H&S NEI study results.[5]

Measure Name	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per kWh	Annual $ per Therm	One-time$ per Therm
VRFHP partially displacing electric heat	All	$0.00	$0.00	$0.095	$0.00	0.00	0.00
VRFHP fully displacing electric heat	All	$0.00	$0.00	$0.095	$0.00	0.00	0.00
GSHP fully displacing electric heat	All	$0.00	$0.00	$0.095	$0.00	0.00	0.00

Endnotes:

1 : Cadeo (2023). Energy Optimization Model Update. 2023_Cadeo_MA22C10_Energy Optimization Model Update

2 : Navigant Consulting (2018). Baseline Study Saturation Result
2018_Navigant_Baseline_Loadshape_Comprehensive_Report

3 : GDS Associates, Inc. (2007). Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures
GDS_2007_Measure_Life_Report_Residential_and_CI_Lighting_and_HVAC_Measures

4 : GDS Associates, Inc. (2007). Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures.
GDS_2007_Measure_Life_Report_Residential_and_CI_Lighting_and_HVAC_Measures

4 : NMR Group, Inc. (2021). Prescriptive and Custom NTG Omnibus Study. 2021_NMR_Prescriptive

and Custom Net-to-Gross Omnibus Study
5 : NMR Group Inc (2021). O&M and Non-O&M NEI Study. 2021_NMR_CIOM and NonOM NEI Study

3.71 HVAC - VRF, GSHP Displacing Gas

Measure Code	COM-HVAC-HPG
Market	Commercial
Program Type	Lost Opportunity, Retrofit
Category	Heating Ventilation and Air Conditioning

Measure Description:

Installation of a ducted or ductless heat pump system to replace baseline fuel (gas) heating system.

BCR Measure IDs:

Measure	Core Initiative	BCR Measure ID
VRF, Partially Displacing Gas Heating (Verified Wx)	C&I New & Replacement Equipment (CI_EQUIP)	GC2b065
VRF, Partially Displacing Gas Heating (Unverified Wx)	C&I New & Replacement Equipment (CI_EQUIP)	GC2b066
VRF, Fully Displacing Gas Heating (Verified Wx)	C&I New & Replacement Equipment (CI_EQUIP)	GC2b067
VRF, Fully Displacing Gas Heating (Unverified Wx)	C&I New & Replacement Equipment (CI_EQUIP)	GC2b087
GSHP, Fully Displacing Gas Heating (Verified Wx)	C&I New & Replacement Equipment (CI_EQUIP)	GC2b068
GSHP, Fully Displacing Gas Heating (Unverified Wx)	C&I New & Replacement Equipment (CI_EQUIP)	GC2b088

Algorithms for Calculating Primary Energy Impact:

Unit savings are deemed based on a model[1] developed to estimate the savings associated with the displacement of existing heating (and cooling) systems.

Measure	Core Initiative	PA	Annual kWh/ton	Annual kW/ton	Annual MMBtu/ton
VRF, Partially Displacing Gas Heating	CI_EQUIP	All	-552	-0.45	7.6

VRF, Fully Displacing Gas Heating	CI_EQUIP	All	-1,082	-0.94	11.5
GSHP, Fully Displacing Gas Heating	CI_EQUIP	All	-1,718[2]	-0.97	26.1

Baseline Efficiency:

A list of baseline HVAC system types was developed based on prevalence in the commercial HVAC market according to available data sources, including the MA Baseline Studies, the 2018 Commercial Building Energy Consumption Survey (CBECS), and a participant survey fielded as part of the 2023 C&I Energy Optimization Model Update study. The technologies modeled were identified as likely candidates for program participation based on their floor area (<75,000 sf) and represented non-heat pump-based technologies utilizing any fuel type other than district steam or hot water.

The efficiency of the baseline systems were derived from multiple sources including MA Baseline Studies and the MA Baseline Repository. Efficiencies of modeled scenarios that were not aviailable in other data sources were used as a lever for calibrating the models as part of the Energy Optimization Model Update. The model used equipment capacities based on typical design conditions and account for typical commercial building geometries and the building characteristics (envelope, internal gains, and ventilation requirements) developed through the study's calibration process.

A comprehensive table of baseline equipment types and efficiencies can be found on page 22 of the Energy Optimization Model Update study report.

High Efficiency:

The high efficiency case is equal to code, using ASHRAE 90.1-2022 Table 6.8.9-1 or equivalent.

Measure Life:

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
VRF, Partially Displacing Gas Heating	CI_EQUIP	All	17	n/a	n/a	17
VRF, Fully Displacing Gas Heating	CI_EQUIP	All	17	n/a	n/a	17
GSHP, Fully Displacing Gas Heating	CI_EQUIP	All	25	n/a	n/a	25

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR$_E$	RR$_{NE}$	RR$_{SP}$	RR$_{WP}$	CF$_{SP}$	CF$_{WP}$
VRF, Partially Displacing Gas Heating	CI_EQUIP	All	1.00	1.00	1.00	1.00	1.00	0.00	1.00
VRF, Fully Displacing Gas Heating	CI_EQUIP	All	1.00	1.00	1.00	1.00	1.00	0.00	1.00
GSHP, Fully Displacing Gas Heating	CI_EQUIP	All	1.00	1.00	1.00	1.00	1.00	0.00	1.00

In-Service Rates:

All installations have 100% in-service rates since all PAs programs include verification of equipment installations.

Realization Rates:
Realization rates are assumed 100% as impacts are deemed based on evaluation results.

Coincidence Factors:
Coincidence factors are calculated to reflect blend of heating and cooling.

Impact Factors for Calculating Net Savings:

Measure Name	Core Initiative	PA	FR	SO$_P$	SO$_{NP}$	NTG [3]
VRF, Partially Displacing Gas Heating	CI_EQUIP	All	0.37	0.03	0.19	0.84
VRF, Fully Displacing Gas Heating	CI_EQUIP	All	0.37	0.03	0.19	0.84
GSHP, Fully Displacing Gas Heating	CI_EQUIP	All	0.37	0.03	0.19	0.84

Non-Energy Impacts:

NEIs are based on study results.[4] [5]

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per KWh	Annual $ per Therm	One-time $ per Therm
VRF, Partially Displacing Gas Heating	CI_EQUIP	All			$0.149			
VRF, Fully Displacing Gas Heating	CI_EQUIP	All			$0.149			

GSHP, Fully Displacing Gas Heating	CI_EQUIP	All			$0.149		

Endnotes:

1 : Cadeo (2023). Energy Optimization Model Update. 2023_Cadeo_MA22C10_Energy Optimization Model Update

2 : The 2023 C&I Energy Optimization Model Update study calculated GSHP impacts for both a downstream and a midstream measure. The PAs do not have a midstream GSHP offer. This electric penalty reflects the sum of the study's reported downstream penalty (-2,029 kWh/ton) and the incremental midstream electric savings (311 kWh/ton).

3 : NMR Group Inc. (2021). C&I Prescriptive and Custom Omnibus Net-to-Gross Study. 2021_NMR_C&I_Omnibus_NTG

4 : DNV (2022). C&I Health & Safety NEIs. 2022_DNV_C&I_Heath_&_Safety_NEIs

5 : NMR Group, Inc. (2021). C&I O&M and Non-O&M NEIs. 2021_NMR_CIOM and NonOM NEI Study

3.72 HVAC - VRF, GSHP Displacing Oil/Propane

Measure Code	COM-HVAC-HPOP
Market	Commercial
Program Type	Lost Opportunity, Retrofit
Category	Heating Ventilation and Air Conditioning

Measure Description:

Installation of a ducted or ductless heat pump system to replace baseline fuel (oil/propane) heating system.

BCR Measure IDs:

Measure	Core Initiative	BCR Measure ID
GSHP fully displacing Oil Heat (weatherized)	C&I New & Replacement Equipment (CI_EQUIP)	EC2b140
GSHP fully displacing Propane Heat (weatherized)	C&I New & Replacement Equipment (CI_EQUIP)	EC2b141
GSHP fully displacing Oil Heat (weatherization unverified)	C&I New & Replacement Equipment (CI_EQUIP)	EC2b158
GSHP fully displacing Propane Heat (weatherization unverified)	C&I New & Replacement Equipment (CI_EQUIP)	EC2b159
VRFHP partially displacing Oil Heat (weatherized)	C&I New & Replacement Equipment (CI_EQUIP)	EC2b134
VRFHP partially displacing Propane Heat (weatherized)	C&I New & Replacement Equipment (CI_EQUIP)	EC2b135
VRFHP fully displacing Oil Heat (weatherized)	C&I New & Replacement Equipment (CI_EQUIP)	EC2b138
VRFHP fully displacing Propane Heat (weatherized)	C&I New & Replacement Equipment (CI_EQUIP)	EC2b139
VRFHP partially displacing Oil Heat (weatherization unverified)	C&I New & Replacement Equipment (CI_EQUIP)	EC2b146
VRFHP partially displacing Propane Heat (weatherization unverified)	C&I New & Replacement Equipment (CI_EQUIP)	EC2b147
VRFHP fully displacing Oil Heat	C&I New & Replacement	EC2b156

| (weatherization unverified) | Equipment (CI_EQUIP) | |
| VRFHP fully displacing Propane Heat (weatherization unverified) | C&I New & Replacement Equipment (CI_EQUIP) | EC2b157 |

Algorithms for Calculating Primary Energy Impact:

Unit savings are deemed based on a model[1] developed to estimate the savings associated with the displacement of existing heating (and cooling) systems.[1]

Measure	Core Initiative	PA	Annual kWh/ton	Annual MMBtu/ton
GSHP fully displacing Oil Heat (weatherized)	CI_EQUIP	All	-1,718	26.7
GSHP fully displacing Propane Heat (weatherized)	CI_EQUIP	All	-1,718	24.8
GSHP fully displacing Oil Heat (weatherization unverified)	CI_EQUIP	All	-1,718	26.7
GSHP fully displacing Propane Heat (weatherization unverified)	CI_EQUIP	All	-1,718	24.8
VRF partially displacing Oil Heat (weatherized)	CI_EQUIP	All	-505	7.4
VRF partially displacing Propane Heat (weatherized)	CI_EQUIP	All	-505	7.4
VRF fully displacing Oil Heat (weatherized)	CI_EQUIP	All	-1,139	12.2
VRF fully displacing Propane Heat (weatherized)	CI_EQUIP	All	-1,139	12.2
VRF partially displacing Oil Heat (weatherization unverified)	CI_EQUIP	All	-505	7.4
VRF partially displacing Propane Heat (weatherization unverified)	CI_EQUIP	All	-505	7.4
VRF fully displacing Oil Heat (weatherization unverified)	CI_EQUIP	All	-1,139	12.2
VRF fully displacing Propane Heat (weatherization unverified)	CI_EQUIP	All	-1,139	12.2

Baseline Efficiency:

A list of baseline HVAC system types was developed based on prevalence in the commercial HVAC market according to available data sources, including the MA Baseline Studies, the 2018 Commercial Building Energy Consumption Survey (CBECS), and a participant survey fielded as part of the 2023 C&I Energy Optimization Model Update study. The technologies modeled were identified as likely

candidates for program participation based on their floor area (<75,000 sf) and represented non-heat pump-based technologies utilizing any fuel type other than district steam or hot water.

The efficiency of the baseline systems were derived from multiple sources including MA Baseline Studies and the MA Baseline Repository. Efficiencies of modeled scenarios that were not avialable in other data sources were used as a lever for calibrating the models as part of the Energy Optimization Model Update. The model used equipment capacities based on typical design conditions and account for typical commercial building geometries and the building characteristics (envelope, internal gains, and ventilation requirements) developed through the study's calibration process.

A comprehensive table of baseline equipment types and efficiencies can be found on page 22 of the Energy Optimization Model Update study report.

High Efficiency:

The high efficiency case is equal to code, using ASHRAE 90.1-2022 Table 6.8.9-1 or equivalent.

Measure Life:

The measure life is based on evaluation results[3]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
GSHP fully displacing Oil Heat (weatherized)	CI_EQUIP	All	25	n/a	n/a	25
GSHP fully displacing Propane Heat (weatherized)	CI_EQUIP	All	25	n/a	n/a	25
GSHP fully displacing Oil Heat (weatherization unverified)	CI_EQUIP	All	25	n/a	n/a	25
GSHP fully displacing Propane Heat (weatherization unverified)	CI_EQUIP	All	25	n/a	n/a	25
VRF partially displacing Oil Heat (weatherized)	CI_EQUIP	All	17	n/a	n/a	17
VRF partially displacing Propane Heat (weatherized)	CI_EQUIP	All	17	n/a	n/a	17
VRF fully displacing Oil Heat (weatherized)	CI_EQUIP	All	17	n/a	n/a	17
VRF fully displacing Propane Heat (weatherized)	CI_EQUIP	All	17	n/a	n/a	17
VRF partially displacing Oil Heat (weatherization unverified)	CI_EQUIP	All	17	n/a	n/a	17

VRF partially displacing Propane Heat (weatherization unverified)	CI_EQUIP	All	17	n/a	n/a	17
VRF fully displacing Oil Heat (weatherization unverified)	CI_EQUIP	All	17	n/a	n/a	17
VRF fully displacing Propane Heat (weatherization unverified)	CI_EQUIP	All	17	n/a	n/a	17

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
GSHP fully displacing Oil Heat (weatherized)	CI_EQUIP	All	1.00	1.00	1.00	1.00	1.00	0.00	1.00
GSHP fully displacing Propane Heat (weatherized)	CI_EQUIP	All	1.00	1.00	1.00	1.00	1.00	0.00	1.00
GSHP fully displacing Oil Heat (weatherization unverified)	CI_EQUIP	All	1.00	1.00	1.00	1.00	1.00	0.00	1.00
GSHP fully displacing Propane Heat (weatherization unverified)	CI_EQUIP	All	1.00	1.00	1.00	1.00	1.00	0.00	1.00
VRF partially displacing Oil Heat (weatherized)	CI_EQUIP	All	1.00	1.00	1.00	1.00	1.00	0.00	1.00
VRF partially displacing Propane Heat (weatherized)	CI_EQUIP	All	1.00	1.00	1.00	1.00	1.00	0.00	1.00
VRF fully displacing Oil Heat (weatherized)	CI_EQUIP	All	1.00	1.00	1.00	1.00	1.00	0.00	1.00
VRF fully displacing Propane Heat (weatherized)	CI_EQUIP	All	1.00	1.00	1.00	1.00	1.00	0.00	1.00
VRF partially displacing Oil Heat (weatherization unverified)	CI_EQUIP	All	1.00	1.00	1.00	1.00	1.00	0.00	1.00
VRF partially displacing Propane Heat (weatherization unverified)	CI_EQUIP	All	1.00	1.00	1.00	1.00	1.00	0.00	1.00
VRF fully displacing Oil Heat (weatherization unverified)	CI_EQUIP	All	1.00	1.00	1.00	1.00	1.00	0.00	1.00

Measure Name	Core Initiative	PA	ISR	RR$_E$	RR$_{NE}$	RR$_{SP}$	RR$_{WP}$	CF$_{SP}$	CF$_{WP}$
VRF fully displacing Propane Heat (weatherization unverified)	CI_EQUIP	All	1.00	1.00	1.00	1.00	1.00	0.00	1.00

In-Service Rates:
All installations have 100% in-service rates since all PAs programs include verification of equipment installations.

Realization Rates:
Realization rates are assumed 100% as deemed impacts are evaluated results.

Coincidence Factors:
Coincidence factors are calculated to reflect blend of heating and cooling.

Impact Factors for Calculating Net Savings:

Measure Name	Core Initiative	PA	FR	SO$_P$	SO$_{NP}$	NTG4
GSHP fully displacing Oil Heat (weatherized)	CI_EQUIP	All	0.31	0.22	0.00	0.84
GSHP fully displacing Propane Heat (weatherized)	CI_EQUIP	All	0.31	0.22	0.00	0.84
GSHP fully displacing Oil Heat (weatherization unverified)	CI_EQUIP	All	0.31	0.22	0.00	0.84
GSHP fully displacing Propane Heat (weatherization unverified)	CI_EQUIP	All	0.31	0.22	0.00	0.84
VRF partially displacing Oil Heat (weatherized)	CI_EQUIP	All	0.31	0.22	0.00	0.84
VRF partially displacing Propane Heat (weatherized)	CI_EQUIP	All	0.31	0.22	0.00	0.84
VRF fully displacing Oil Heat (weatherized)	CI_EQUIP	All	0.31	0.22	0.00	0.84
VRF fully displacing Propane Heat (weatherized)	CI_EQUIP	All	0.31	0.22	0.00	0.84
VRF partially displacing Oil Heat (weatherization unverified)	CI_EQUIP	All	0.31	0.22	0.00	0.84
VRF partially displacing Propane Heat (weatherization unverified)	CI_EQUIP	All	0.31	0.22	0.00	0.84
VRF fully displacing Oil Heat (weatherization unverified)	CI_EQUIP	All	0.31	0.22	0.00	0.84
VRF fully displacing Propane Heat (weatherization unverified)	CI_EQUIP	All	0.31	0.22	0.00	0.84

Non-Energy Impacts:

NEIs are based on study results.[5][6]

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per KWh	Annual $ per Therm	One-time $ per Therm
GSHP fully displacing Oil Heat (weatherized)	CI_EQUIP	All			$0.149			
GSHP fully displacing Propane Heat (weatherized)	CI_EQUIP	All			$0.149			
GSHP fully displacing Oil Heat (weatherization unverified)	CI_EQUIP	All			$0.149			
GSHP fully displacing Propane Heat (weatherization unverified)	CI_EQUIP	All			$0.149			
VRF partially displacing Oil Heat (weatherized)	CI_EQUIP	All			$0.149			
VRF partially displacing Propane Heat (weatherized)	CI_EQUIP	All			$0.149			
VRF fully displacing Oil Heat (weatherized)	CI_EQUIP	All			$0.149			
VRF fully displacing Propane Heat (weatherized)	CI_EQUIP	All			$0.149			
VRF partially displacing Oil Heat (weatherization unverified)	CI_EQUIP	All			$0.149			
VRF partially displacing Propane Heat (weatherization unverified)	CI_EQUIP	All			$0.149			
VRF fully displacing Oil Heat (weatherization unverified)	CI_EQUIP	All			$0.149			
VRF fully displacing Propane Heat (weatherization unverified)	CI_EQUIP	All			$0.149			

Endnotes:

1 : The 2023 C&I Energy Optimization Model Update study calculated GSHP impacts for both a downstream and a midstream measure. The PAs do not have a midstream GSHP offer. This electric penalty reflects the sum of the study's reported downstream penalty (-2,029 kWh/ton) and the incremental midstream electric savings (311 kWh/ton). 2023_Cadeo_MA22C10_Energy Optimization Model Update

2 : MA19C04-E-EO - MA Energy Optimization Model_19APR2021

3 : GDS Associates, Inc. (2007). Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures.
GDS_2007_Measure_Life_Report_Residential_and_CI_Lighting_and_HVAC_Measures

4 : NMR Group Inc. (2021). C&I Prescriptive and Custom Omnibus Net-to-Gross Study.
2021_NMR_C&I_Omnibus_NTG

5 : NMR Group Inc (2021). O&M and Non-O&M NEI Study 2021_NMR_CIOM and NonOM NEI Study

6 : DNV (2022). C&I Health & Safety NEIs 2022_DNV_C&I_Heath_&_Safety_NEIs

3.73 Hot Water - Commercial Pool Heater Midstream

Measure Code	COM-WH-PH
Market	Commercial
Program Type	Retrofit
Category	Hot Water

Measure Description:

Installation of a high-efficiency gas-fired pool heater.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Commercial Pool Heater - Midstream	C&I New & Replacement Equipment (CI_EQUIP)	GC2b070

Algorithms for Calculating Primary Energy Impact:

Savings values are tied to unit Mbtuh[1].

Measure Name	ΔMMBtu/Mbtuh
Commercial Pool Heater - Midstream	0.21

Baseline Efficiency:

The assumed baseline is 82% thermal efficiency gas-fired pool heater.

High Efficiency:

The high efficiency case is a gas-fired pool heater with thermal efficiency >= 84%.

Measure Life:

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Commercial Pool Heater- Midstream	CI_EQUIP	All	5	n/a	n/a	5

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Commercial Pool Heater-Midstream	CI_EQUIP	All	1.00	n/a	1.00	n/a	n/a	n/a	n/a

In-Service Rates:

All installations have 100% in service rate since programs include verification of equipment installations.

Realization Rates:

All PAs use a 100% realization rate. The summer and winter peak realization rates are not applicable for this
measure since there are no electric savings claimed.

Coincidence Factors:

Not applicable for this measure since no electric savings are claimed.

Impact Factors for Calculating Net Savings:

Values based on 2021 C&I Upstream HVAC & Gas Water Heating NTG study[2].

Measure Name	Core Initiative	PA	FR	NTG
Commercial Pool Heater - Midstream	CI_EQUIP	All	0.62	0.38

Non-Energy Impacts:

There are no non-energy impacts associated with this measure.

Endnotes:

1 : DNV GL, Inc (2019). Impact Evaluation of Commercial Water Heaters: Baseline Adjustment Memo Including Water Consumption Estimates. Table 5.
2 : NMR Group, Inc. (2021). C&I Upstream HVAC & Gas Water Heating NTG Study
2021_NMR_C&I_HVAC_NTG

3.74 Hot Water - Condensing Water Heater

Measure Code	COM-WH-CWH
Market	Commercial
Program Type	Replace on Burnout
Category	Water Heating

Measure Description:

Installation of a high-efficiency gas-fired water heater.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Water Heater, Condensing, Gas - Upstream	C&I New & Replacement Equipment (CI_EQUIP)	GC2b025

Algorithms for Calculating Primary Energy Impact:

Savings values are tied to unit Mbtuh.[1] Updates to algorithms, baseline efficiency, and high-efficiency edits are suggestions from the C&I Comprehensive TRM Review[2]

Measure Name	ΔMMBtu
Condensing Water Heater, Gas 0.94 - Upstream	0.1441

Baseline Efficiency:

The baseline efficiency case assumes compliance with the efficiency requirements as mandated by Massachusetts State Building Code. As described in the MA State Building Code, energy efficiency must be met via compliance with the relevant International Energy Conservation Code (IECC). For condensing stand-alone water heaters, the assumed baseline is a stand-alone tank water heater with a thermal efficiency of 80%.[3]

High Efficiency:

The high efficiency case is a condensing stand alone commercial water heater with a thermal efficiency of 94% or greater and a capacity greater than 75,000 Btu.

Measure Life:

The measure life is 15 years.[4]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Condensing Water Heater, Gas 0.94 - Upstream	CI_EQUIP	All	15	n/a	n/a	15

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Condensing Water Heater, Gas 0.94 - Upstream	CI_EQUIP	All	1.00	n/a	1.00	n/a	n/a	n/a	n/a

In-Service Rates:
All installations have 100% in-service rates since programs include verification of equipment installations.

Realization Rates:
All PAs use 100% energy realization rates. The summer and winter peak realization rates are not applicable for this measure since there are no electric savings claimed.

Coincidence Factors:
Not applicable for this measure since no electric savings are claimed.

Impact Factors for Calculating Net Savings:

Values based on 2021 C&I Upstream HVAC NTG study.[5]

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	2022 NTG	2023 NTG	2024 NTG
Condensing Water Heater, Gas - Upstream	CI_EQUIP	All	0.71			0.29	0.29	0.29

Non-Energy Impacts:

Measure Name	Core Initiative	PA	Annual $ per kWh	Annual $ per Therm
Hot Water - Condensing Water Heater	CI_EQUIP	All		$0.079

Endnotes:

1 : Unit savings are unevaluated and developed by upstream subcommittee in response to NTG findings going into the 2019-2021 plan. Original savings set lower HE thresholds, though NTG results suggested establishing higher thresholds to ensure the program was targeting the right units. Efficiency threshold increased from 90% AFUE to 94% AFUE.

2 : DNV (2019) MA19C10-G-WHGPD Final Combined Baseline Adjustment Memo_5_27_19, Condensing Tank Style

3 : GDS Associates, Inc. (2009). Natural Gas Energy Efficiency Potential in Massachusetts. Prepared for GasNetworks; Page 2 of Appendix B-2, measure GDS C-WH-4. The GDS study references "ACEEE (2004). Emerging technologies and practices; W1 - pg 46."
GDS_2009_Natural_Gas_Energy_Efficiency_Potential_in_MA

4 : NMR Group, Inc. (2021). C&I Upstream HVAC & Gas Water Heating NTG Study
2021_NMR_Upstream_HVAC_WH_Process_Eval

3.75 Hot Water - Faucet Aerator

Measure Code	COM-WH-FA
Market	Commercial
Program Type	Retrofit
Category	Water Heating

Measure Description:

Installation of a faucet aerator with a flow rate of 1.5 GPM or less on an existing faucet with high flow in a commercial setting with service water heated by natural gas.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Faucet Aerator, Electric (Turnkey)	C&I Existing Building Retrofit (CI_RETRO)	EC2a138
Faucet Aerator, Oil (Turnkey)	C&I Existing Building Retrofit (CI_RETRO)	EC2a139
Faucet Aerator, Propane (Turnkey)	C&I Existing Building Retrofit (CI_RETRO)	EC2a140
Faucet Aerator, Electric	C&I New & Replacement Equipment (CI_EQUIP)	EC2b162
Faucet Aerator, Oil	C&I New & Replacement Equipment (CI_EQUIP)	EC2b163
Faucet Aerator, Propane	C&I New & Replacement Equipment (CI_EQUIP)	EC2b164
Faucet Aerator, Gas	C&I Existing Building Retrofit (CI_RETRO)	GC2a021
Faucet Aerator, Gas (Turnkey)	C&I Existing Building Retrofit (CI_RETRO)	GC2a042
Faucet Aerator, Gas (OMP)	C&I New and Replacement Equipment (CI_EQUIP)	GC2b076

Algorithms for Calculating Primary Energy Impact:

Unit gas savings are deemed based on study results[1,2] Updates to deemed savings, algorithms, baseline efficiency, and/or high-efficiency edits are suggestions from the C&I Comprehensive TRM Review[3]

Measure Name	ΔkWh	ΔkW	ΔMMBtu
Faucet Aerator, Gas			1.7
Faucet Aerator, Electric	348	0.08	
Faucet Aerator, Oil			1.7
Faucet Aerator, Propane			1.7

Baseline Efficiency:

The baseline efficiency case is a 2.2 GPM faucet.[3] [5]

High Efficiency:

The high efficiency case is a faucet with 1.5 GPM or less aerator installed.[4] [7]

Measure Life:

The measure life is 3 years.[5]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Faucet Aerator	CI_RETRO	All	10	n/a	n/a	3

Other Resource Impacts:

There are deemed water savings of 5,460 gallons/unit.[6]

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Faucet Aerator, Electric (Turnkey)	CI_RETRO	All	1.00	1.00	1.00	1.00	1.00	0.31	0.84

In-Service Rates:
All installations have 100% in service rate since programs include verification of equipment installations.

Realization Rates:
All PAs use 100% energy and demand realization rates.

Coincidence Factors:
Summer and winter coincidence factors are estimated using the demand allocation methodology described in the Demand Impact Model which is developed based on the Residential Baseline Study.[7]

Impact Factors for Calculating Net Savings:

Net to gross factors are based on evaluation results.[8]

Measure Name	Core Initiative	PA	FR	SO$_P$	SO$_{NP}$	NTG
Faucet Aerator, Gas	CI_RETRO	All	0.369	0.000	0.032	0.663
Faucet Aerator, Gas (Turnkey)	CI_RETRO	All	0.285	0.000	0.000	0.715
Faucet Aerator, Electric/Oil/Propane (Turnkey)	CI_RETRO	All	0.077	0.013	0.004	0.940
Faucet Aerator, Electric/Oil/Propane (OMP)	CI_RETRO	All	0.25	0.00	0.09	0.84
Faucet Aerator, Gas (OMP)	CI_RETRO	All	0.37	0.03	0.19	0.840

Non-Energy Impacts:

Non-energy impacts identified for this measure are as below.[9]

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per KWh	Annual $ per Therm	One-time $ per Therm
Faucet Aerator, Gas	CI_RETRO	All					$ 0.357	
Faucet Aerator, Gas (Turnkey)	CI_RETRO	All					$ 0.357	

Endnotes:

1 : GDS Associates, Inc (2009). Natural Gas Energy Efficiency Potential in Massachusetts.
GDS_2009_Natural_Gas_Energy_Efficiency_Potential_in_MA
2 : mmBTU for delivered fuels assumed to be 1:1 with already existing gas measure.
3 : GDS Associates, Inc (2009). Natural Gas Energy Efficiency Potential in Massachusetts, Table B-2a.
GDS_2009_Natural_Gas_Energy_Efficiency_Potential_in_MA
4 : GDS Associates, Inc (2009). Natural Gas Energy Efficiency Potential in Massachusetts, Table B-2a
GDS_2009_Natural_Gas_Energy_Efficiency_Potential_in_MA
5 : DNV GL (2021). Prescriptive Measures NRNC and ISP Results. 2021_DNV_Prescriptive Measures NRNC and ISP Results
6 : Federal Energy Management Program (2011). Energy Cost Calculator for Faucets and Showerheads.
7 : Guidehouse (2020). Residential Baseline Study Phase 4
2020_Guidehouse_Residential_Baseline_Phase_4
8 : NMR Group, Inc. (2018). Massachusetts Sponsors' Commercial and Industrial Free-ridership and Spillover Study. 2018_NMR_CI FR-SO Report
9 : NMR Group Inc (2021). O&M and Non-O&M NEI Study. 2021_NMR_CIOM and NonOM NEI Study

3.76 Hot Water - Faucet Aerator - C&I Metered Multi-Family

Measure Code	COM-WH-FAREU
Market	Commercial
Program Type	Retrofit
Category	Water Heating

Measure Description:

An existing faucet aerator with a high flow rate is replaced with a new low flow aerator.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Faucet Aerator, Electric (Residential End Use)	C&I Existing Building Retrofit (CI_RETRO)	EC2a066
Faucet Aerator, Gas (Residential End Use)	C&I Existing Building Retrofit (CI_RETRO)	EC2a067
Faucet Aerator, Oil (Residential End Use)	C&I Existing Building Retrofit (CI_RETRO)	EC2a068
Faucet Aerator, Other (Residential End Use)	C&I Existing Building Retrofit (CI_RETRO)	EC2a069
Faucet Aerator, Gas (Residential End Use)	C&I Existing Building Retrofit (CI_RETRO)	GC2a062

Algorithms for Calculating Primary Energy Impact:

Unit kWh and MMBtu savings are deemed based on study results.[1] Demand savings are derived from the demand impact model which is developed as part of the Residential Baseline Study.[2]

Measure Name	ΔkWh	ΔkW	Δ MMBtu
Faucet Aerator, Electric (Residential End Use)	97.0	0.02	
Faucet Aerator, Gas (Residential End Use)			0.86
Faucet Aerator, Oil (Residential End Use)			0.86
Faucet Aerator, Other (Residential End Use)			0.86

Baseline Efficiency:

The baseline efficiency case is the existing faucet aerator with a high flow.

High Efficiency:

The high efficiency case is a low flow faucet aerator having a maximum flow rate of 1.5 GPM.

Measure Life:

The measure life is 7 years.[3]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Faucet Aerator	CI_RETRO	All	7	n/a	n/a	7

Other Resource Impacts:

Residential water savings for faucet aerators is 332 gallons per unit.[4]

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Faucet Aerator	CI_RETRO	All	1.00	1.00	1.00	1.00	1.00	0.31	0.84

In-Service Rates:

All installations have 100% in service rate since programs include verification of equipment installations.

Realization Rates:

Realization rates are set to 100% for deemed measures.

Coincidence Factors:

Summer and winter coincidence factors are estimated using the demand allocation methodology described in the Demand Impact Model which is developed based on the Residential Baseline Study.[5]

Impact Factors for Calculating Net Savings:

Net to gross factors are based on evaluation results.[6]

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Faucet Aerator (Residential End Use)	CI_RETRO	All	0.14	0.0	0.0	0.86

Non-Energy Impacts:

NEI values are rolled up, component values can be found in Appendix B.

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per KWh	Annual $ per Therm	One-time $ per Therm
Faucet Aerator (Residential End Use)	CI_RETRO	All	0.58	0.00	0.00	0.00	0.00	0.00

Endnotes:

1 : Navigant Consulting (2018). Multi-Family Program Impact and Net-to-Gross Evaluation.
2018_Navigant_Multifamily_Program_Impact_Evaluation
2 : Guidehouse (2020). Residential Baseline Study Phase 4
2020_Guidehouse_Residential_Baseline_Phase_4
3 : MA Common Assumptions
4 : NMR Group, Inc., Tetra Tech (2011). Massachusetts Special and Cross-Sector Studies Area, Residential and Low-Income Non-Energy Impacts (NEI) Evaluation.
Tetra_Tech_and_NMR_2011_MA_Res_and_LI_NEI_Evaluation
5 : Guidehouse (2020). Residential Baseline Study Phase 4
2020_Guidehouse_Residential_Baseline_Phase_4
6 : Guidehouse (2021). Residential Programs Net-to-Gross Research of RCD and Select Products.
2021_Guidehouse_MA_Res_NTG_Final_Report

3.77 Hot Water - High Speed Clothes Washer Midstream

Measure Code	COM-WH-HSCW
Market	Commercial
Program Type	Retrofit
Category	Hot Water

Measure Description:

Installation of a commercial high speed clothes washer.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
High Speed Clothes Washer - Midstream	C&I New & Replacement Equipment (CI_EQUIP)	GC2b071

Algorithms for Calculating Primary Energy Impact:

Savings values are tied to pound of capacity.[1]

Measure Name	ΔMMBtu/lb
High Speed Clothes Washer - Midstream	0.465

Baseline Efficiency:

The assumed baseline is a clothes washer with extraction speed <100G.

High Efficiency:

The high efficiency case is a clothes washer with extraction speed >200G.

Measure Life:

Measure Name	Core Initiative	PA	EUL[2]	OYF	RUL	AML
High Speed Clothes Washer- Midstream	CI_EQUIP	All	7	n/a	n/a	7

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR$_E$	RR$_{NE}$	RR$_{SP}$	RR$_{WP}$	CF$_{SP}$	CF$_{WP}$
High Speed Clothes Washer - Midstream	CI_EQUIP	All	1.00	n/a	1.00	n/a	n/a	n/a	n/a

In-Service Rates:

All installations have 100% in service rate since programs include verification of equipment installations.

Realization Rates:

All PAs use a 100% realization rate[3]. The summer and winter peak realization rates are not applicable for this
measure since there are no electric savings claimed.

Coincidence Factors:

Not applicable for this measure since no electric savings are claimed.

Impact Factors for Calculating Net Savings:

Values based on 2021 C&I Prescriptive & Custom Omnibus NTG study[4].

Measure Name	Core Initiative	PA	FR	SO$_P$	SO$_{NP}$	NTG
High Speed Clothes Washer - Midstream	CI_EQUIP	All	0.37	0.03	0.19	0.84

Non-Energy Impacts:

There are no non-energy impacts identified for this measure.

Endnotes:

1 : DNV GL, Inc (2019). Impact Evaluation of Commercial Water Heaters: Baseline Adjustment Memo Including Water Consumption Estimates.
2 : GDS Associates, Inc. (2009). Natural Gas Energy Efficiency Potential in Massachusetts; Appendix A-2. GDS_2007_Measure_Life_Report_Residential_and_CI_Lighting_and_HVAC_Measures
3 : DNV GL, Inc (2019). Impact Evaluation of Commercial Water Heaters: Baseline Adjustment Memo Including Water Consumption Estimates. NOTE - realization rate changed b/w 2019 and 2020 as net impacts have been folded into deemed savings values beginning in 2020.
4 : NMR Group, Inc. (2021). C&I Upstream HVAC & Gas Water Heating NTG Study
2021_NMR_C&I_HVAC_NTG

3.78 Hot Water - Indirect Water Heater

Measure Code	COM-WH-IWH
Market	Commercial
Program Type	Replace on Burnout
Category	Water Heating

Measure Description:

Indirect water heaters use a storage tank that is heated by the main boiler. The energy stored by the water tank allows the boiler to turn off and on less often, saving considerable energy.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Water Heater, Indirect, Gas - Upstream	C&I New & Replacement Equipment (CI_EQUIP)	GC2b023

Algorithms for Calculating Primary Energy Impact:

Unit savings are deemed per unit based on the algorithms and deemed inputs outlined below.[1]

Measure Name	ΔMMBtu
Indirect Water Heater, Gas - Upstream	10.0

Annual Electric Energy Savings

$$\Delta kWh = N/A$$

Summer Peak Coincident Demand Savings

$$\Delta kW = N/A$$

Annual Fossil Fuel Energy Savings

$$\Delta MMBtu = units\ x\ \left[\frac{GPD\ x\ 365\ x\ 8.33\ x\ (T_{set} - T_{main})}{1,000,000}\ x\ \left(\frac{1}{Eff_{basline}} - \frac{1}{Eff_{ee}} \right) \right.$$
$$\left. + \left(\frac{UA_{baseline}}{Eff_{baseline}} - \frac{UA_{ee}}{Eff_{ee}} \right) x\ \frac{(T_{set} - T_{amb})}{1,000,000}\ x\ 8,760 \right]$$

Where:

ΔkWh   = Annual electric energy savings

ΔkW   = Peak coincident demand electric savings
ΔMMBtu   = Annual fossil fuel energy savings

Units   = number of measures installed under the program
GPD   = Gallons per day, 154[2]
T_{main} = Average temperature of supply water temperature in water main, 55.7°F[3]
T_{amb} = Average surrounding ambient air temperature, 70°F
T_{set} = Average water heater set point temperature, 140°F[4]
Eff $_{baseline}$ = Boiler space heating baseline condition, 85% AFUE[5]
Eff $_{ee}$ = Boiler space heating energy efficiency condition, 90% AFUE[6]
$UA_{baseline}$ = Overall heat loss coefficient (BTU/h-°F), 15[7]
365   = Days in one year
8.33   = Energy required (BTU) to heat one gallon of water by one-degree Fahrenheit
1,000,000   = Conversion factor, on MMBtu equals 1,000,000 Btu
8,760   = Hours per year

Baseline Efficiency:

The baseline efficiency case assumes space heating boiler operating at 85% AFUE. Additionally a baseline storage water heater was assumed for purposed of estimating standby losses.[8]

High Efficiency:

The high-efficiency case assumes the space heating boiler operating at 90% AFUE.

Measure Life:

The measure life is 15 years.[9]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Indirect Water Heater, Gas - Upstream	CI_EQUIP	All	15	n/a	n/a	15

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR$_E$	RR$_{NE}$	RR$_{SP}$	RR$_{WP}$	CF$_{SP}$	CF$_{WP}$
Indirect Water Heater, Gas - Upstream	CI_EQUIP	All	1.00	1.00	n/a	n/a	n/a	n/a	n/a

In-Service Rates:
All installations have 100% in service rate since programs include verification of equipment installations.

Realization Rates:

All PAs use 100% energy realization rate. The summer and winter peak realization rates are not applicable for this measure since there are no electric savings claimed.

Coincidence Factors:
Not applicable for this measure since no electric savings are claimed.

Impact Factors for Calculating Net Savings:

Values based on 2021 MA C&I Upstream HVAC NTG study.[10]

Measure Name	Core Initiative	PA	FR	2022 NTG	2023 NTG	2024 NTG
Indirect Water Heater, Gas - Upstream	CI_EQUIP	All	64%	36%	36%	36%

Non-Energy Impacts:

Measure Name	Core Initiative	PA	Annual $ per kWh	Annual $ per Therm
Hot Water - Indirect Water Heater	CI_EQUIP	All		$0.079

Endnotes:

1 : KEMA (2013). Impact Evaluation of 2011 Prescriptive Gas Measures; Page 1-6
KEMA_2013_Prescriptive_Gas_Impact_Eval_PY2011
2 : Title 10, Code of Federal Regulations, Part 430 - Energy Conservation Program for Consumer Products, Subpart C - Energy and Water Conservation Standards and Their Effective Dates. January 1, 2010; Energy Conservation standards for Residential Water Heaters, Direct Heating Equipment, and Pool Heaters: Final Rule, Federal Register, 75 FR 20112, April 16, 2010.
9 : GDS Associates, Inc. (2009). Natural Gas Energy Efficiency Potential in Massachusetts
GDS_2007_Measure_Life_Report_Residential_and_CI_Lighting_and_HVAC_Measures
10 : NMR Group, Inc. (2021). C&I Upstream HVAC & Gas Water Heating NTG Study
2021_NMR_C&I_HVAC_NTG

3.79 Hot Water - Low-Flow Showerhead

Measure Code	COM-WH-LFSH
Market	Commercial
Program Type	Retrofit
Category	Water Heating

Measure Description:

Installation of a low flow showerhead with a flow rate of 1.5 GPM or less in a commercial setting with service water heated by natural gas.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Low-Flow Showerhead, Electric	C&I Existing Building Retrofit (CI_RETRO)	EC2a042
Low-Flow Showerhead, Electric (Turnkey)	C&I Existing Building Retrofit (CI_RETRO)	EC2a141
Low-Flow Showerhead, Electric (OMP)	C&I New & Replacement Equipment (CI_EQUIP)	EC2b165
Low-Flow Showerhead, Oil (Turnkey)	C&I Existing Building Retrofit (CI_RETRO)	EC2a142
Low-Flow Showerhead, Oil (OMP)	C&I New & Replacement Equipment (CI_EQUIP)	EC2b166
Low-Flow Showerhead, Propane (Turnkey)	C&I Existing Building Retrofit (CI_RETRO)	EC2a143
Low-Flow Showerhead, Propane (OMP)	C&I New & Replacement Equipment (CI_EQUIP)	EC2b167
Low-Flow Showerhead with TSV, Electric	C&I New & Replacement Equipment (CI_EQUIP)	EC2b168
Low-Flow Showerhead with TSV, Oil	C&I New & Replacement Equipment (CI_EQUIP)	EC2b169
Low-Flow Showerhead with TSV, Other	C&I New & Replacement Equipment (CI_EQUIP)	EC2b170
Low-Flow Showerhead, Gas	C&I Existing Building Retrofit (CI_RETRO)	GC2a022

Low-Flow Showerhead, Gas (Turnkey)	C&I Existing Building Retrofit (CI_RETRO)	GC2a043
Low-Flow Showerhead, Gas (OMP)	C&I New and Replacement Equipment (CI_EQUIP)	GC2b077
Low-Flow Showerhead with TSV, Gas (OMP)	C&I New and Replacement Equipment (CI_EQUIP)	GC2b078

Algorithms for Calculating Primary Energy Impact:

Unit savings are deemed.[1] mmBTU savings for delivered fuels assumed to be in a 1:1 ratio with already existing gas measure. Updates to endnotes are suggestions from the C&I comprehensive TRM Review[2].

Measure Name	ΔkWh	ΔkW	ΔMMBtu
Low-Flow Showerhead, Electric	513	0.09	
Low-Flow Showerhead, Gas			2.65
Low-Flow Showerhead, Oil			2.65
Low-Flow Showerhead, Propane			2.65

Baseline Efficiency:

The baseline efficiency case is a 2.5 GPM showerhead.[2]

High Efficiency:

The high efficiency case is a 1.5 GPM showerhead.[3]

Measure Life:

The measure life is 7 years.[4]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Low-Flow Showerhead	CI_RETRO	All	10	n/a	n/a	7

Other Resource Impacts:

It is assumed that 7,300 gallons/unit are saved.[5]

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Low-Flow Showerhead, Electric	CI_RETRO	All	1.00	1.00	n/a	1.00	1.00	0.31	0.81
Low-Flow Showerhead, Gas	CI_RETRO	All	1.00	n/a	1.00	n/a	n/a	n/a	n/a
Low-Flow Showerhead, Oil	CI_RETRO	All	1.00	n/a	1.00	n/a	n/a	n/a	n/a
Low-Flow Showerhead, Propane	CI_RETRO	All	1.00	n/a	1.00	n/a	n/a	n/a	n/a

In-Service Rates:
All installations have 100% in service rate since programs include verification of equipment installations.

Realization Rates:
All PAs use 100% energy, demand, and non-energy realization rates.

Coincidence Factors:
Summer and winter coincidence factors are estimated using the demand allocation methodology described in the Demand Impact Model which is developed based on the Residential Baseline Study.[6]

Impact Factors for Calculating Net Savings:

Net-to-Gross values are based on evaluation results.[8]

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Low-Flow Showerhead, Electric	CI_RETRO	All	0.179	0.03	0.054	0.878
Low-Flow Showerhead, Electric/Oil/Propane (Turnkey)	CI_RETRO	All	0.077	0.013	0.004	0.940
Low-Flow Showerhead, Electric/Oil/Propane (OMP)	CI_EQUIP	All	0.25	0.00	0.09	0.84
Low-Flow Showerhead with TSV, Electric/Oil/Other	CI_EQUIP	All	0.25	0.00	0.09	0.84
Low-Flow Showerhead, Gas	CI_RETRO	All	0.369	0.000	0.032	0.664
Low-Flow Showerhead, Gas (Turnkey)	CI_RETRO	All	0.285	0.000	0.000	0.715
Low-Flow Showerhead, Gas (OMP)	CI_EQUIP	All	0.37	0.026	0.19	0.840
Low-Flow Showerhead with TSV, Gas (OMP)	CI_EQUIP	All	0.37	0.026	0.19	0.840

Non-Energy Impacts:

C&I values from 2021 C&I NEI study.[8]

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per KWh	Annual $ per Therm	One-time $ per Therm
Low-Flow Showerhead, Electric	CI_RETRO	All				$ 0.004		
Low-Flow Showerhead, Gas	CI_RETRO	All					$ 0.36	
Low-Flow Showerhead, Oil	CI_RETRO	All				$ 0.004		
Low-Flow Showerhead, Propane	CI_RETRO	All				$ 0.004		

Endnotes:

1 : Department of Energy Calculator for Faucets & Showerheads. https://www.energy.gov/eere/femp/energy-cost-calculator-faucets-and-showerheads-0 Subsequently revised for lower anticipated hot water use. Baseline values were used with the exception of hot water use. This was changed from 100% to 50%.
2 : 2022 TRM Review investigated revising baseline flow rate based on changes in the market. As of January 1, 1994, federal standard limited the flowrate of showerheads to 2.5 GPM or less. As it has been nearly 30 years since that regulation took effect it is reasonable to assume an average market baseline would be lower than 2.5 GPM; however, newer market data is not available to support a change at this time.
3 : 2022 TRM Review confirmed that implementation programs use multiple high efficiency flow rates in field including 1.6 GPM and 1.5 GPM.
4 : DNV GL (2021). Prescriptive Measures NRNC and ISP Results. 2021_DNV_Prescriptive Measures NRNC and ISP Results
5 : Federal Energy Management Program (2011). Energy Cost Calculator for Faucets and Showerheads.
6 : Guidehouse (2020). Residential Baseline Study Phase 4
2020_Guidehouse_Residential_Baseline_Phase_4
7 : NMR Group, Inc (2021). C&I Prescriptive and Custom Net-to-Gross Omnibus Study.
2021_NMR_C&I_Omnibus_NTG
8 : NMR Group Inc (2021). O&M and Non-O&M NEI Study. 2021_NMR_CIOM and NonOM NEI Study

3.80 Hot Water - Low-Flow Showerhead - C&I Metered Multi-Family

Measure Code	COM-WH-SREU
Market	Commercial
Program Type	Retrofit
Category	Water Heating

Measure Description:

An existing showerhead with a high flow rate is replaced with a new low flow showerhead.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Low-Flow Showerhead, Electric (Residential End Use)	C&I Existing Building Retrofit (CI_RETRO)	EC2a070
Low-Flow Showerhead, Gas (Residential End Use)	C&I Existing Building Retrofit (CI_RETRO)	EC2a071
Low-Flow Showerhead, Oil (Residential End Use)	C&I Existing Building Retrofit (CI_RETRO)	EC2a072
Low-Flow Showerhead, Other (Residential End Use)	C&I Existing Building Retrofit (CI_RETRO)	EC2a073
Low-Flow Showerhead, Gas (Residential End Use)	C&I Existing Building Retrofit (CI_RETRO)	GC2a063

Algorithms for Calculating Primary Energy Impact:

Unit savings are deemed based on study results.[1] kW savings are calculated using the Demand Impact Model which is developed as part of the Residential Baseline Study.[2]

Measure Name	∆kWh	∆kW	∆ MMBtu
Low-Flow Showerhead, Electric (Residential End Use)	129.0	0.03	
Low-Flow Showerhead, Gas (Residential End Use)			1.14
Low-Flow Showerhead, Oil (Residential End Use)			1.14
Low-Flow Showerhead, Other (Residential End Use)			1.14

Baseline Efficiency:

The baseline efficiency case is the existing showerhead with a baseline flow rate of 2.5 GPM.

High Efficiency:

The high efficiency case is a low flow showerhead having a maximum flow rate between 1.5 and 1.7 GPM.

Measure Life:

The measure life is 15 years. [3]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Low-Flow Showerhead	CI_RETRO	All	15	n/a	n/a	15

Other Resource Impacts:

Water savings for Single Family are 2,401 gallons per unit and for Attached Low Rise and High Rise water savings are 2,165 gallons per unit.[4]

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Low-Flow Showerhead, Electric (Residential End Use)	CI_RETRO	All	1.00	1.00	1.00	n/a	n/a	0.31	0.84
Low-Flow Showerhead, Gas (Residential End Use)	CI_RETRO	All	1.00	1.00	1.00	n/a	n/a	n/a	n/a
Low-Flow Showerhead, Oil (Residential End Use)	CI_RETRO	All	1.00	1.00	1.00	n/a	n/a	n/a	n/a
Low-Flow Showerhead, Other (Residential End Use)	CI_RETRO	All	1.00	1.00	1.00	n/a	n/a	n/a	n/a

In-Service Rates:

All installations have 100% in service rate since programs include verification of equipment installations.

Realization Rates:

All PAs use 100% energy realization rate.

Coincidence Factors:

Summer and winter coincidence factors are estimated using the demand allocation methodology described in the Demand Impact Model which is developed based on the Residential Baseline Study.[5]

Impact Factors for Calculating Net Savings:

Net to gross factors are based on evaluation results.[6]

Measure Name	Core Initiative	PA	FR	SO$_P$	SO$_{NP}$	NTG
Low-Flow Showerhead (Residential End Use)	CI_RETRO	All	0.14	0.0	0.0	0.86

Non-Energy Impacts:

NEI values are rolled up, component values can be found in Appendix B.

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per KWh	Annual $ per Therm	One-time $ per Therm
Low-Flow Showerhead (Residential End Use)	CI_RETRO	All	0.58	0.00	0.00	0.00	0.00	0.00

Endnotes:

1 : The Cadmus Group (2012). Massachusetts Multifamily Program Impact Analysis July 2012 – Revised May 2013. CADMUS_2012_Multifamily_Impacts_Analysis_Report
2 : Guidehouse (2020). Residential Baseline Study Phase 4
2020_Guidehouse_Residential_Baseline_Phase_4
3 : Guidehouse (2021). Comprehensive TRM Review. 2021_Guidehouse_TRM_Final_Report
4 : Staff calculations based on the methodology from The Cadmus Group, Inc. (2012). Home Energy Services Impact Evaluation. CADMUS_2012_ HES_Impact_Evaluation_Report
5 : Guidehouse (2020). Residential Baseline Study Phase 4.
2020_Guidehouse_Residential_Baseline_Phase_4
6 : Guidehouse (2021). Residential Programs Net-to-Gross Research of RCD and Select Products.
2021_Guidehouse_MA_Res_NTG_Final_Report

3.81 Hot Water - Low-Flow Showerhead with Thermostatic Valve - C&I Metered Multi-Family

Measure Code	COM-WH-STV-REU
Market	Commercial
Program Type	Retrofit
Category	Water Heating

Measure Description:

An existing showerhead is replaced with a low-flow showerhead with an integrated thermostatic shut-off valve (TSV).

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Low-Flow Showerhead with TSV, Electric	C&I Existing Building Retrofit (CI_RETRO)	EC2a041
Low-Flow Showerhead with TSV, Electric (Residential End Use)	C&I Existing Building Retrofit (CI_RETRO)	EC2a074
Low-Flow Showerhead with TSV, Oil (Residential End Use)	C&I Existing Building Retrofit (CI_RETRO)	EC2a075
Low-Flow Showerhead with TSV, Other (Residential End Use)	C&I Existing Building Retrofit (CI_RETRO)	EC2a076
Low-Flow Showerhead with TSV, Gas (Residential End Use)	C&I Existing Building Retrofit (CI_RETRO)	GC2a064

Algorithms for Calculating Primary Energy Impact:

Unit kWh and MMBtu savings are deemed.[1] Demand savings are derived from the demand impact model which is developed as part of the Residential Baseline Study.[2]

Measure Name	ΔkWh	ΔkW	ΔMMBtu
Low-Flow Showerhead with TSV, Gas			1.41
Low-Flow Showerhead with TSV, Electric	183	0.04	
Low-Flow Showerhead with TSV, Oil			1.44

Low-Flow Showerhead with TSV, Other			1.41

Baseline Efficiency:

The Baseline Efficiency case is an existing standard-flow showerhead (2.5 GPM) with no thermostatic shut-off valve.

High Efficiency:

The high efficiency case is a low-flow showerhead (1.5 GPM) with integrated thermostatically actuated valve.

Measure Life:

The measure life is 15 years.[3]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Low-Flow Showerhead with TSV	CI_RETRO	All	15	n/a	n/a	15

Other Resource Impacts:

Water savings are 2,723 gallons per unit.[4]

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR$_E$	RR$_{NE}$	RR$_{SP}$	RR$_{WP}$	CF$_{SP}$	CF$_{WP}$
Low-Flow Showerhead with TSV	CI_RETRO	All	1.00	1.00	1.00	1.00	1.00	0.31	0.84

In-Service Rates:
All installations have 100% in service rate.

Realization Rates:
Realization rates are set to 100% for deemed measures.

Coincidence Factors:
Summer and winter coincidence factors are estimated using the demand allocation methodology described in the Demand Impact Model which is developed based on the Residential Baseline Study.[5]

Impact Factors for Calculating Net Savings:

Net to gross factors are based on evaluation results.[6]

Measure Name	Core Initiative	PA	FR	SO$_P$	SO$_{NP}$	NTG

| Low-Flow Showerhead with TSV | CI_RETRO | All | 0.14 | 0.0 | 0.0 | 0.86 |

Non-Energy Impacts:

NEI values are rolled up, component values can be found in Appendix B.

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per KWh	Annual $ per Therm	One-time $ per Therm
Low-Flow Showerhead with TSV	CI_RETRO	All	$0.58					

Endnotes:

1 : Guidehouse (2021). Comprehensive TRM Review. 2021_Guidehouse_TRM_Final_Report

2 : Guidehouse (2020). Residential Baseline Study Phase 4
2020_Guidehouse_Residential_Baseline_Phase_4

3 : Guidehouse (2021). Comprehensive TRM Review. 2021_Guidehouse_TRM_Final_Report

4 : National Grid (2014). Review of ShowerStart evolve.
National_Grid_2014_ShowerStart_Savings_Final_2015-2-9

5 : Guidehouse (2020). Residential Baseline Study Phase 4
2020_Guidehouse_Residential_Baseline_Phase_4

6 : Guidehouse (2021). Residential Programs Net-to-Gross Research of RCD and Select Products.
2021_Guidehouse_MA_Res_NTG_Final_Report

3.82 Hot Water - Pipe Wrap (Water Heating)

Measure Code	COM-WH-PWWH
Market	Commercial
Program Type	Retrofit
Category	Water Heating

Measure Description:

Install insulation on hot water located in non-conditioned spaces.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Pipe Wrap, Hot Water, Electric (Turnkey)	C&I Existing Building Retrofit (CI_RETRO)	EC2a135
Pipe Wrap, Electric (OMP)	C&I New & Replacement Equipment (CI_EQUIP)	EC2b177
Pipe Wrap, Hot Water, Oil (Turnkey)	C&I Existing Building Retrofit (CI_RETRO)	EC2a136
Pipe Wrap, Oil (OMP)	C&I New & Replacement Equipment (CI_EQUIP)	EC2b178
Pipe Wrap, Hot Water, Propane (Turnkey)	C&I Existing Building Retrofit (CI_RETRO)	EC2a137
Pipe Wrap, Propane (OMP)	C&I New & Replacement Equipment (CI_EQUIP)	EC2b179
Pipe Wrap (Water Heating), Gas, <=1.5"	C&I Existing Building Retrofit (CI_RETRO)	GC2a024
Pipe Wrap (Water Heating), Gas, 2"	C&I Existing Building Retrofit (CI_RETRO)	GC2a025
Pipe Wrap (Water Heating), Gas , <=1.5" (Turnkey)	C&I Existing Building Retrofit (CI_RETRO)	GC2a045
Pipe Wrap (Water Heating), Gas , 2" (Turnkey)	C&I Existing Building Retrofit (CI_RETRO)	GC2a046

Algorithms for Calculating Primary Energy Impact:

Unit savings are deemed based on PA calculations.[1]

Measure Name	ΔMMBtu per linear foot	ΔkWh	ΔkW
Pipe Wrap (Water Heating), Gas/Oil/Propane, <= 1.5"	0.21		
Pipe Wrap (Water Heating), Gas/Oil/Propane, 2"	0.36		
Pipe Wrap (Water Heating), Electric, <= 1.5"		20	0.01
Pipe Wrap (Water Heating), Electric, 2"		35	0.01

Baseline Efficiency:

The baseline efficiency case is un-insulated hot water piping in unconditioned space.

High Efficiency:

The high efficiency condition is hot water piping in unconditioned space with insulation installed.

Measure Life:

The measure life is 15 years.[2]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Pipe Wrap (Water Heating)	CI_RETRO	All	15	n/a	n/a	15

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Pipe Wrap (Water Heating), Gas	CI_RETRO	All	1.00	n/a	1.00	n/a	n/a	n/a	n/a
Pipe Wrap (Water Heating), Electric	CI_RETRO	All	1.00	1.00	n/a	1.00	1.00	0.31	0.81
Pipe Wrap (Water Heating), Oil	CI_RETRO	All	1.00	n/a	1.00	n/a	n/a	n/a	n/a
Pipe Wrap (Water Heating), Propane	CI_RETRO	All	1.00	n/a	1.00	n/a	n/a	n/a	n/a

In-Service Rates:
All installations have 100% in service rate since programs include verification of equipment installations.

Realization Rates:
All PAs use 100% energy, demand, and non-energy realization rates.

Coincidence Factors:
Summer and winter coincidence factors are estimated using the demand allocation methodology described in the Demand Impact Model which is developed based on the Residential Baseline Study.[3]

Impact Factors for Calculating Net Savings:

Values are based on an evaluation study.[4]

Measure Name	Core Initiative	PA	FR	SO$_P$	SO$_{NP}$	NTG
Pipe Wrap (Water Heating), Gas	CI_RETRO	All	0.369	0.000	0.032	0.663
Pipe Wrap (Water Heating), Gas (Turnkey)	CI_RETRO	All	0.285	0.000	0.000	0.715
Pipe Wrap (Water Heating), Electric/Oil/Propane (Turnkey)	CI_RETRO	All	0.077	0.013	0.004	0.940
Pipe Wrap Electric/Oil/Propane (OMP)	CI_EQUIP	All	0.25	0.00	0.09	0.84

Non-Energy Impacts:

C&I values from 2021 C&I NEI Study.[5] NEIs for Turnkey Electric, Oil and Propane measures are referencing 2022 C&I Health and Safety NEI Study[6]

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per KWh	Annual $ per Therm	One-time $ per Therm
Pipe Wrap (Water Heating), Gas	CI_RETRO	All					$ 0.08	
Pipe Wrap (Water Heating), Gas (Turnkey)	CI_RETRO	All					$ 0.86	
Pipe Wrap (Water Heating), Electric (Turnkey)	CI_RETRO	All			0.095			
Pipe Wrap (Water Heating), Oil (Turnkey)	CI_RETRO	All			0.095			
Pipe Wrap (Water Heating), Propane (Turnkey)	CI_RETRO	All			0.095			

Endnotes:

1 : National Grid Staff Calculation (2010). Pipe insulation for SBS DI measures 2010 Excel Workbook. NGrid_Pipe_insulation_for_SBS_DImeasures_2010

2 : GDS Associates, Inc (2009). Natural Gas Energy Efficiency Potential in Massachusetts GDS_2009_Natural_Gas_Energy_Efficiency_Potential_in_MA

3 : Guidehouse (2020). Residential Baseline Study Phase 4 2020_Guidehouse_Residential_Baseline_Phase_4

4 : NMR Group, Inc. (2018). Massachusetts Sponsors' Commercial and Industrial Free-ridership and Spillover Study. 2018_NMR_CI FR-SO Report

5 : NMR Group Inc (2021). O&M and Non-O&M NEI Study. 2021_NMR_CIOM and NonOM NEI Study

3.83 Hot Water - Pipe Wrap (Water Heating) - C&I Metered Multi-Family

Measure Code	COM-WH-PWREU
Market	Commercial
Program Type	Retrofit
Category	Water Heating

Measure Description:

Installation of DHW pipe wraps.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Pipe Wrap (Water Heating), Electric (Residential End Use)	C&I Existing Building Retrofit (CI_RETRO)	EC2a080
Pipe Wrap (Water Heating), Gas (Residential End Use)	C&I Existing Building Retrofit (CI_RETRO)	GC2a060

Algorithms for Calculating Primary Energy Impact:

Unit savings are deemed based on study results where unit is a household with pipe wrap installed on hot water pipes.[1] Demand savings are derived from the demand impact model which is developed as part of the Residential Baseline Study.[2]

Savings for Pipe Wrap (Water Heating):

Measure Name	ΔkWh	ΔkW	ΔMMBtu
Pipe Wrap (Water Heating), Electric (Residential End Use)	129	0.03	
Pipe Wrap (Water Heating), Gas (Residential End Use)			1.14

Baseline Efficiency:

The baseline efficiency case is the existing hot water equipment.

High Efficiency:

The high efficiency case includes pipe wrap.

Measure Life:

The measure life is 15 years.[3]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Pipe Wrap (Water Heating) (Residential End Use)	CI_RETRO	All	15	n/a	n/a	15

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Pipe Wrap (Water Heating), Electric (Residential End Use)	CI_RETRO	All	1.00	1.00	1.00	1.00	1.00	0.31	0.84
Pipe Wrap (Water Heating), Gas (Residential End Use)	CI_RETRO	All	1.00	1.00	1.00	n/a	n/a	n/a	n/a

In-Service Rates:
All installations have 100% in service rate since all PAs programs include verification of equipment installations.

Realization Rates:
The realization rates are set to 100% since deemed savings are based on evaluation results.

Coincidence Factors:
Summer and winter coincidence factors are estimated using the demand allocation methodology described in the Demand Impact Model which is developed based on the Residential Baseline Study.[4]

Impact Factors for Calculating Net Savings:

Net to Gross factors are based on evaluation results.[5]

Measure Name	Core Initiative	PA	FR	SOP	SONP	NTG
Pipe Wrap (Water Heating)(Residential End Use)	CI_RETRO	All	0.14	0.0	0.0	0.86

Non-Energy Impacts:

There are no non energy benefits identified for this measure.

Endnotes:

1 : The Cadmus Group (2015). Massachusetts Low Income Multifamily Impact Evaluation.
CADMUS_2015_Low_Income_Multifamily_Impact_Evaluation
2 : Guidehouse (2020). Residential Baseline Study Phase 4
2020_Guidehouse_Residential_Baseline_Phase_4
3 : GDS_2007_Measure_Life_Report_Residential_and_CI_Lighting_and_HVAC_Measures
GDS_2007_Measure_Life_Report_Residential_and_CI_Lighting_and_HVAC_Measures
4 : Guidehouse (2020). Residential Baseline Study Phase 4
2020_Guidehouse_Residential_Baseline_Phase_4
5 : Guidehouse (2021). Residential Programs Net-to-Gross Research of RCD and Select Products.
2021_Guidehouse_MA_Res_NTG_Final_Report

3.84 Hot Water - Pre-Rinse Spray Valve

Measure Code	COM-WH-PRSV
Market	Commercial
Program Type	Retrofit
Category	Water Heating

Measure Description:

Retrofitting existing standard spray nozzles in locations where service water is supplied by natural gas fired hot water heater with new low flow pre-rinse spray nozzles with an average flow rate of 1.6 GPM.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Pre-Rinse Spray Valve, Electric (Turnkey)	C&I Existing Building Retrofit (CI_RETRO)	EC2a147
Pre-Rinse Spray Valve, Electric (OMP)	C&I New & Replacement Equipment (CI_EQUIP)	EC2b174
Pre-Rinse Spray Valve, Oil (Turnkey)	C&I Existing Building Retrofit (CI_RETRO)	EC2a148
Pre-Rinse Spray Valve, Oil (OMP)	C&I New & Replacement Equipment (CI_EQUIP)	EC2b175
Pre-Rinse Spray Valve, Propane (Turnkey)	C&I Existing Building Retrofit (CI_RETRO)	EC2a149
Pre-Rinse Spray Valve, Propane (OMP)	C&I New & Replacement Equipment (CI_EQUIP)	EC2b176
Pre-Rinse Spray Valve	C&I Existing Building Retrofit (CI_RETRO)	GC2a023
Pre-Rinse Spray Valve (Turnkey)	C&I Existing Building Retrofit (CI_RETRO)	GC2a044
Pre-Rinse Spray Valve - Midstream	C&I New & Replacement Equipment (CI_EQUIP)	GC2b044
Pre-Rinse Spray Valve - OMP	C&I New & Replacement Equipment (CI_EQUIP)	GC2b075

Algorithms for Calculating Primary Energy Impact:

Unit savings are deemed and based on study results[1]. mmBTU savings for delivered fuel products assumed to be at a 1:1 relationship with already existing gas measure.

Measure Name	ΔMMBtu	ΔkWh	ΔkW
Pre-Rinse Spray Valve, Gas	5.0		
Pre-Rinse Spray Valve, Electric		1300	0
Pre-Rinse Spray Valve, Oil	5.0		
Pre-Rinse Spray Valve, Propane	5.0		

Annual Electric Energy Savings

$$\Delta kWh = \ units\ x\ \frac{(GPM_{baseline} - GPM_{ee})\ x\ Hrs\ x\ 60\ x\ (T_{PRSV} - T_{main})\ x\ 8.33}{\left(\frac{3,412\ BTU}{1\ kWh}\ x\ Eff_{elec}\right)}$$

Summer Peak Coincident Demand Savings

$$\Delta kW = N/A$$

Annual Fossil Fuel Energy Savings

$$\Delta MMBtu = units\ x\ \frac{(GPM_{baseline} - GPM_{ee})\ x\ Hrs\ x\ 60x\ (T_{PRSV} - T_{main})\ x\ 8.33}{\left(\frac{1,000,000\ BTU}{1\ MMBtu}\ x\ Eff_{gas}\right)}$$

Where:

Units	= number of measures installed under the program
$GPM_{baseline}$	= Flow rate of existing PRSV, default 1.6 GPM[2]
GPM_{ee}	= Flow rate of high efficiency installed PRSV, default 1.1 GPM[3]
Eff_{gas}	= Water heater efficiency (natural gas), default 80% E_t[4]
Eff_{elec}	= Water heater efficiency (electric), default 98% E_t[5]
T_{PRSV}	= Average end-use temperature (°F), default 108°F[6]
T_{main}	= Supply water temperature in water main (°F), default 55.7°F[7]
Hrs	= Annual operating hours of PRSV, default 333 hrs[8]
60	= minutes per hour
8.33	= Energy required (BTU) to heat one gallon of water by one-degree Fahrenheit
365	= Days in one year
1,000,000	= Conversion factor, on MMBtu equals 1,000,000 BTU

Baseline Efficiency:

The baseline efficiency case is 1.6 GPM spray valve.

High Efficiency:

The high efficiency case is a low flow pre-rinse spray valve with an average flow rate of 1.1 GPM.

Measure Life:

The measure life is 3 years.[9]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Pre-Rinse Spray Valve	CI_RETRO	All	8	n/a	n/a	3

Other Resource Impacts:

There are water savings of 9,990 gallons per unit.[10]

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Pre-Rinse Spray Valve, Gas	CI_RETRO	All	1.00	n/a	1.00	n/a	n/a	n/a	n/a
Pre-Rinse Spray Valve, Electric	CI_RETRO	All	1.00	1.00	n/a	1.00	1.00	0.31	0.84
Pre-Rinse Spray Valve, Oil	CI_RETRO	All	1.00	n/a	1.00	n/a	n/a	n/a	n/a
Pre-Rinse Spray Valve, Propane	CI_RETRO	All	1.00	n/a	1.00	n/a	n/a	n/a	n/a

In-Service Rates:

All installations have 100% in service rate since programs include verification of equipment installations.

Realization Rates:

All PAs use 100% energy, demand, and non-energy realization rates.

Coincidence Factors:

Summer and winter coincidence factors are estimated using the demand allocation methodology described in the Demand Impact Model which is developed based on the Residential Baseline Study.[11]

Impact Factors for Calculating Net Savings:

Values from 2021 C&I NTG study.[12]

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Pre-Rinse Spray Valve, Gas	CI_RETRO	All	0.369	0.000	0.032	0.663
Pre-Rinse Spray Valve, Gas (Turnkey)	CI_RETRO	All	0.285	0.000	0.000	0.715
Pre-Rinse Spray Valve, Gas	CI_EQUIP	All	0.373	0.026	0.191	0.844

(Midstream)						
Pre-Rinse Spray Valve, Electric/Oil/Propane (Turnkey)	CI_RETRO	All	0.077	0.013	0.004	0.940
Pre-Rinse Spray Valve, Electric/Oil/Propane (OMP)	CI_EQUIP	All	0.25	0.00	0.09	0.84
Pre-Rinse Spray Valve, Gas (OMP)	CI_EQUIP	All	0.37	0.03	0.09	0.840

Non-Energy Impacts:

C&I values from 2021 C&I NEI study.[13]

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per KWh	Annual $ per Therm	One-time $ per Therm
Pre-Rinse Spray Valve, Gas	CI_RETRO	All					$ 0.36	

Endnotes:

1 : DNV GL (2014). Impact Evaluation of Massachusetts Prescriptive Gas Pre-Rinse Spray Valves. DNVGL_2014_Impact_Evaluation_MA_2012_Gas_Pre-Rinse_Spray_Valve
2 : Per program administrator internal analysis.

3 : DNV GL (2014). Impact Evaluation of Massachusetts Prescriptive Gas Pre-Rinse Spray Valves. DNVGL_2014_Impact_Evaluation_MA_2012_Gas_Pre-Rinse_Spray_Valve
4 : Guidehouse (2020). Residential Baseline Study Phase 4
2020_Guidehouse_Residential_Baseline_Phase_4

9 : DNV GL (2021). Prescriptive Measures NRNC and ISP Results. 2021_DNV_Prescriptive Measures NRNC and ISP Results
10 : DNV GL (2014). Impact Evaluation of Massachusetts Prescriptive Gas Pre-Rinse Spray Valves. DNVGL_2014_Impact_Evaluation_MA_2012_Gas_Pre-Rinse_Spray_Valve
11 : Guidehouse (2020). Residential Baseline Study Phase 4
2020_Guidehouse_Residential_Baseline_Phase_4
12 : NMR Group, Inc. (2018). Massachusetts Sponsors' Commercial and Industrial Free-ridership and Spillover Study. 2018_NMR_CI FR-SO Report
13 : NMR Group Inc (2021). O&M and Non-O&M NEI Study 2021_NMR_CIOM and NonOM NEI Study

3.85 Hot Water - Stand-Alone Thermostatic Valve

Measure Code	COM-WH-STV
Market	Commercial
Program Type	Retrofit
Category	Water Heating

Measure Description:

Installation of a stand-alone thermostatic shut-off valve on standard-flow showerhead.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Thermostatic Shut-Off Valve, Electric (Turnkey)	C&I Existing Building Retrofit (CI_RETRO)	EC2a144
Thermostatic Shut-Off Valve, Electric (OMP)	C&I New & Replacement Equipment (CI_EQUIP)	EC2b171
Thermostatic Shut-Off Valve, Oil (Turnkey)	C&I Existing Building Retrofit (CI_RETRO)	EC2a145
Thermostatic Shut-Off Valve, Oil (OMP)	C&I New & Replacement Equipment (CI_EQUIP)	EC2b172
Thermostatic Shut-Off Valve, Propane (Turnkey)	C&I Existing Building Retrofit (CI_RETRO)	EC2a146
Thermostatic Shut-Off Valve, Propane (OMP)	C&I New & Replacement Equipment (CI_EQUIP)	EC2b173
Thermostatic Shu-Off Valve, Gas (OMP)	C&I New and Replacement Equipment (CI_EQUIP)	GC2b079

Algorithms for Calculating Primary Energy Impact:

Unit savings are deemed based on engineering analysis.[1] Demand savings are derived from the demand impact model which is developed as part of the Residential Baseline Study.[2] MMBtu savings assumed to be at 1:1 relationship with already existing gas measure.

Measure Name	ΔkWh	ΔkW	ΔMMBtu
Standalone TSV, Electric	69	0.01	

Measure Name	ΔkWh	ΔkW	ΔMMBtu
Standalone TSV, Gas			0.33
Standalone TSV, Oil			0.33
Standalone TSV, Propane			0.33

Baseline Efficiency:

The baseline efficiency is an existing standard-flow showerhead (2.5 GPM) with no thermostatic shut-off valve.

High Efficiency:

The high efficiency case is a a standard flow showerhead (2.5 GPM) with the addition of a stand-alone thermostatic shut-off valve.

Measure Life:

The measure life is 10 years.[3]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Standalone TSV	CI_RETRO	All	10	n/a	n/a	10

Other Resource Impacts:

Annual per unit water savings of 558 gallons.[4]

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR$_E$	RR$_{NE}$	RR$_{SP}$	RR$_{WP}$	CF$_{SP}$	CF$_{WP}$
Standalone TSV, Electric	CI_RETRO	All	1.00	1.00	n/a	1.00	1.00	0.31	0.84
Standalone TSV, Gas	CI_RETRO	All	1.00	n/a	1.00	n/a	n/a	n/a	n/a
Standalone TSV, Oil	CI_RETRO	All	1.00	n/a	1.00	n/a	n/a	n/a	n/a
Standalone TSV, Propane	CI_RETRO	All	1.00	n/a	1.00	n/a	n/a	n/a	n/a

In-Service Rates:

All installations have 100% in service rate since programs include verification of equipment installations.

Realization Rates:

All PAs use 100% energy, demand, and non-energy realization rates.

Coincidence Factors:

Summer and winter coincidence factors are estimated using the demand allocation methodology described in the Demand Impact Model which is developed based on the Residential Baseline Study.[5]

Impact Factors for Calculating Net Savings:

Net to gross values based on evaluated numbers.[6]

Measure Name	Core Initiative	PA	FR	SO$_P$	SO$_{NP}$	NTG
Standalone TSV, Electric/Oil/Propane (Turnkey)	CI_RETRO	All	0.077	0.013	0.004	0.940
Standalone TSV, Propane (Turnkey)	CI_RETRO	All	0.077	0.013	0.004	0.940
Standalone TSV, Gas (Turnkey)	CI_RETRO	All	0.285	0.00	0.00	0.715
Standalone TSV, Gas (OMP)	CI_EQUIP	All	0.370	0.03	0.19	0.840

Non-Energy Impacts:

C&I values are from 2021 C&I NEI Study. [7]

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per KWh	Annual $ per Therm	One-time $ per Therm
Standalone TSV, Gas	CI_RETRO	All					$ 0.004	

Endnotes:

1 : National Grid (2014). Review of ShowerStart evolve
National_Grid_2014_ShowerStart_Savings_Final_2015-2-9
2 : Guidehouse (2020). Residential Baseline Study Phase 4
2020_Guidehouse_Residential_Baseline_Phase_4
3 : GDS Associates, Inc. (2009). Natural Gas Energy Efficiency Potential in Massachusetts. Prepared for GasNetworks; Table B-2a, measure C-WH-15.
GDS_2009_Natural_Gas_Energy_Efficiency_Potential_in_MA
4 : National Grid (2014). Review of ShowerStart evolve
National_Grid_2014_ShowerStart_Savings_Final_2015-2-9
5 : Guidehouse (2020). Residential Baseline Study Phase 4
2020_Guidehouse_Residential_Baseline_Phase_4
6 : NMR Group, Inc. (2018). Massachusetts Sponsors' Commercial and Industrial Free-ridership and Spillover Study. 2018_NMR_CI FR-SO Report

7 : NMR Group Inc (2021). O&M and Non-O&M NEI Study. [2021_NMR_CIOM and NonOM NEI Study](#)

3.86 Hot Water - Steam Trap

Measure Code	COM-HVAC-ST
Market	Commercial
Program Type	Retrofit
Category	Water Heating

Measure Description:

Repair or replace malfunctioning steam traps.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Steam Trap, Gas	C&I Existing Building Retrofit (CI_RETRO)	GC2a012

Algorithms for Calculating Primary Energy Impact:

Savings are deemed per unit.[1]

Measure Name	ΔMMBtu
Steam Trap	8.4

Baseline Efficiency:

The baseline efficiency case is a failed steam trap.

High Efficiency:

The high efficiency case is a repaired or replaced steam trap.

Measure Life:

The measure life is 3 years.[2]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Steam Trap	CI_RETRO	All	3	n/a	n/a	3

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR$_E$	RR$_{NE}$	RR$_{SP}$	RR$_{WP}$	CF$_{SP}$	CF$_{WP}$
Steam Trap	CI_RETRO	All	1.00	1.00	1.00	n/a	n/a	n/a	n/a

In-Service Rates:
All installations have 100% in service rate since programs include verification of equipment installations.

Realization Rates:
All PAs use 100% energy realization rate. The summer and winter peak realization rates are not applicable for this measure since there are no electric savings claimed.

Coincidence Factors:
Not applicable for this measure since no electric savings are claimed.

Impact Factors for Calculating Net Savings:

Values from 2021 C&I NTG study.[3]

Measure Name	Core Initiative	PA	FR	SO$_P$	SO$_{NP}$	NTG
Steam Trap	CI_RETRO	All	0.369	0.00	0.032	0.663

Non-Energy Impacts:

NEIs are from 2021 Study.[4]

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per KWh	Annual $ per Therm	One-time $ per Therm
Steam Trap	CI_RETRO	All					$ 0.08	

Endnotes:

1 : Energy & Resource Solutions (2018). Two-Tier Steam Trap Savings Study. As a note, the 8.4 mmBTU savings value pertains to low pressure traps, ERS_2018_Two_Tier_Steam_Traps
2 : DNV (2022) Steam Traps and Boiler Efficiency Research – Phase II 2022_DNV_Stram Trap and Boiler Efficiency

3.87 Hot Water - Tankless Water Heater

Measure Code	COM-WH-TWH
Market	Commercial
Program Type	Replace on Burnout
Category	Water Heating

Measure Description:

Tankless water heaters circulate water through a heat exchanger to be heated for immediate use, eliminating the standby heat loss associated with a storage tank .

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Water Heater, Instantaneous, Gas - Upstream	C&I New & Replacement Equipment (CI_EQUIP)	GC2b022

Algorithms for Calculating Primary Energy Impact:

Unit savings are per algorithm below and building specific.

$$Annual\ Energy\ Savings\ (therms) = \frac{365 \times \rho_W \times Temperature\ Rise}{100,000\ \frac{Btu}{therm}} \times \left(\frac{1}{EF_{installed}} - \frac{1}{EF_{baseline}}\right) \times GPD$$

Temperature Rise = 80 (°F)

GPD = building specific per table below

$EF_{Baseline} = 0.71$

$EF_{Installed} = 0.94$

Water Density (ρ_w) = 8.33

Building Type GPD Table[1]

Building Type	HW Usage Category	GPD
Education	Medium	222
Healthcare	High	1903
Lodging	Medium	222
Mercantile	Low	34

Building Type	HW Usage Category	GPD
Office	Low	34
Other	Low	34
Religious Worship	Low	34
Warehouse	Low	34
Fast Food Restaurant	Medium	222
Full Service Restaurant	High	1903
Grocery	Medium	222
Gym	High	1903
Laundromat	Medium	222
Multi-Family	Multi-Family	64
Public Safety	Low	34
Manufacturing	Manufacturing	78

Baseline Efficiency:

For on-demand tankless water heaters the baseline is based on evaluated results, EF = 0.71[2] .

High Efficiency:

The high efficiency equipment is either a gas-fired instantaneous hot water heater with an Energy Factor of at least 0.94.

Measure Life:

The measure life is 20 years.[3]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Tankless Water Heater, Gas 0.94 - Upstream	CI_EQUIP	All	20	n/a	n/a	20

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}

Tankless Water Heater, Gas 0.94 - Upstream	CI_EQUIP	All	1.00	n/a	0.96	n/a	n/a	n/a	n/a

In-Service Rates:

All installations have 100% in service rate since programs include verification of equipment installations.

Realization Rates:

All PAs use a 96% non-energy realization rate.[4] The summer and winter peak realization rates are not applicable for this measure since there are no electric savings claimed.

Coincidence Factors:

Not applicable for this measure since no electric savings are claimed

Impact Factors for Calculating Net Savings:

Values based on 2021 C&I Upstream HVAC NTG study[5] .

Measure Name	Core Initiative	PA	FR	SO$_P$	SO$_{NP}$	2022 NTG	2023 NTG	2024 NTG
Tankless Water Heater, Gas - Upstream	CI_EQUIP	All	0.62			0.38	0.38	0.38

Non-Energy Impacts:

Measure Name	Core Initiative	PA	Annual $ per kWh	Annual $ per Therm
Hot Water - Tankless Water Heater	CI_EQUIP	All		$0.079

Endnotes:

1 : DNV GL, Inc (2019) Impact Evaluation of Commercial Water Heaters: Baseline Adjustment Memo Including Consumption Estimates. Table 3.
2 : DNV GL, Inc (2019). Impact Evaluation of Commercial Water Heaters: Baseline Adjustment Memo Including Water Consumption Estimates.
3 : Hewitt, D. Pratt, J. & Smith, G. (2005). Tankless Gas Water Heaters: Oregon Market Status. Prepared for the Energy Trust of Oregon Hewitt_Pratt_Smith_2005_Tankless_Gas_Water_Heaters
4 : DNV GL, Inc (2019) Upstream Water Heater Deemed Savings Impact Evaluation & Market Quick Hit Study on Water Consumption for Tankless Water Heaters
5 : NMR Group, Inc. (2021). C&I Upstream HVAC & Gas Water Heating NTG Study
2021_NMR_C&I_HVAC_NTG

3.88 Hot Water - Thermostatic Valve - C&I Metered Multi-Family

Measure Code	COM-WH-TVREU
Market	Commercial
Program Type	Retrofit
Category	Water Heating

Measure Description:

A stand-alone valve that may be used with existing showerhead. Thermostatic shut-off valve technology is known by the trademarked name ShowerStart™.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Thermostatic Shut-off Valve, Electric (Residential End Use)	C&I Existing Building Retrofit (CI_RETRO)	EC2a077
Thermostatic Shut-off Valve, Oil (Residential End Use)	C&I Existing Building Retrofit (CI_RETRO)	EC2a078
Thermostatic Shut-off Valve, Other (Residential End Use)	C&I Existing Building Retrofit (CI_RETRO)	EC2a079
Thermostatic Shut-off Valve, Gas (Residential End Use)	C&I Existing Building Retrofit (CI_RETRO)	GC2a065

Algorithms for Calculating Primary Energy Impact:

The unit savings are deemed based on engineering analysis.[1] kW savings are calculated using the demand impact model.[2]

Measure Name	ΔkWh	ΔkW	Δ MMBtu
Thermostatic Shut-off Valve, Electric (Residential End Use)	69	0.02	
Thermostatic Shut-off Valve, Gas (Residential End Use)			0.34
Thermostatic Shut-off Valve, Oil (Residential End Use)			0.39
Thermostatic Shut-off Valve, Other (Residential End Use)			0.34

Baseline Efficiency:

The Baseline Efficiency case is an existing standard-flow showerhead (2.5 GPM) with no thermostatic shut-off valve.

High Efficiency:

The high efficiency case is a standard-flow showerhead (2.5 GPM) with the addition of the stand-alone thermostatic shut-off valve (the "Ladybug").

Measure Life:

The measure life is 15 years.[3]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Thermostatic Shut-off Valve	CI_RETRO	All	15	n/a	n/a	15

Other Resource Impacts:

The annual water savings are 558 gallons per unit.[4]

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Thermostatic Shut-off Valve, Electric	CI_RETRO	All	1.00	1.00	1.00	1.00	1.00	0.31	0.84
Thermostatic Shut-off Valve, Gas	CI_RETRO	All	1.00	1.00	1.00	n/a	n/a	n/a	n/a
Thermostatic Shut-off Valve, Oil	CI_RETRO	All	1.00	1.00	1.00	n/a	n/a	n/a	n/a
Thermostatic Shut-off Valve, Other	CI_RETRO	All	1.00	1.00	1.00	n/a	n/a	n/a	n/a

In-Service Rates:
All installations have 100% in service rate.

Realization Rates:
Realization rates are set to 100% since savings are deemed

Coincidence Factors:
Summer and winter coincidence factors are estimated using the demand allocation methodology described in the Demand Impact Model which is developed based on the Residential Baseline Study.[5]

Impact Factors for Calculating Net Savings:

Net to gross factors based on evaluation results.[6]

Measure Name	Core Initiative	PA	FR	SO$_P$	SO$_{NP}$	NTG
Thermostatic Shut-off Valve (Residential End Use)	CI_RETRO	All	0.14	0.0	0.0	0.86

Non-Energy Impacts:

There are no non-energy impacts identified for this measure.

Endnotes:

1 : National Grid (2014). Review of ShowerStart evolve.
National_Grid_2014_ShowerStart_Savings_Final_2015-2-9
2 : Navigant Consulting (2018). Demand Impact Model Update.
2018_Navigant_Baseline_Loadshape_Comprehensive_Report
3 : Guidehouse (2021). Comprehensive TRM Review. 2021_Guidehouse_TRM_Final_Report
4 : National Grid (2014). Review of ShowerStart evolve.
National_Grid_2014_ShowerStart_Savings_Final_2015-2-9
5 : Guidehouse (2020). Residential Baseline Study Phase 4.
2020_Guidehouse_Residential_Baseline_Phase_4
6 : Guidehouse (2021). Residential Programs Net-to-Gross Research of RCD and Select Products.
2021_Guidehouse_MA_Res_NTG_Final_Report

3.89 Hot Water - Volume Water Heater

Measure Code	COM-WH-VWH
Market	Commercial
Program Type	Replace on Burnout
Category	Water Heating

Measure Description:

Installation of a high-efficiency gas-fired water heater.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Water Heater, Volume, Gas - Upstream	C&I New & Replacement Equipment (CI_EQUIP)	GC2b027

Algorithms for Calculating Primary Energy Impact:

Savings values are tied to unit Mbtuh[1].

Measure Name	ΔMMBtu/Mbtuh
Volume Water Heater, Gas 0.94 TE - Upstream	0.460

Baseline Efficiency:

The assumed baseline is per evaluation results, 83% TE volume water heater[2] .

High Efficiency:

The high efficiency case is a volume water heater with a 94% TE.

Measure Life:

The measure life is 15 years.[3]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Volume Water Heater, Gas 0.94 TE - Upstream	CI_EQUIP	All	15	n/a	n/a	15

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Volume Water Heater, Gas 0.94 TE - Upstream	CI_EQUIP	All	1.00	n/a	1.00	n/a	n/a	n/a	n/a

In-Service Rates:

All installations have 100% in service rate since programs include verification of equipment installations.

Realization Rates:

All PAs use a 100% realization rate[4] . The summer and winter peak realization rates are not applicable for this measure since there are no electric savings claimed.

Coincidence Factors:

Not applicable for this measure since no electric savings are claimed.

Impact Factors for Calculating Net Savings:

Values based on 2021 C&I Upstream HVAC NTG study[5].

Measure Name	Core Initiative	PA	FR	2022 NTG	2023 NTG	2024 NTG
Volume Water Heater, Gas - Upstream	CI_EQUIP	All	0.56	0.44	0.44	0.44

Non-Energy Impacts:

Measure Name	Core Initiative	PA	Annual $ per kWh	Annual $ per Therm
Hot Water - Volume Water Heater	CI_EQUIP	All		$0.079

Endnotes:

1 : DNV GL, Inc (2019). Impact Evaluation of Commercial Water Heaters: Baseline Adjustment Memo Including Water Consumption Estimates. Table 5.
2 : DNV GL, Inc (2019). Impact Evaluation of Commercial Water Heaters: Baseline Adjustment Memo Including Water Consumption Estimates.
3 : GDS Associates, Inc. (2009). Natural Gas Energy Efficiency Potential in Massachusetts; Appendix

A-2. GDS_2007_Measure_Life_Report_Residential_and_CI_Lighting_and_HVAC_Measures
4 : DNV GL, Inc (2019). Impact Evaluation of Commercial Water Heaters: Baseline Adjustment Memo Including Water Consumption Estimates. NOTE - realization rate changed b/w 2019 and 2020 as net impacts have been folded into deemed savings values beginning in 2020.
5 : NMR Group, Inc. (2021). C&I Upstream HVAC & Gas Water Heating NTG Study
2021_NMR_C&I_HVAC_NTG

3.90 Lighting - C&I Metered Multi-Family

Measure Code	COM-L-FREU
Market	Commercial
Program Type	Retrofit
Category	Lighting

Measure Description:

Removal of existing inefficient fixtures with the installation of new efficient fixtures.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
LED Fixture, Indoor Common Area (Residential End Use)	C&I Existing Building Retrofit (CI_RETRO)	EC2a095
LED Fixture, Linear Indoor Common Area (Residential End Use)	C&I Existing Building Retrofit (CI_RETRO)	EC2a096
LED Fixture, Outdoor Common Area (Residential End Use)	C&I Existing Building Retrofit (CI_RETRO)	EC2a097

Algorithms for Calculating Primary Energy Impact:

Although these measures are reported within the C&I sector in order to follow Department directives regarding sector cross-subsidization, these measures are delivered as part of the Residential Coordination Delivery program and evaluated as such. Therefore, please refer to the residential TRM entry for the savings calculations for these measures: "Lighting - Residential".

3.91 Lighting - Controls

Measure Code	COM-L-LC
Market	Commercial
Program Type	Retrofit
Category	Lighting

Measure Description:

This measure promotes the installation of lighting controls in both lost-opportunity and retrofit applications. Promoted technologies include occupancy sensors and daylight dimming controls.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Lighting Controls - Daylight Dimming	C&I New Buildings & Major Renovations (CI_NB&MR)	EC1a020
Lighting Controls - Occupancy Sensor	C&I New Buildings & Major Renovations (CI_NB&MR)	EC1a021
Lighting Controls - Dual Sensor/Other	C&I New Buildings & Major Renovations (CI_NB&MR)	EC1a022
Lighting Controls - Daylight Dimming	C&I Existing Building Retrofit (CI_RETRO)	EC2a015
Lighting Controls - Occupancy Sensor	C&I Existing Building Retrofit (CI_RETRO)	EC2a016
Lighting Controls - Dual Sensor/Other	C&I Existing Building Retrofit (CI_RETRO)	EC2a017
Lighting Controls - Interior (Turnkey)	C&I Existing Building Retrofit (CI_RETRO)	EC2a050
Lighting Controls - Daylight Dimming	C&I New & Replacement Equipment (CI_EQUIP)	EC2b019
Lighting Controls - Occupancy Sensor	C&I New & Replacement Equipment (CI_EQUIP)	EC2b020
Lighting Controls - Dual Sensor/Other	C&I New & Replacement Equipment (CI_EQUIP)	EC2b021

Algorithms for Calculating Primary Energy Impact:

Updates to deemed savings, algorithms, baseline efficiency, and/or high-efficiency edits are suggestions from the C&I Comprehensive TRM Review.[1]

C&I New Buildings & Major Renovations, C&I Initial Purchase & End of Useful Life, C&I Existing Building Retrofit:
$\Delta kWh = ControlledkW * Hours_{base} * (\%_{Sav})$
$\Delta kW = (ControlledkW)$

C&I Small Business:
$\Delta kWh = (ControlledkW) (Hours_{base} - Hours_{ee})$
$\Delta kW = (ControlledkW)$

Where:
Controlled kW = Controlled fixture wattage
$\%_{Sav}$ = Percentage of kWh that is saved by utilizing the control measure.
$Hours_{BASE}$ = Total annual hours that the connected Watts operated in the pre-retrofit case (retrofit installations) or would have operated with code-compliance controls (new construction installations).
$Hours_{EE}$ = Annual hours that the connect Watts operate with controls implemented

Savings factors are deemed based on study results.[2]

Measure Name	% Savings Factor
61 - Remote Mounted Occupancy Sensor	0.24
64 - Wall Mounted Occupancy Sensor	0.24
68 - Integral Occupancy Sensor for High Bay Fixtures	0.24
62 - Daylight Dimming System and/or Occupancy Controlled Dimming System	0.28
63 - Interior Integral Fixture Mounted Dual Sensors	0.38
65 - Outdoor Sensor with Integral Dual Sensors	0.38
63A - Integral Fixture Mounted Dual Sensors and Network-Capable Controls	0.49
65A - Outdoor Integral Dual Sensors with Adaptive, Network-Capable Controls	0.49

Baseline Efficiency:

The baseline efficiency case assumes no controls (retrofit) or code-compliant controls (new construction).

High Efficiency:

The high efficiency case involves lighting fixtures connected to controls that reduce the pre-retrofit or baseline hours of operation.

Measure Life:

Measure life for retrofit control measures is 9 years and for lost opportunity control measures is 10 years.[3]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Lighting Controls	CI_RETRO	All	9	n/a	n/a	9
Lighting Controls	CI_NB&MR CI_EQUIP	All	10	n/a	n/a	10

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Lighting Controls – Interior (Turnkey)	CI_RETRO	All	1.00	0.42	0.42	0.92	0.92	0.18	0.13
Lighting Controls – Exterior (Turnkey)	CI_RETRO	All	1.00	0.42	0.42	0.92	0.92	1.00	0.00
Lighting Controls – Daylighting Dimming	CI_RETRO CI_NB&MR CI_EQUIP	All	1.00	1.03	1.03	0.94	0.94	0.15	0.13
Lighting Controls – Occupancy Sensor	CI_RETRO CI_NB&MR CI_EQUIP	All	1.00	1.03	1.03	0.94	0.94	0.15	0.13
Lighting Controls – Dual Sensor/Other	CI_RETRO CI_NB&MR CI_EQUIP	All	1.00	1.03	1.03	0.94	0.94	0.15	0.13
Lighting Controls – Exterior	CI_RETRO CI_NB&MR CI_EQUIP	All	1.00	0.72	0.72	0.94	0.94	1.00	0.00

In-Service Rates:

All installations have 100% in service rate since all PAs programs include verification of equipment installations.

Realization Rates:

- Large C&I: energy and demand RRs from 12 month logging impact evaluation of MA PAs LCI prescriptive lighting programs. Demand RR is the connected demand RR; Energy RR includes connected kWh RR, hours of use RR, and HVAC Interactive adjustment.[4]
- Small C&I Existing Building Retrofit: RRs from statewide Pre/Post Occupancy Sensor study.[5]

Coincidence Factors:

- Large C&I: CFs are from 12 month logging impact evaluation of MA PAs LCI prescriptive lighting programs.[6]
- C&I Small Business: CFs from statewide Pre/Post Occupancy Sensor study.[7]

Impact Factors for Calculating Net Savings:

Net-to-gross values are deemed based on study results.[8] [9]

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Lighting Controls (All)	CI_NB&MR	All	0.583	0.227	n/a	0.644
Lighting Controls (Whole Initiative)	CI_RETRO	All	0.306	0.001	0.016	0.711
Lighting Controls (Turnkey)	CI_RETRO	All	0.222	0.013	0.004	0.795
Lighting Controls (All)	CI_EQUIP	All	0.250	0.002	0.085	0.837

Non-Energy Impacts:

NEIs are based on 2021 NEI study.[10] H&S NEIs are based on 2022 H&S NEI study.[11]

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per KWh	Annual $ per Therm	One-time $ per Therm
Lighting Controls (All)	CI_NB&MR	All			$0.116			
Lighting Controls (All)	CI_RETRO	All			$0.130			
Lighting Controls (All)	CI_EQUIP	All			$0.116			

Endnotes:

1 : Cadeo (2022) MA C&I TRM Review [MA22C01-B_TRM Review_FINAL_31OCT2022](#)

2 : DNV (2022). CT X1931-4 ALC PSD Phase 2 Memo Recommendations for ALC Measure Parameters. Product codes 61, 64, and 68 correspond to occupancy sensors, 62 to daylighting dimming, 63 and 65 to dual sensors and non-commissioned LLLCs, and 63A and 65A to commissioned LLLCs and NLCs. The PAs/EEAC also decided to use "non-commissioned LLLC" rather than the evaluation report measure name (Integrated fixture with Room-Based Controls) to avoid market confusion until the Design Lights Consortium (DLC) creates a category for these products in the future. The November 2023 DNV study Performance Testing and Networking for C&I Lighting Controls recommended replacing "commissioning" with using "Performance Tested." [2022_DNV_CT X1931-4 ALC PSD Phase 2 Memo Recommendations for ALC Measure Parameters](#)

3 : ERS (2005). Measure Life Study. [ERS_2005_Measure_Life_Study](#)

4 : DNV KEMA (2013). Impact Evaluation of 2010 Prescriptive Lighting Installations. [DNV_KEMA_2013_Prescriptive_Ltg_Impact_Eval_PY2010](#)

5 : The Cadmus Group (2012). Final Report, Small Business Direct Install Program: Pre/Post Occupancy Sensor Study. [CADMUS_2012_SBDI_PrePostLightingControl_Final](#)

6 : DNV KEMA (2013). Impact Evaluation of 2010 Prescriptive Lighting Installations. [DNV_KEMA_2013_Prescriptive_Ltg_Impact_Eval_PY2010](#)

7 : The Cadmus Group (2012). Final Report, Small Business Direct Install Program: Pre/Post Occupancy Sensor Study. [CADMUS_2012_SBDI_PrePostLightingControl_Final](#)

8 : NMR Group, Inc. (2021). Non Residential New Construction NTG Report. [2021_NMR_Non_Residential_New_Construction_NTG_Report](#)

9 : NMR Group, Inc. (2021). C&I Prescriptive and Custom Net-to-Gross Omnibus Study (MA20X07-B-CIOMNINTG) [2021_NMR_C&I_Omnibus_NTG](#)

10 : NMR (2021). O&M and Non-O&M NEI Study. [2021_NMR_CIOM and NonOM NEI Study](#)

11 : NMR (2022). C&I Health and Safety Non-Energy Impacts. [2022_DNV_C&I_Heath_&_Safety_NEIs](#)

3.92 Lighting - Freezer/Cooler LED

Measure Code	COM-L-FCLED
Market	Commercial
Program Type	Retrofit
Category	Lighting

Measure Description:

Installation of LED lighting in freezer and/or cooler cases. The LED lighting consumes less energy, and results in less waste heat which reduces the cooling/freezing load.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Freezer/Cooler LEDs	C&I Existing Building Retrofit (CI_RETRO)	EC2a030
Freezer/Cooler LEDs (Turnkey)	C&I Existing Building Retrofit (CI_RETRO)	EC2a152

Algorithms for Calculating Primary Energy Impact:

Updates to the deemed savings algorithms, baseline efficiency, and/or high-efficiency edits are suggestions from the C&I Comprehensive TRM Review.[1]

$\Delta kWh = \Delta kWh_{LED} + \Delta kWh_{HeatFreezer}$

$\Delta kWh = \Delta kWh_{LED} + \Delta kWh_{HeatRefrigerator}$

$\Delta kWh_{HeatFreezer} = \Delta kWh_{LED} \times 0.28 \times Eff_{Freezer}$

$\Delta kWh_{HeatRefrigerator} = \Delta kWh_{LED} \times 0.28 \times Eff_{Refrigerator}$

ΔkWh_{LED} = Summation of i=1 to n ($Count_i * kW_i * Hours_i)_{BASE}$ - Summation of i=1 to m ($Count_j * kW_j * Hours_j)_{LED}$

$\Delta kW = \Delta kWh / Hours_j$

Where:
ΔkWh_{LED} = Reduction in lighting energy
ΔkWh_{Heat} = Reduction in refrigeration energy due to reduced heat loss from the lighting fixtures
N = Total number of lighting fixture types in the pre-retrofit case
M = Total number of lighting fixture types in the post-retrofit case
$Count_i$ = Quantity of type i fixtures in the pre-retrofit case
kW_i = Power demand of pre-retrofit lighting fixture type i (kW/fixture)
$Hours_i$ = Pre-retrofit annual operating hours of fixture type i
$Count_j$ = Quantity of type j fixtures in the pre-retrofit case
kW_j = Power demand of lighting fixture type j (kW/fixture)
$Hours_j$ = Post-retrofit annual operating hours of fixture type j
0.28 = Unit conversion between kW and tons calculated as 3,413 Btuh/kW divided by 12,000 Btuh/ton

$Eff_{Freezer}$ = Efficiency of typical freezer system: 1.87 kW/ton[2]
$Eff_{Refrigerator}$ = Efficiency of typical refrigerator system: 1.05 kW/ton[3]

Baseline Efficiency:

The baseline efficiency case is the existing lighting fixtures in the cooler or freezer cases.

High Efficiency:

The high efficiency case is the installation of LED lighting fixtures on the cooler or freezer cases, replacing the existing lighting fixtures.

Measure Life:

The measure life is per the table below and reflects the evaluated, ambient linear measure life category.[4]

Measure Name	Core Initiative	PA	2022	2023	2024
Freezer/Cooler LEDs	CI_RETRO	All	10	10	10

Other Resource Impacts:

There are no other resource impacts for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Freezer/Cooler LEDs	Retrofit	All	1.00	0.94	1.00	1.01	1.01	1.00	1.00

In-Service Rates:
All installations have 100% in service rate since programs include verification of equipment installations.

Realization Rates:
All PAs energy and demand RRs from 12 month logging impact evaluation of MA PAs LCI prescriptive lighting programs.[5]

Coincidence Factors:
All PAs CFs from 12 month logging impact evaluation of MA PAs LCI prescriptive lighting programs.[6]

Impact Factors for Calculating Net Savings:

Net-to-Gross is based on study results.[7]

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Freezer/Cooler LEDs (Whole Initative)	CI_RETRO	All	0.306	0.001	0.016	0.771

Freezer/Cooler LEDs (Turnkey)	CI_RETRO	All	0.222	0.013	0.004	0.795

Non-Energy Impacts:

There are no non-energy impacts identified for this measure.

Endnotes:

1 : Cadeo (2022) MA C&I TRM Review. MA22C01-B_TRM Review_FINAL_31OCT2022
2 : DNV (2022). CT x1931-5 Commercial Refrigeration ACOP Final Report. DNV_2022_CT x1931-5 Commercial Refrigeration ACOP Final Report_051222
3 : DNV (2022). CT x1931-5 Commercial Refrigeration ACOP Final Report. DNV_2022_CT x1931-5 Commercial Refrigeration ACOP Final Report_051222
4 : DNV GL, (2020). C&I Linear Lighting Saturation & Market Model Adjusted Measure Lives
5 : DNV KEMA (2013). Impact Evaluation of 2010 Prescriptive Lighting Installations DNV_KEMA_2013_Prescriptive_Ltg_Impact_Eval_PY2010
6 : DNV KEMA (2013). Impact Evaluation of 2010 Prescriptive Lighting Installations DNV_KEMA_2013_Prescriptive_Ltg_Impact_Eval_PY2010
7 : NMR (2021). C&I Prescriptive and Custom Net-to-Gross Omnibus Study (MA20X07-B-CIOMNINTG) 2021_NMR_C&I_Omnibus_NTG

3.93 Lighting - Performance Lighting

Measure Code	COM-L-ALD
Market	Commercial
Program Type	Retrofit
Category	Lighting

Measure Description:

Advanced lighting design refers to the implementation of various lighting design principles aimed at creating a quality and appropriate lighting experience while reducing unnecessary light usage. This is often done by a professional in a new construction situation. Advanced lighting design uses techniques like maximizing task lighting and efficient fixtures to create a system of optimal energy efficiency and functionality.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Performance Lighting (Interior)	C&I New Buildings & Major Renovations (CI_NB&MR)	EC1a014
Performance Lighting (Exterior)	C&I New Buildings & Major Renovations (CI_NB&MR)	EC1a015
Performance Lighting (Interior with Controls)	C&I New Buildings & Major Renovations (CI_NB&MR)	EC1a016
Performance Lighting (Exterior with Controls)	C&I New Buildings & Major Renovations (CI_NB&MR)	EC1a017
Performance Lighting (Interior)	C&I Existing Building Retrofit (CI_RETRO)	EC2a009
Performance Lighting (Exterior)	C&I Existing Building Retrofit (CI_RETRO)	EC2a010
Performance Lighting (Interior with Controls)	C&I Existing Building Retrofit (CI_RETRO)	EC2a011
Performance Lighting (Exterior with Controls)	C&I Existing Building Retrofit (CI_RETRO)	EC2a012
Performance Lighting (Interior)	C&I New & Replacement Equipment (CI_EQUIP)	EC2b013
Performance Lighting (Exterior)	C&I New & Replacement Equipment (CI_EQUIP)	EC2b014

Performance Lighting (Interior with Controls)	C&I New & Replacement Equipment (CI_EQUIP)	EC2b015
Performance Lighting (Exterior with Controls)	C&I New & Replacement Equipment (CI_EQUIP)	EC2b016

Algorithms for Calculating Primary Energy Impact:

Updates to deemed savings, algorithms, baseline efficiency, and/or high-efficiency edits are suggestions from the C&I Comprehensive TRM Review.[1]

$$\Delta kWh = \sum_{i=1}^{n} (LPD_{Base,i} - LPD_{Proposed,i} + LPD_{Proposed,i} \times Controlled \times \%_{Sav}) \times Area_i \times Hours_i \times 1/1000$$

$$\Delta kW_{Fixture} = \sum_{i=1}^{n} (LPD_{Base,i} - LPD_{Proposed,i}) \times Area_i \times 1/1000$$

$$\Delta kWControlled = \sum_{i=1}^{n} (LPD_{Proposed,i} \times Controlled) \times Area_i \times 1/1000$$

Where:
n = Total number of spaces or 1 for Building Area Method
$LPD_{Base,i}$ = Baseline lighting power density for building or space type i (Watts/ft^2)
$Area_i$ = Area of building or space i (ft^3)
$Hours_i$ = Annual hours of operation of the lighting equipment for space type i
$LPD_{Proposed,i}$ = Proposed lighting power density for building or space type i (Watts/ft^4)
Controlled = % of controlled lighting above required amounts for each tier
1000 = Conversion factor: 1000 watts per 1 kW
$\%_{Sav}$ = Percentage of kWh that is saved by utilizing the control measure.

Note on HVAC system interaction: Additional Electric savings from cooling system interaction are included in the calculation of adjusted gross savings for Lighting Systems projects. The HVAC interaction adjustment factor is determined from lighting project evaluations and is included in the energy realization rates and demand coincidence factors and realization rates.

Note on Performance Lighting tiers: Performance Lighting has 3 tiers, for New Buildings & Major Renovations the min percentage of controlled lighting above required amounts at 0% for tier 1, 20% for tier 2, and 30% for tier 3. All other Preformance Lighting programs have min percentage of controlled lighting above required amounts of 15% for tier 1, 35% for tier 2, and 45% for tier 3.

Savings factors are deemed based on study results.[2]

Corresponding Product Description	**% Savings Factor**
61 - Remote Mounted Occupancy Sensor	0.24
64 - Wall Mounted Occuapancy Sensors	0.24

Corresponding Product Description	% Savings Factor
68 - Integral Occupancy Sensor for High Bay Fixtures	0.24
62 - Daylight Dimming System and/or Occupancy Controlled Dimming System	0.28
63 - Interior Integral Fixture Mounted Dual Sensors	0.38
65 - Outdoor Sensor with Integral Dual Sensors	0.38
63A - Integral Fixture Mounted Dual Sensors with Network-Capable Controls	0.49
65A - Outdoor Integral Dual Sensors with Network-Capable Controls	0.49

Baseline Efficiency:

The new construction Baseline Efficiency assumes lighting power density align with industry standard practice. Interior lighting projects assumes an adjustment factor of 0.60 applied to IECC 2015 code specified maximum LPD. Exterior lighting project assumes an adjustment factor of 0.67 applied to IECC 2015 code specific maximum LPD.[3]

The retrofit Baseline Efficiency will assume pre-existing conditions for baseline lighting power density.

High Efficiency:

The high efficiency scenario assumes lighting systems that achieve lighting power densities below those required by Massachusetts State Building Code. Actual site lighting power densities should be determined on a case-by-case basis. Please refer to the current year application form for minimum percentage better than code efficiency requirements.

Measure Life:

Measures lives are deemed based on study results for 2022.[4] 2023 and 2024 Measure lives are estimated based off of historical trajectory for planning purposes.

Application	Core Initiative	PA	2022	2023	2024
Ambient Linear TLED	CI_EQUIP CI_RETRO	All	7	6	5
Ambient Linear Fixtures	CI_EQUIP CI_RETRO	All	7	6	5
High/Low Bay Lamps	CI_EQUIP CI_RETRO	All	8	7	6
High/Low Bay TLED	CI_EQUIP CI_RETRO	All	8	7	6
High/Low Bay Fixtures	CI_EQUIP	All	8	7	6

Application	Core Initiative	PA	2022	2023	2024
	CI_RETRO				
Exterior/Outdoor Lamps	CI_EQUIP CI_RETRO	All	6	5	4
Exterior/Outdoor TLED	CI_EQUIP CI_RETRO	All	6	5	4
Exterior/Outdoor Fixtures	CI_EQUIP CI_RETRO	All	6	5	4
A-Lamps	CI_EQUIP CI_RETRO	All	2	1	1
Decoratives	CI_EQUIP CI_RETRO	All	2	1	1
Downlights/Track	CI_EQUIP CI_RETRO	All	2	1	1
Performance Lighting (Interior)	CI_NB&MR	All	15	15	15
Performance Lighting (Exterior)	CI_NB&MR	All	15	15	15
Performance Lighting (Interior with Controls)	CI_NB&MR	All	15	15	15
Performance Lighting (Exterior with Controls)	CI_NB&MR	All	15	15	15

The CI_EQUIP and CI_RETRO measure lives above are to be applied by PAs to the measures in their tracking system. PAs' lighting BCR line items will be a weighted average of the evaluated measure lives of the underlying lighting products for that category. For CI_NB&MR, the measure lives remain unchanged at 15 years.

Other Resource Impacts:

Heating penalties are from the 12-month lighting logger study performed on lighting systems.[5]

Measure Name	Core Initiative	PA	MMBtu/kWh
Performance Lighting (Interior)	CI_NB&MR CI_EQUIP	All	-0.000175
Performance Lighting (Exterior)	CI_NB&MR CI_EQUIP	All	n/a

Performance Lighting (Interior w/ Controls)	CI_NB&MR CI_EQUIP	All	-0.000175	
Performance Lighting (Exterior w/ Controls)	CI_NB&MR CI_EQUIP	All	n/a	
Performance Lighting (Interior)	CI_RETRO	All	-0.000175	
Performance Lighting (Exterior)	CI_RETRO	All	n/a	
Performance Lighting (Interior w/ Controls)	CI_RETRO	All	-0.000175	
Performance Lighting (Exterior w/ Controls)	CI_RETRO	All	n/a	

Impact Factors for Calculating Adjusted Gross Savings:

Performance Lighting (Interior w/ and w/o Controls)	CI_NB&MR CI_EQUIP CI_RETRO	All	1.00	1.19	1.19	1.01	1.01	0.80	0.61
Performance Lighting (Exterior w/ and w/o Controls)	CI_NB&MR CI_EQUIP CI_RETRO	All	1.00	1.12	1.12	1.01	1.01	0.00	1.00

In-Service Rates:
All installations have 100% in service rate since programs include verification of equipment installations.

Realization Rates:
Energy and demand RRs from 12 month logging impact evaluation of MA PAs LCI prescriptive lighting programs. Demand RR is the connected demand RR; energy RR includes connected kW RR, hours of use RR and HVAC Interactive adjustment.[6]

Coincidence Factors:
All CFs from 12 month logging impact evaluation of MA PAs LCI prescriptive lighting program.[7]

Impact Factors for Calculating Net Savings:

Factors are deemed based on study results.[8]

Net-to-gross values for the New Buildings and Major Renovations Core Initiative are based on study results.[9]

Measure Name	Core Initiative	PA	FR	SO$_P$	SO$_{NP}$	NTG

Performance Lighting (All)	CI_NB&MR	All	0.58	0.23	0.00	0.65
Performance Lighting (All)	CI_RETRO	All	0.306	0.001	0.016	0.711
Performance Lighting (All)	CI_EQUIP	All	0.250	0.002	0.085	0.837

Non-Energy Impacts:

New Construction non-energy benefits are from the 2016 NEI study.[10] Retrofit non-energy benefits are from the 2012 NEI study.[11] Lighting Controls H&S NEIs are from the 2022 H&S study.[12]

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per KWh	Annual $ per Therm	One-time $ per Therm
Performance Lighting	CI_NB&MR	All			$0.106			
Perfomance Lighting with Controls	CI_NB&MR	All			$0.116			
Performance Lighting	CI_RETRO	All			$0.127			
Performance Lighting with Controls	CI_RETRO	All			$0.130			
Performance Lighting	CI_EQUIP	All			$0.106			
Performance Lighting with Controls	CI_EQUIP	All			$0.116			

Endnotes:

1 : Cadeo (2022) MA C&I TRM Review. MA22C01-B_TRM Review_FINAL_31OCT2022
2 : DNV (2022). CT X1931-4 ALC PSD Phase 2 Memo Recommendations for ALC Measure Parameters. Product codes 61, 64, and 68 correspond to occupancy sensors, 62 to daylighting dimming, 63 and 65 to dual sensors and non-commissioned LLLCs, and 63A and 65A to commissioned LLLCs and NLCs. The PAs/EEAC also decided to use "non-commissioned LLLC" rather than the evaluation report measure name (Integrated fixture with Room-Based Controls) to avoid market confusion until the Design Lights Consortium (DLC) creates a category for these products in the future. PAs should update the measure name once the DLC creates a category. 2022_DNV_CT X1931-4 ALC PSD Phase 2 Memo Recommendations for ALC Measure Parameters

3 : DNV (2021). Application of MA19C08-B-NRNCMKT Results. 2021_DNV_NRNC Market Characterization

4 : DNV GL (2021). C&I Linear Lighting Saturation & Market Model Adjusted Measure Lives. 2021_DNV_CI Lighting_Adjusted Measure Life_2021-2022_Memo

5 : DNV KEMA (2013). Impact Evaluation of 2010 Prescriptive Lighting Installations. DNV_KEMA_2013_Prescriptive_Ltg_Impact_Eval_PY2010

6 : DNV KEMA (2013). Impact Evaluation of 2010 Prescriptive Lighting Installations. DNV_KEMA_2013_Prescriptive_Ltg_Impact_Eval_PY2010

7 : DNV KEMA (2013). Impact Evaluation of 2010 Prescriptive Lighting Installations. DNV_KEMA_2013_Prescriptive_Ltg_Impact_Eval_PY2010

8 : NMR (2021). C&I Prescriptive and Custom Net-to-Gross Omnibus Study (MA20X07-B-CIOMNINTG) 2021_NMR_C&I_Omnibus_NTG

9 : NMR Group, Inc. (2021). Non Residential New Construction NTG Report. 2021_NMR_Non_Residential_New_Construction_NTG_Report

10 : Tetra Tech (2016). C&I New Construction Non-Energy Impacts Study. DNVGL_2016_CI_NC_NEI

11 : Tetra Tech (2012). C&I Retrofit Non-Energy Impacts Study TETRATECH_2012_MA_CI_NEI_REPORT

12 : NMR (2022). C&I Health and Safety Non-Energy Impacts. 2022_DNV_C&I_Heath_&_Safety_NEIs

3.94 Lighting - System

Measure Code	COM-L-LS
Market	Commercial
Program Type	Retrofit
Category	Lighting

Measure Description:

This measure promotes the installation of efficient lighting including, but not limited to, efficient fluorescent lamps, ballasts, and fixtures, and solid state lighting.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Lighting Systems - Interior	C&I New Buildings & Major Renovations (CI_NB&MR)	EC1a018
Lighting Systems - Exterior	C&I New Buildings & Major Renovations (CI_NB&MR)	EC1a019
Lighting Systems Interior	C&I Existing Building Retrofit (CI_RETRO)	EC2a013
Lighting Systems Exterior	C&I Existing Building Retrofit (CI_RETRO)	EC2a014
Lighting Systems - Interior (Turnkey)	C&I Existing Building Retrofit (CI_RETRO)	EC2a048
Lighting Systems - Exterior (Turnkey)	C&I Existing Building Retrofit (CI_RETRO)	EC2a049
Lighting Systems - Interior	C&I New & Replacement Equipment (CI_EQUIP)	EC2b017
Lighting Systems - Exterior	C&I New & Replacement Equipment (CI_EQUIP)	EC2b018
Midstream - LED Screw In	C&I New & Replacement Equipment (CI_EQUIP)	EC2b059
Midstream - LED Stairwell Kit	C&I New & Replacement Equipment (CI_EQUIP)	EC2b060

Measure Name	Core Initiative	BCR Measure ID
Midstream - LED Linear Lamp (TLED)	C&I New & Replacement Equipment (CI_EQUIP)	EC2b058
Midstream - LED Linear Lamp (TLED) with Controls	C&I New & Replacement Equipment (CI_EQUIP)	EC2b099
Midstream - LED Linear Fixture	C&I New & Replacement Equipment (CI_EQUIP)	EC2b088
Midstream - LED Linear Fixture with Controls	C&I New & Replacement Equipment (CI_EQUIP)	EC2b061
Midstream - High Bay / Low Bay	C&I New & Replacement Equipment (CI_EQUIP)	EC2b062
Midstream - High Bay / Low Bay with Controls	C&I New & Replacement Equipment (CI_EQUIP)	EC2b096
Midstream - LED Exterior	C&I New & Replacement Equipment (CI_EQUIP)	EC2b063
Midstream - LED Exterior with Controls	C&I New & Replacement Equipment (CI_EQUIP)	EC2b100

Algorithms for Calculating Primary Energy Impact:

$\Delta kWh = (\text{Summation } i=1 \text{ to } n(\text{Count}_i * \text{Watts}_i /1000)_{BASE} - \text{Summation } j=1 \text{ to } n(\text{Count}_j * \text{Watts}_j/1000)_{EE}) \text{ (Hours)}$

$\Delta kW = \text{Summation } i=1 \text{ to } n(\text{Count}_i * \text{Watts}_i /1000)_{BASE} - \text{Summation } j=1 \text{ to } n (\text{Count}_j * \text{Watts}_j/1000)_{EE}$

Where:
n = Total number of fixture types in baseline or pre-retrofit case
m = Total number of installed fixture types
Count_i = Quantity of existing fixtures of type i (for lost-opportunity, $\text{Count}_i = \text{Count}_j$).
Watts_i = Existing fixture or baseline wattage for fixture type i
Count_j = Quantity of efficient fixtures of type j.
Watts_j = Efficient fixture wattage for fixture type j.
1000 = Conversion factor: 1000 watts per kW.
Hours = Lighting annual hours of operation.

Midstream lighting measures will calculate gross energy savings in the 2022-2024 term using annual hours of operation defined for the particular building type the lamp was installed. These categories and hours of use are defined in the table below. For all downstream measures the annual hours of operation are site specific or per the downstream table below.

Midstream Hours of Use By Building Type[1]

Building Type	Hours of Use
College & University	4,132
Grocery/Food Sales	5,920
Hospital	5,601
Industrial/Manufacturing	5,229
K-12 School	2,902
Lodging	4,194
Medical Office	3,673
Office Building	4,171
Other	4,141
Restaurant/Food Service	4,891
Retail	4,957
Warehouse and Storage	6,512
Parking Garages	8,760

Downstream Hours of Use By Building Type[2]

Building Type	Hours of Use
Auto Related	4,336
Daycare	2,788
Education - School	2,788
Education - College/University	4,839
Grocery	5,468
Health/Medical - Clinic	3,673
Hospital	5,413
Industrial Manufacturing - 1 Shift	2,857
Industrial Manufacturing - 2 Shifts	4,730
Industrial Manufacturing - 3 Shifts	6,631

Building Type	Hours of Use
Library	2,788
Lodging - Guest Room	914
Lodging - Common Space	4,026
Multi-Family High-Rise - Common Area	4,336
Nursing Home	4,026
Office	4,181
Parking Garage	6,552
Public Order & Safety	4,336
Public Assembly - 1 Shift	2,610
Public Service - Non Food	3,425
Restaurant	5,018
Retail	4,939
Religious Worship/Church	1,810
Storage - Conditioned/Unconditioned	3,420
Warehouse - Inactive Storage	2,316
Warehouse - Distribution Center	6,512

Note on HVAC system interaction: Additional Electric savings from cooling system interaction are included in the calculation of adjusted gross savings for Lighting Systems projects. The HVAC interaction adjustment factor is determined from lighting project evaluations and is included in the energy realization rates and demand coincidence factors and realization rates.

The following savings factors are applied to midstream.[3]

Measure	Control Savings Factor
Networked Lighting Control (NLC) - Performance-Tested, or Luminaire-Level Lighting Control (LLLC) - Networked and Performance-Tested[4]	0.49
Dual Occupancy and Daylight Sensor, or Non-Performance-Tested LLLC[5] or NLC	0.38
Occupancy Sensors	0.24

Baseline Efficiency:

For retrofit installations, the baseline efficiency case is project-specific and is determined using actual fixture counts from the existing space. For lost opportunity installations, the baseline efficiency case is determined using assumed baseline wattages for each of the installed fixtures unless baseline assumptions have been evaluated.

High Efficiency:

For both new construction and retrofit installations, the high efficiency case is project-specific and is determined using actual fixture counts for the project and the MassSave Wattage Tables.

Measure Life:

Measure lives are deemed based on study results for 2022.[6] 2023 and 2024 Measure lives are estimated based off of historical trajectory for planning purposes.

Application	Core Initiative	PA	2022	2023	2024
Ambient Linear TLED	CI_EQUIP CI_RETRO	All	7	6	5
Ambient Linear Fixtures	CI_EQUIP CI_RETRO	All	7	6	5
High/Low Bay Lamps	CI_EQUIP CI_RETRO	All	8	7	6
High/Low Bay TLED	CI_EQUIP CI_RETRO	All	8	7	6
High/Low Bay Fixtures	CI_EQUIP CI_RETRO	All	8	7	6
Exterior/Outdoor Lamps	CI_EQUIP CI_RETRO	All	6	5	4
Exterior/Outdoor TLED	CI_EQUIP CI_RETRO	All	6	5	4
Exterior/Outdoor Fixtures	CI_EQUIP CI_RETRO	All	6	5	4
A-Lamps	CI_EQUIP CI_RETRO	All	2	1	1
Decoratives	CI_EQUIP CI_RETRO	All	2	1	1
Downlights/Track	CI_EQUIP	All	2	1	1

	CI_RETRO				
Lighting Systems - Interior	CI_NB&MR	All	15	15	15
Lighting Systems - Exterior	CI_NB&MR	All	15	15	15

The CI_EQUIP and CI_RETRO measure lives above are to be applied by PAs to the measures in their tracking system. PAs' lighting BCR line items will be a weighted average of the evaluated measure lives of the underlying lighting products for that category. For CI_NB&MR, the measure lives remain unchanged at 15 years.

Other Resource Impacts:

There are fossil fuel heating penalties associated with lighting as follows.

Measure Name	Core Initiative	PA	MMBtu/kWh
Lighting Systems - Interior	CI_NB&MR CI_EQUIP, CI_RETRO	All	-0.000691
Lighting Systems - Exterior	CI_NB&MR CI_EQUIP, CI_RETRO	All	n/a
Lighting Systems – Interior (Turnkey)	CI_RETRO	All	-0.00090
Lighting Systems – Exterior (Turnkey)	CI_RETRO	All	n/a
Lighting Upstream – LED Linear	CI_EQUIP	All	-0.000162
Lighting Upstream – LED Screw In	CI_EQUIP	All	-0.000329
Lighting Upstream – LED Stairwell	CI_EQUIP	All	n/a
Lighting Upstream – LED Linear w/ Controls	CI_EQUIP	All	-0.000162
Lighting Upstream – High/Low Bay	CI_EQUIP	All	-0.000329
Lighting Upstream – LED Exterior	CI_EQUIP	All	n/a
Lighting Upstream - High/Low Bay w/Controls	CI_EQUIP	All	-0.000329
Lighting Upstream - LED Linear Lamp (TLED) with Controls	CI_EQUIP	All	-0.000162
Lighting Upstream - LED Exterior with Controls	CI_EQUIP	All	n/a

Heating penalties for downstream, interior lighting systems (non-turnkey) are from the 12-month data logging study.[7] Penalties for interior, turnkey are from the 2018 small business lighting impact evaluation[8] . Penalties for upstream lighting products are from the 2017 upstream lighting impact evaluation[9] .

Impact Factors for Calculating Adjusted Gross Savings:

Impact factors are based on study results.[10] [11] [12]

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Lighting Systems - Interior	CI_NB&MR CI_EQUIP, CI_RETRO	All	1.00	1.12	1.12	1.00	1.00	0.80	0.61
Lighting Systems - Exterior	CI_NB&MR CI_EQUIP, CI_RETRO	All	1.00	1.12	1.12	1.00	1.00	0.00	1.00
Lighting Systems – Interior (Turnkey)	CI_RETRO	All	1.00	0.93	0.93	0.91	1.03	0.57	0.58
Lighting Systems – Exterior (Turnkey)	CI_RETRO	All	1.00	0.93	0.93	0.91	1.03	0.00	1.00
Lighting Upstream – LED Linear	CI_EQUIP	All	1.00	0.88	0.88	0.99	0.99	0.72	0.66
Lighting Upstream – LED Screw In	CI_EQUIP	All	1.00	0.61	0.61	0.70	0.55	0.59	0.52
Lighting Upstream – LED Stairwell	CI_EQUIP	All	1.00	0.86	0.86	0.86	0.86	0.81	0.82
Lighting Upstream – LED Linear w/ Controls	CI_EQUIP	All	1.00	0.94	0.94	1.06	0.91	0.72	0.66
Lighting Upstream – High/Low Bay	CI_EQUIP	All	1.00	0.91	0.91	1.02	0.88	0.72	0.66
Lighting Upstream – LED Exterior	CI_EQUIP	All	1.00	0.92	0.92	0.92	0.92	0.00	1.00
Lighting Upstream – High/Low Bay w/ Controls	CI_EQUIP	All	1.00	0.91	0.91	1.02	0.88	0.72	0.66
Lighting Upstream - LED Linear Lamp	CI_EQUIP	All	1.00	0.88	0.88	0.99	0.85	0.72	0.66

Measure Name	Core Initiative	PA	ISR	RR$_E$	RR$_{NE}$	RR$_{SP}$	RR$_{WP}$	CF$_{SP}$	CF$_{WP}$
(TLED) with Controls									
Lighting Upstream - LED Exterior with Controls	CI_EQUIP	All	1.00	0.92	0.92	0.92	0.92	0.00	1.00

In-Service Rates:

All downstream installations have 100% in service rate since programs include verification of equipment installations. All midstream in-service rates are incorporated into the realization rates, so the ISR is set to 1.00 to avoid double counting.

Realization Rates:

- C&I New Construction: For all measures except MidstreamLighting, all PAs Energy and Demand RRs from 12 month logging impact evaluation of MA PAs LCI prescriptive lighting programs.[13]
- C&I Upstream: Upstream Lighting Energy RR includes connected kW RR, Hours of Use RR, In service rate, and HVAC Interactive adjustment. All Upstream Lighting Demand RR includes the connected kW RR and demand interactive adjustment.[14]
- C&I Existing Building Retrofit: All PAs energy and demand RRs from 12 month logging impact evaluation of MA PAs LCI prescriptive lighting programs. Demand RR is the connected demand RR; energy RR includes connected kWh RR, hours of use RR and HVAC Interactive adjustment.[15]
- C&I Small Business: Energy and demand RRs are the statewide results from the 2018 Small Business Impact Evaluation - Phase I and subsequent correction memo to adjust interactive effects.[16]

Coincidence Factors:

- C&I New Construction: For all measures except Upstream Lighting, all CFs are from 12 month logging impact evaluation of MA PAs LCI prescriptive lighting programs.[17]
- C&I Upstream: All PAs CFs are from the 2017 Upstream Lighting Impact evaluation.[18]
- C&I Existing Building Retrofit: All CFs are from 12 month logging impact evaluation of MA PAs LCI prescriptive lighting programs.[19]
- C&I Small Business: All PAs use CF values from the 2018 Small Business Impact Evaluation - Phase I and subsequent correction memo to adjust interactive effects.[20]

Impact Factors for Calculating Net Savings:

2024 Net-to-gross values are based on study results.[21] [21]

Measure Name	Core Initiative	PA	FR	SO$_P$	SO$_{NP}$	NTG
Lighting System – Interior	CI_NB&MR	All	0.580	0.230	n/a	0.650
Lighting System – Exterior	CI_NB&MR	All	0.580	0.230	n/a	0.650
Lighting System – Interior (Turnkey)	CI_RETRO	All	0.222	0.013	0.004	0.795
Lighting System – Exterior (Turnkey)	CI_RETRO	All	0.222	0.013	0.004	0.795
Lighting System – Interior	CI_RETRO	All	0.306	0.001	0.016	0.711
Lighting System – Exterior	CI_RETRO	All	0.306	0.001	0.016	0.711
Lighting System – Interior	CI_EQUIP	All	0.25	0.002	0.085	0.837
Lighting System – Exterior	CI_EQUIP	All	0.25	0.002	0.085	0.837

Midstream Net-to-Gross for 2024

Midstream lighting NTG are per the 2021 upstream lighting NTG study.[23]

Measure Name	Core Initiative	PA	2022		2023		2024	
			FR	NTG	FR	NTG	FR	NTG
Lighting Midstream – LED Linear	CI_EQUIP	All	0.74	0.26	0.80	0.20	0.86	0.14
Lighting Midstream – LED Screw In	CI_EQUIP	All	0.55	0.45	0.60	0.40	0.65	0.35
Lighting Midstream – LED Stairwell	CI_EQUIP	All	0.74	0.26	0.80	0.20	0.86	0.14
Lighting Midstream - LED Linear Fixtures	CI_EQUIP	All	0.73	0.27	0.78	0.22	0.83	0.17
Lighting Midstream – LED Linear Fixtures w/ Controls	CI_EQUIP	All	0.42	0.58	0.44	0.56	0.47	0.53
Lighting Midstream – High/Low Bay	CI_EQUIP	All	0.51	0.49	0.56	0.44	0.62	0.38
Lighting Midstream – LED Exterior	CI_EQUIP	All	0.83	0.17	0.88	0.12	0.93	0.07
Lighting Midstream - High/Low Bay w/Controls	CI_EQUIP	All	0.51	0.49	0.56	0.44	0.62	0.38
Lighting Midstream - LED Linear Lamp (TLED) with Controls	CI_EQUIP	All	0.74	0.26	0.80	0.20	0.86	0.14
Lighting Midstream - LED Exterior with Controls	CI_EQUIP	All	0.83	0.17	0.88	0.12	0.93	0.07

Non-Energy Impacts:

Non-energy benefits come from the 2021 NEI study.[24] Lighting controls come from the 2021 NEI study as well as the 2022 C&I H&S NEI study.[24]

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per KWh	Annual $ per Therm	One-time $ per Therm
Lighting Systems - Interior	CI_NB&MR, CI_EQUIP	All			$0.048			
Lighting Systems - Exterior	CI_NB&MR, CI_EQUIP	All			$0.048			
Lighting Systems - Interior	CI_RETRO	All			$0.048			
Lighting Systems - Exterior	CI_RETRO	All			$0.048			
Lighting Systems – Interior (Turnkey)	CI_RETRO	All			$0.048			
Lighting Systems – Exterior (Turnkey)	CI_RETRO	All			$0.048			
Lighting Midstream – LED Linear	CI_EQUIP	All			$0.048			
Lighting Midstream – LED Screw In	CI_EQUIP	All			$0.048			
Lighting Midstream – LED Stairwell	CI_EQUIP	All			$0.048			
Lighting Midstream – LED Linear w/ Controls	CI_EQUIP	All			$0.116			
Lighting Midstream – High/Low Bay	CI_EQUIP	All			$0.048			
Lighting Midstream – LED Exterior	CI_EQUIP	All			$0.048			
Lighting Midstream - High/Low Bay w/Controls	CI_EQUIP	All			$0.116			
Lighting Midstream - LED Linear Lamp (TLED) with Controls	CI_EQUIP	All			$0.116			
Lighting Midstream - LED	CI_EQUIP	All			$0.116			

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per KWh	Annual $ per Therm	One-time $ per Therm
Exterior with Controls								

Endnotes:

1 : DNV GL (2021). Impact Evaluation of PY2019 Massachusetts C&I Upstream Lighting Initiative. 2021_DNV_Upstream_Lighting_Impact_Report

2 : Downstream hours of use leverage the upstream evaluation HOU study previously referenced where applicable, and include additional layers of granularity for those building types not covered by the evaluation and in accordance with NY TRM guidance and/or engineering judgement. Parking garage HOU are lower than upstream assumption as there isn't an explicit requirement for 24/7 usage per code.

3 : DNV (2022). CT X1931-4 ALC PSD Phase 2 Memo Recommendations for ALC Measure Parameters. Table is based on Section 2.1.2 of Connecticut 2022 Program Savings Document, which shows control savings factors being applied for upstream offerings. 2022_DNV_CT X1931-4 ALC PSD Phase 2 Memo Recommendations for ALC Measure Parameters

4 : DNV (2023). Performance Testing and Networking for C&I Lighting Controls. DNV recommends the PAs change the naming of ALCs as follows: Networked lighting control (NLC) changed to Networked lighting control (NLC) – Performance Tested (PT); Luminaire-level Lighting Controls (LLLC) – Networked and Commissioned changed to Luminaire-level Lighting Controls (LLLC) – Networked and Performance tested (PT); Non-Commissioned LLLCs changed to Non-Performance Tested LLLCs 2023_DNV_MA23C03-E-LGTCTRLC Lighting Controls Performance Testing Report-Draft Final-11

5 : The PAs/EEAC decided to not use the evaluation report measure name (Integrated fixture with Room-Based Controls) in the table to avoid market confusion until the Design Lights Consortium (DLC) creates a category for these products in the future. PAs should update the measure name once the DLC creates a category.

6 : DNV (2021). C&I Linear Lighting Saturation & Market Model Adjusted Measure Lives. 2021_DNV_CI Lighting_Adjusted Measure Life_2021-2022_Memo

7 : DNV KEMA (2013). Impact Evaluation of 2010 Prescriptive Lighting Installations. DNV_KEMA_2013_Prescriptive_Ltg_Impact_Eval_PY2010

8 : DNV GL, ERS (2018). Impact Evaluation of PY2016 Small Business Initiative: Phase I 2018_DNVGL_ERS_SBS_Impact

9 : DNV GL (2017). Impact Evaluation of PY2015 Massachusetts Commercial and Industrial Upstream Lighting Initiative. DNVGL_2017_Upstream_Lighting_Impact_Evaluation

10 : DNV (2021). Impact Evaluation of PY2019 Massachusetts C&I Upstream Lighting Initiative. 2021_DNV_Upstream_Lighting_Impact_Report

11 : DNV KEMA (2013). Impact Evaluation of 2010 Prescriptive Lighting Installations. DNV_KEMA_2013_Prescriptive_Ltg_Impact_Eval_PY2010

12 : DNV GL (2018). Impact Evaluation of PY2016 Massachusetts Commercial & Industrial Small Business Initiative: Phase I. 2018_DNVGL_ERS_SBS_Impact

13 : DNV KEMA (2013). Impact Evaluation of 2010 Prescriptive Lighting Installations. DNV_KEMA_2013_Prescriptive_Ltg_Impact_Eval_PY2010

14 : DNV GL (2021). Impact Evaluation of PY2019 Massachusetts C&I Upstream Lighting Initiative. 2021_DNV_Upstream_Lighting_Impact_Report

15 : DNV KEMA (2013). Impact Evaluation of 2010 Prescriptive Lighting Installations. DNV_KEMA_2013_Prescriptive_Ltg_Impact_Eval_PY2010

16 : DNV GL (2018). Impact Evaluation of PY2016 Masachusetts Commercial & Industrial Small Business Initiative: Phase I (Lighting). 2018_DNVGL_ERS_SBS_Impact

17 : DNV KEMA (2013). Impact Evaluation of 2010 Prescriptive Lighting Installations. DNV_KEMA_2013_Prescriptive_Ltg_Impact_Eval_PY2010

18 : DNV GL (2017). Impact Evaluation of PY2015 Massachusetts Commercial and Industrial Upstream Lighting Initiative. DNVGL_2017_Upstream_Lighting_Impact_Evaluation

19 : DNV KEMA (2013). Impact Evaluation of 2010 Prescriptive Lighting Installations. DNV_KEMA_2013_Prescriptive_Ltg_Impact_Eval_PY2010

20 : DNV GL (2018). Impact Evaluation of PY2016 Masachusetts Commercial & Industrial Small Business Initiative: Phase I (Lighting). 2018_DNVGL_ERS_SBS_Impact

21 : NMR Group, Inc. (2021). Non Residential New Construction NTG Report. 2021_NMR_Non_Residential_New_Construction_NTG_Report

22 : NMR (2021). C&I Prescriptive and Custom Net-to-Gross Omnibus Study (MA20X07-B-CIOMNINTG). 2021_NMR_C&I_Omnibus_NTG

23 : DNV (2021). Massachusetts C&I Upstream Lighting Net-to-Gross Study 2022-2024. 2021_DNV_CI Lighting_Upstream_NTG_2022-2024

24 : NMR Group Inc (2021). O&M and Non-O&M NEI Study. 2021_NMR_CIOM and NonOM NEI Study

25 : NMR (2022). C&I Health and Safety Non-Energy Impacts. 2022_DNV_C&I_Heath_&_Safety_NEIs

3.95 Motor - Variable Frequency Drive

Measure Code	COM-MAD-VFD
Market	Commercial
Program Type	Retrofit
Category	Motors and Drives

Measure Description:

This measure covers the installation of variable speed drives according to the terms and conditions stated on the statewide worksheet. The measure covers multiple end use types and building types. The installation of this measure saves energy since the power required to rotate a pump or fan at lower speeds requires less power than when rotated at full speed.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Prescriptive - Motors & VFD (Turnkey)	C&I Existing Building Retrofit (CI_RETRO)	EC2a054

Algorithms for Calculating Primary Energy Impact:

$\Delta kWh = (HP)(kWh/HP)$

$\Delta kW = (HP)(kW/HP_{SP})$

Where:

HP = Rated horsepower for the impacted motor.

kWh / HP = Annual electric energy reduction based on building and equipment type. See table below.

kW / HP$_{SP}$ = Summer demand reduction based on building and equipment type. See table below.

kW / HP$_{WP}$ = Winter demand reduction based on building and equipment type. See table below.

Savings factors below already account for motor efficiency and consequently an adjustment is not required in the algorithm.

Savings Factors for C&I VFDs (kWh/HP and kW/HP) [1]

Building Type	Building Exhaust Fan	Cooling Tower Fan	Chilled Water Pump	Boiler Feed Water Pump	Hot Water Circulating Pump	MAF - Make-up Air Fan	Return Fan	Supply Fan	WS Heat Pump Circulating Loop
Annual Energy Savings Factors (kWh/HP)									

Building Type	Building Exhaust Fan	Cooling Tower Fan	Chilled Water Pump	Boiler Feed Water Pump	Hot Water Circulating Pump	MAF - Make-up Air Fan	Return Fan	Supply Fan	WS Heat Pump Circulating Loop
University/ College	3641	449	745	2316	2344	3220	1067	1023	3061
Elementary/ High School	3563	365	628	1933	1957	3402	879	840	2561
Multi-Family	3202	889	1374	2340	2400	3082	1374	1319	3713
Hotel/ Motel	3151	809	1239	2195	2239	3368	1334	1290	3433
Health	3375	1705	2427	2349	2406	3002	1577	1487	3670
Warehouse	3310	455	816	2002	2087	3229	1253	1205	2818
Restaurant	3440	993	1566	1977	2047	2628	1425	1363	3542
Retail	3092	633	1049	1949	2000	2392	1206	1146	2998
Grocery	3126	918	1632	1653	1681	2230	1408	1297	3285
Offices	3332	950	1370	1866	1896	3346	1135	1076	3235
Summer Demand Savings Factors (kW/HP$_{SP}$)									
University/ College	0.109	-0.023	0.174	0.457	0.091	0.109	0.287	0.274	0.218
Elementary/ High School	0.377	-0.023	0.174	0.457	0.091	0.109	0.287	0.274	0.218
Multi-Family	0.109	-0.023	0.174	0.457	0.091	0.109	0.287	0.274	0.218
Hotel/ Motel	0.109	-0.023	0.174	0.457	0.091	0.109	0.287	0.274	0.218
Health	0.109	-0.023	0.174	0.457	0.091	0.109	0.287	0.274	0.218
Warehouse	0.109	-0.023	0.174	0.457	0.091	0.261	0.287	0.274	0.218
Restaurant	0.261	-0.023	0.174	0.457	0.091	0.109	0.287	0.274	0.218
Retail	0.109	-0.023	0.174	0.457	0.091	0.109	0.287	0.274	0.218

Building Type	Building Exhaust Fan	Cooling Tower Fan	Chilled Water Pump	Boiler Feed Water Pump	Hot Water Circulating Pump	MAF - Make-up Air Fan	Return Fan	Supply Fan	WS Heat Pump Circulating Loop
Grocery	0.261	-0.023	0.174	0.457	0.091	0.109	0.287	0.274	0.218
Offices	0.109	-0.023	0.174	0.457	0.091	0.109	0.287	0.274	0.218
Winter Demand Savings Factors (kW/HP$_{WP}$)									
University/ College	0.377	-0.006	0.184	0.457	0.21	0.109	0.26	0.252	0.282
Elementary/ High School	0.457	-0.006	0.184	0.457	0.21	0.109	0.26	0.252	0.282
Multi-Family	0.109	-0.006	0.184	0.355	0.21	0.109	0.26	0.252	0.282
Hotel/ Motel	0.109	-0.006	0.184	0.418	0.21	0.109	0.26	0.252	0.282
Health	0.377	-0.006	0.184	0.275	0.21	0.109	0.26	0.252	0.282
Warehouse	0.377	-0.006	0.184	0.178	0.21	0.261	0.26	0.252	0.282
Restaurant	0.109	-0.006	0.184	0.355	0.21	0.109	0.26	0.252	0.282
Retail	0.109	-0.006	0.184	0.275	0.21	0.109	0.26	0.252	0.282
Grocery	0.457	-0.006	0.184	0.418	0.21	0.109	0.26	0.252	0.282
Offices	0.457	-0.006	0.184	0.418	0.21	0.109	0.26	0.252	0.282

Baseline Efficiency:

The baseline efficiency case measure varies with equipment type. All baselines assume either a constant or 2-speed motor. Air or water volume/temperature is controlled using valves, dampers, and/or reheats.

High Efficiency:

In the high efficiency case, pump flow or fan air volume is directly controlled using downstream information. The pump or fan will automatically adjust its speed based on inputted set points and the downstream feedback it receives.

Measure Life:

This measure has been determined to be an add on single baseline measure for retrofit scenarios.[2] [3]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Prescriptive - Motors & VFD (Turnkey)	CI_RETRO	All	13	n/a	n/a	13

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
VFD (turnkey)	CI_RETRO	Eversource / Unitil	1.00	0.946	n/a	1.265	1.415	1.00	1.00
VFD (turnkey)	CI_RETRO	National Grid / CLC	1.00	1.049	n/a	0.941	1.174	1.00	1.00

In-Service Rates:

All installations have 100% in service rate since all PAs programs include verification of equipment installations.

Realization Rates:

- Energy and Demand RRs for Turnkey installations are based on the Impact Evaluation of PY 2017 Small Business Initiative Non-Lighting Measures study.[4]

Coincidence Factors:

CFs for all PAs set to 1.0 since summer and winter demand savings are based on evaluation results.

Impact Factors for Calculating Net Savings:

All PAs use statewide prescriptive net-to-gross results for non-residential end use measures.[5]

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
VFD - Prescriptive (Turnkey)	CI_RETRO	All	0.13	0.05	0.02	0.94

Non-Energy Impacts:

Non-energy benefits come from the 2021 NEI study.[6]

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh[6]	One-time $ per KWh	Annual $ per Therm	One-time $ per Therm

VFD - Prescriptive (Turnkey)	CI_RETRO	All			$0.002			

Endnotes:

1 : Chan, Tumin (2010). Formulation of a Prescriptive Incentive for the VFD and Motors & VFD impact tables at NSTAR.
Chan_2010_Formulation_of_a_Prescriptive_Incentive_for_the_VFD_and_Motors_and_VFD_Impact_Tables_at_NSTAR

2 : Energy & Resource Solutions (2005). Measure Life Study. ERS_2005_Measure_Life_Study

3 : Baseline Categories and preliminary Out Year Factors are described at a high level in DNV GL, ERS (2018). Portfolio Model Companion Sheet. Additional background on the baseline categorization given in DNV GL, ERS (2018). Portfolio Model Methods and Assumptions – Electric and Natural Gas Memo.
2018_DNVGL_ERS_Portfolio_Model_Companion_Sheet

4 : DNV GL. (2019). Impact Evaluation of PY 2017 Small Business Initiative Non-lighting measures.
Final Report MA19C03-E-SBIMPCT 03202020

5 : NMR Group, Inc. (2018). Massachusetts Sponsors' Commercial and Industrial Free-ridership and Spillover Study. 2018_NMR_CI FR-SO Report

6 : NMR Group Inc (2021). O&M and Non-O&M NEI Study. 2021_NMR_CIOM and NonOM NEI Study

3.96 Motor - Variable Frequency Drive - C&I Metered Multi- Family

Measure Code	COM-MAD-VFDREU
Market	Commercial
Program Type	Retrofit
Category	Motors and Drives

Measure Description:

This measure covers the installation of variable speed drives according to the terms and conditions stated on the statewide worksheet. The measure covers multiple end use types and building types. The installation of this measure saves energy since the power required to rotate a pump or fan at lower speeds requires less power than when rotated at full speed.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Custom - Motors & VFD (Residential End Use)	C&I Existing Building Retrofit (CI_RETRO)	EC2a109

Algorithms for Calculating Primary Energy Impact:

$\Delta kWh = (HP)(kWh/HP)$
$\Delta kW = (HP)(kW/HP_{SP})$

Where:

HP   = Rated horsepower for the impacted motor.
kWh / HP   = Annual electric energy reduction based on building and equipment type. See table below.
kW / HPSP = Summer demand reduction based on building and equipment type. See table below.
kW / HP_WP = Winter demand reduction based on building and equipment type. See table below.

Savings factors below already account for motor efficiency and consequently an adjustment is not required in the algorithm.

Savings Factors for VFDs[1] [2] (kWh/HP and kW/HP) - Multi-Family

Savings Factor	Building Exhaust Fan	Cooling Tower Fan	Chilled Water Pump	Boiler Feed Water Pump	Hot Water Circulating Pump	MAF - Make-up Air Fan	Return Fan	Supply Fan	WS Heat Pump Circulating Loop

Savings Factor	Building Exhaust Fan	Cooling Tower Fan	Chilled Water Pump	Boiler Feed Water Pump	Hot Water Circulating Pump	MAF - Make-up Air Fan	Return Fan	Supply Fan	WS Heat Pump Circulating Loop
Annual Energy Savings Factors (kWh/HP)	3202	889	1633	2340	1548	3082	1788	2033	2562
Summer Demand Savings Factors (kW/HP$_{SP}$)	0.109	-0.023	0.183	0.457	0.096	0.109	0.302	0.288	0.229
Winter Demand Savings Factors (kW/HP$_{WP}$)	0.109	-0.006	0.194	0.355	0.221	0.109	0.274	0.265	0.297

Baseline Efficiency:

The baseline efficiency case measure varies with equipment type. All baselines assume either a constant or 2-speed motor. Air or water volume/temperature is controlled using valves, dampers, and/or reheats.

High Efficiency:

In the high efficiency case, pump flow or fan air volume is directly controlled using downstream information. The pump or fan will automatically adjust its speed based on inputted set points and the downstream feedback it receives.

Measure Life:

Measure lives are PA specific or are determined on a case-by-case basis.

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR$_E$	RR$_{NE}$	RR$_{SP}$	RR$_{WP}$	CF$_{SP}$	CF$_{WP}$
VFDs (Residential End Use)	CI_RETRO	All	1.00	0.86	0.86	0.86	0.86	1.00	1.00

In-Service Rates:

All installations have 100% in service rate since all PAs programs include verification of equipment installations.

Realization Rates:

Realization rate is based on evaluation results.[4]

Coincidence Factors:

CFs for all PAs set to 1.0 since summer and winter demand savings are based on evaluation results.

Impact Factors for Calculating Net Savings:

Net to gross factors are based on evaluation results.[5]

Measure Name	Core Initiative	PA	FR	SO$_P$	SO$_{NP}$	NTG
VFDs (Residential End Use)	CI_RETRO	All	0.14	0.0	0.0	0.86

Non-Energy Impacts:

NEI values are rolled up, component values can be found in Appendix B.

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per KWh	Annual $ per Therm	One-time $ per Therm
VFD (Residential End Use)	CI_RETRO	All	$0.00	$0.00	$0.20	$0.00	$0.00	$0.00

Endnotes:

1 : For Chilled Water Pump, Hot Water Circ. Pump, Return Fan, Supply Fan, and WSHP Circ. Loop: kW and kWh /HP estimates derived from Cadmus (2012). Variable Speed Drive Loadshape Project. Prepared for the NEEP Regional Evaluation, Measurement & Verification Forum. Other drive type savings estimates based on Chan, Tumin (2010). Formulation of a Prescriptive Incentive for the VFD and Motors & VFD impact tables at NSTAR. Cadmus_2014_VSD_Loadshape_Project

2 : For Chilled Water Pump, Hot Water Circ. Pump, Return Fan, Supply Fan, and WSHP Circ. Loop: kW and kWh /HP estimates derived from Cadmus (2012). Variable Speed Drive Loadshape Project. Prepared for the NEEP Regional Evaluation, Measurement & Verification Forum. Other drive type savings estimates based on Chan, Tumin (2010). Formulation of a Prescriptive Incentive for the VFD and Motors & VFD impact tables at NSTAR.

Chan_2010_Formulation_of_a_Prescriptive_Incentive_for_the_VFD_and_Motors_and_VFD_Impact_Tables_at_NSTAR

3 : Energy & Resource Solutions (2005). Measure Life Study. ERS_2005_Measure_Life_Study

4 : Navigant Consulting (2018). Multi-Family Program Impact and Net-to-Gross Evaluation. 2018_Navigant_Multifamily_Program_Impact_Evaluation

5 : Guidehouse (2021). Residential Programs Net-to-Gross Research of RCD and Select Products. 2021_Guidehouse_MA_Res_NTG_Final_Report

3.97 Motor - Variable Frequency Drive with Motor

Measure Code	COM-MD-MVFD
Market	Commercial
Program Type	Retrofit
Category	Motors and Drives

Measure Description:

This measure covers the installation of a high efficiency motor with a variable speed drives according to the terms and conditions stated on the statewide worksheet. The measure covers multiple end use types and building types. The installation of this measure saves energy since the power required to rotate a pump or fan at lower speeds requires less power than when rotated at full speed.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Prescriptive - Motors & VFD	C&I New Buildings & Major Renovations (CI_NB&MR)	EC1a025
Prescriptive - Motors & VFD	C&I Existing Building Retrofit (CI_RETRO)	EC2a020
Prescriptive - Motors & VFD	C&I New & Replacement Equipment (CI_EQUIP)	EC2b024

Algorithms for Calculating Primary Energy Impact:

$$\Delta kWh = (HP)(kWh/HP)$$

$$\Delta kW = (HP)(kW/HP_{SP})$$

Where:
HP = Rated horsepower for the impacted motor.
kWh / HP = Annual electric energy reduction based on building and equipment type. See table below.
kW / HP_{SP} = Summer demand reduction based on building and equipment type. See table below.
kW / HP_{WP} = Winter demand reduction based on building and equipment type. See table below.

Savings factors below already account for motor efficiency and consequently an adjustment is not required in the algorithm.

Savings Factors for C&I VFDs with Motor Replacement (kWh/HP and kW/HP)[1] :

Building Type	Building Exhaust Fan	Cooling Tower	Chilled Water Pump	Boiler Feed Water Pump	Hot Water Circulating. Pump	MAF Make-up Air Fan	Return Fan	Supply Fan
Annual Energy Savings Factors (kWh/HP)								
University/ College	3,802	486	780	2,415	2,442	3,381	1,143	1,100
Elementary/ High School	3,721	396	657	2,015	2,040	3,561	941	903
Multi-Family	3,368	954	1,435	2,443	2,504	3,248	1,466	1,412
Hotel/Motel	3,317	866	1,294	2,291	2,335	3,534	1,425	1,381
Health	3,541	1,815	2,535	2,453	2,510	3,168	1,676	1,586
Warehouse	3,476	496	853	2,098	2,183	3,396	1,342	1,294
Restaurant	3,606	1,066	1,636	2,067	2,138	2,794	1,519	1,457
Retail	3,258	685	1,097	2,036	2,087	2,558	1,288	1,229
Grocery	3,292	1,001	1,710	1,724	1,753	2,396	1,498	1,386
Offices	3,498	1,014	1,432	1,947	1,977	3,512	1,210	1,151
Summer Demand Savings Factors (kW/HP$_{SP}$)								
University/ College	0.257	(0.004)	0.465	0.952	0.190	0.257	0.679	0.706
Elementary/ High School	1.187	(0.006)	0.697	1.428	0.286	0.385	1.019	1.058
Multi-Family	0.385	(0.006)	0.697	1.428	0.286	0.385	1.019	1.058
Hotel/Motel	0.257	(0.004)	0.465	0.952	0.190	0.257	0.679	0.706
Health	0.128	(0.002)	0.232	0.476	0.095	0.128	0.340	0.353
Warehouse	0.770	(0.012)	1.394	2.855	0.571	1.677	2.038	2.117
Restaurant	0.839	(0.006)	0.697	1.428	0.286	0.385	1.019	1.058
Retail	0.514	(0.008)	0.930	1.904	0.381	0.514	1.358	1.411
Grocery	0.280	(0.002)	0.232	0.476	0.095	0.128	0.340	0.353
Offices	0.257	(0.004)	0.465	0.952	0.190	0.257	0.679	0.706

Building Type	Building Exhaust Fan	Cooling Tower	Chilled Water Pump	Boiler Feed Water Pump	Hot Water Circulating. Pump	MAF Make-up Air Fan	Return Fan	Supply Fan
Winter Demand Savings Factors (kW/HP$_{WP}$)								
University/ College	0.791	(0.001)	0.384	0.952	0.437	0.257	0.563	0.544
Elementary/ High School	1.428	(0.002)	0.575	1.428	0.655	0.385	0.844	0.816
Multi-Family	0.385	(0.002)	0.575	1.123	0.661	0.385	0.844	0.816
Hotel/Motel	0.257	(0.001)	0.384	0.874	0.438	0.257	0.563	0.544
Health	0.396	(0.001)	0.192	0.294	0.223	0.128	0.281	0.272
Warehouse	2.374	(0.003)	1.151	1.181	1.384	1.677	1.688	1.632
Restaurant	0.385	(0.002)	0.575	1.123	0.661	0.385	0.844	0.816
Retail	0.514	(0.002)	0.767	1.178	0.893	0.514	1.125	1.088
Grocery	0.476	(0.001)	0.192	0.437	0.219	0.128	0.281	0.272
Offices	0.952	(0.001)	0.384	0.874	0.438	0.257	0.563	0.544

Baseline Efficiency:

In the baselines, air or water volume/temperature is controlled using valves, dampers, and/or reheats.

High Efficiency:

In the high efficiency case, pump flow or fan air volume is directly controlled using downstream information. The pump or fan will automatically adjust its speed based on inputted set points and the downstream feedback it receives.

Measure Life:

This measure was determined to have an add on single baseline for retrofit applications.[2] [3]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
VFD with Motor	CI_RETRO	All	15	n/a	n/a	15

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
VFD with Motor	CI_RETRO	All	1.00	0.94	n/a	1.00	1.00	1.00	1.00
VFD with Motor (Turnkey)	CI_RETRO	Eversource / Unitil	1.00	0.946	n/a	1.265	1.415	1.00	1.00
VFD with Motor (Turnkey)	CI_RETRO	National Grid / CLC	1.00	1.049	n/a	0.941	1.174	1.00	1.00

In-Service Rates:

All installations have 100% in service rate since all PAs programs include verification of equipment installations.

Realization Rates:

Energy RRs for all PAs based on impact evaluation of 2011-2012 prescriptive VSD projects.[4] Demand RRs from study not used due to low precision of demand results. Demand RRs for Chilled Water Pump, Hot Water Circ.

Pump, Return Fan, Supply Fan, and WSHP Circ. Loop set to 1 since savings based on NEEP VSD Loadshape study.

Energy and Demand RRs for Turnkey installations are based on the Impact Evaluation of PY 2017 Small Business Initiative Non-Lighting Measures study.[5]

Coincidence Factors:

CFs for all PAs set to 1.0 since summer and winter demand savings are based on evaluation results.

Impact Factors for Calculating Net Savings:

All PAs use statewide prescriptive net-to-gross results.[6]

Net-to-gross values for the New Buildings and Major Renovations Core Initiative are based on study results.[7]

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
VFD with Motor	CI_RETRO	All	0.18	0.00	0.05	0.88
VFD with Motor	CI_NB&MR	All	0.58	0.23	0.00	0.65
VFD with Motor	CI_EQUIP	All	0.25	0.00	0.09	0.84

Non-Energy Impacts:

Non-energy benefits come from the 2021 NEI study.[8]

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per KWh	Annual $ per Therm	One-time $ per Therm
VFD with motor	CI_EQUIP	All			$0.02			

Endnotes:

1 : For Chilled Water Pump, Hot Water Circ. Pump, Return Fan, Supply Fan, and WSHP Circ. Loop: kW/HP estimates derived from Cadmus (2012). Variable Speed Drive Loadshape Project. Prepared for the NEEP Regional Evaluation, Measurement & Verification Forum. Other drive type kW/HP savings estimates based on Chan, Tumin (2010). Formulation of a Prescriptive Incentive for the VFD and Motors & VFD impact tables at NSTAR. Prepared for NSTAR.
Chan_2010_Formulation_of_a_Prescriptive_Incentive_for_the_VFD_and_Motors_and_VFD_Impact_Tables_at_NSTAR
2 : Baseline Categories and preliminary Out Year Factors are described at a high level in DNV GL, ERS (2018). Portfolio Model Companion Sheet. Additional background on the baseline categorization given in DNV GL, ERS (2018). Portfolio Model Methods and Assumptions – Electric and Natural Gas Memo.
2018_DNVGL_ERS_Portfolio_Model_Companion_Sheet
3 : Energy & Resource Solutions (2005). Measure Life Study. ERS_2005_Measure_Life_Study
4 : KEMA, Inc. and DMI, Inc. (2013). 2011-2012 Massachusetts Prescriptive VSD Impact Evaluation.
KEMA_2013_Prescriptive_VSD_Report
5 : DNV GL (2020). Impact Evaluation of PY 2017 Small Business Initiative Non-Lighting Measures.
6 : NMR Group, Inc. (2021). Prescriptive and Custom NTG Omnibus Study.
2021_NMR_C&I_Omnibus_NTG
7 : NMR Group, Inc. (2021). Non Residential New Construction NTG Report.
2021_NMR_Non_Residential_New_Construction_NTG_Report
8 : NMR Group Inc (2021). O&M and Non-O&M NEI Study. 2021_NMR_CIOM and NonOM NEI Study

3.98 Other - Codes and Standards Advocacy

Measure Code	COM-CM-CSA
Market	Commercial
Program Type	Lost Opportunity, New Construction
Category	Other

Measure Description:

The MassSave Codes and Standards Advocacy program works with stakeholders to advocate for higher energy code and appliance standards. This Advocacy is on both the state and federal level.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Codes Development and Support	C&I New Buildings & Major Renovations (CI_NB&MR)	EC1a053
Standards Adoption	C&I New & Replacement Equipment (CI_EQUIP)	EC2b121
Codes Development and Support	C&I New Buildings & Major Renovations (CI_NB&MR)	GC1a034
Standards Adoption	C&I New & Replacement Equipment (CI_EQUIP)	GC2b058

Algorithms for Calculating Primary Energy Impact:

Savings for Program Administrator activity in the Codes and Standards Advocacy initiative will be reviewed on a case by case basis. Each activity will have its own unique level of effort and its own corresponding level of savings. 2024 savings are based on Program Administrator activity in advocating for the passage of appliance standards passed in the 2021 Climate Act. 2024 savings are based on study results and assumes a 20% attribution factor.[1] The 2022-2024 Plan Order allows the Program Administrators to use a placeholder attribution value of 10% while a study was conducted. The study was submitted to the DPU for review as part of the Program Administrator's 2022 Annual Report.[2] Savings are outlined in the tables below for the Electric and Gas Program Administrators.

Savings from Standards Adoption Efforts

Program Administrator	2024 Savings
Savings (kWh)	

Program Administrator	2024 Savings
CLC	483,015
Eversource	3,415,448
National Grid	2,924,046
Unitil	79,134
Savings (therms)	
Berkshire	7,230
EGMA	44,046
Eversource	39,824
Liberty	6,925
National Grid	119,100
Unitil	2,874

Savings for the Codes Development and Support measure are outlined in the table below. There are no Gas PA C&I savings for this measure. Savings are based on an evaluation study.[3] Savings were distributed among electric PAs based on C&I customer counts.

2024 Savings from C&I Code Promulgation Efforts

Program Administrator	Savings (MWh)	Savings (Therms) - Electric Interactive Effects
CLC	90	(300)
Eversource	637	(2,124)
National Grid	545	(1,818)
Unitil	15	(49)

Baseline Efficiency:

The baseline level of efficiency will also be determined on a case by case basis. The baseline level of efficiency for each avenue of advocacy would correspond to the energy code or appliance standard that would have been in place without the intervention of the Program Administrators.

High Efficiency:

The high efficiency case would be the energy code or appliance standard that was advocated for by the Program Administrators.

Measure Life:

Measure lives for Standards Adoption are based on evaluation results.[4]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Codes Development and Support	CI_NB&MR	All	20	n/a	n/a	20
Standards Adoption, Electric	CI_EQUIP	All	6	n/a	n/a	6
Standards Adoption, Gas	CI_EQUIP	All	12	n/a	n/a	12

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Codes Development and Support	CI_NB&MR	All	1.00	1.00	1.00	1.00	1.00	n/a	n/a
Standards Adoption	CI_EQUIP	All	1.00	1.00	1.00	1.00	1.00	n/a	n/a

In-Service Rates:
All PAs use 100% in service rate.

Realization Rates:
All PAs use 100% realization rates.

Coincidence Factors:
Per Statewide agreement, kW will not be claimed for this measure.

Impact Factors for Calculating Net Savings:

The net-to-gross value is assumed to be 100% but will be adjusted on a case by case basis. Each activity will have its own unique level of effort and its own corresponding net-to-gross value.

Measure Name	Core Initiative	PA	FR	SO$_P$	SO$_{NP}$	NTG
Codes Development and Support	CI_NB&MR	All	0.00	0.00	0.00	1.00
Standards Adoption	CI_EQUIP	All	0.00	0.00	0.00	1.00

Non-Energy Impacts:

NEI values can be found in Appendix B. [5]

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per KWh	Annual $ per Therm	One-time $ per Therm
Codes Development and Support	CI_NB&MR	All			-$.065		$0.61	

Endnotes:

1 : NMR (2023). Appliance Standards Energy Savings Report (MA23X12-B-ASGS).
2023_NMR_MA23X12-B-ASGS_Appliance Standards Gross Savings Report_FINAL_2023
2 : NMR (2023). Standards Promulgation and Attribution. 2023_NMR_MA22X01-B-SPA_Standards Promulgation Attribution Report FINAL_19may23
3 : NMR Group, Inc. (2023) Code Promulgation Gross Savings Update for 2024 and 2025 (MA23X13-E-CICPSA). 2023_NMR_Code_Promulgation_Gross_Savings_2024
4 : NMR (2023). Appliance Standards Gross Savings. 2023_NMR_MA23X12-B-ASGS_Appliance Standards Gross Savings Report_FINAL_2023
5 : NMR Group Inc. (2021). C&I O&M and non-O&M NEI Study. 2021_NMR_CIOM and NonOM NEI Study

3.99 Other - Small Equipment Electrification

Measure Code	COM-HVAC-ELEC
Market	Commercial
Program Type	Lost Opportunity
Category	Plug Load

Measure Description:

Rebates provided for the purchase of battery-powered electric equipment instead of gas or propane equipment.

BCR Measure IDs:

Measure	Core Initiative	BCR Measure ID
Electric Lawnmower	C&I New & Replacement Equipment (CI_EQUIP)	EC2b119
Electric Leafblower	C&I New & Replacement Equipment (CI_EQUIP)	EC2b122
Electric Trimmer	C&I New & Replacement Equipment (CI_EQUIP)	EC2b123
Electric Chainsaw	C&I New & Replacement Equipment (CI_EQUIP)	EC2b124
Electric Forklift	C&I New & Replacement Equipment (CI_EQUIP)	EC2b125

Algorithms for Calculating Primary Energy Impact:

Unit kWh savings are deemed.[1] Demand savings are derived from the demand impact model which is developed as part of the Residential Baseline Study.[2]

Measure Name	Core Initiative	ΔkWh	ΔkW
Electric Lawnmower	CI_EQUIP	-218	-0.23
Electric Leafblower	CI_EQUIP	-0.78	0.00
Electric Trimmer	CI_EQUIP	-0.71	0.00
Electric Chainsaw	CI_EQUIP	-1.02	0.00

Electric Forklift	CI_EQUIP	-13,866	-14.62

Baseline Efficiency:

The baseline efficiency case for electric equipment is gas powered versions of the equipment.

High Efficiency:

The high efficiency case is electric lawn equipment and an electric induction stove.

Measure Life:

The measure life is shown below.[3]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Electric Lawnmower	CI_EQUIP	All	7	n/a	n/a	7
Electric Leafblower	CI_EQUIP	All	2	n/a	n/a	2
Electric Trimmer	CI_EQUIP	All	2	n/a	n/a	2
Electric Chainsaw	CI_EQUIP	All	2	n/a	n/a	2
Electric Forklift	CI_EQUIP	All	8	n/a	n/a	8

Other Resource Impacts:

Measure Name	Core Initiative	PA	Gasoline (MMBTUs)[4]	Propane (MMBTUs)
Electric Lawnmower	CI_EQUIP	All	2.5	
Electric Leafblower	CI_EQUIP	All	1.4	
Electric Trimmer	CI_EQUIP	All	1.4	
Electric Chainsaw	CI_EQUIP	All	1.4	
Electric Forklift	CI_EQUIP	All		137.4

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Electric Lawnmower	CI_EQUIP	All	1.00	1.00	1.00	1.00	1.00	0.55	0.00
Electric Leafblower	CI_EQUIP	All	1.00	1.00	1.00	1.00	1.00	0.55	0.00

Electric Trimmer	CI_EQUIP	All	1.00	1.00	1.00	1.00	1.00	0.55	0.00
Electric Chainsaw	CI_EQUIP	All	1.00	1.00	1.00	1.00	1.00	0.55	0.00
Electric Forklift	CI_EQUIP	All	1.00	1.00	1.00	1.00	1.00	0.55	0.00

In-Service Rates:

The in-service rate is assumed to be 100% absent evaluation.

Realization Rates:

The realization rate is assumed to be 100% absent evaluation.

Coincidence Factors:

Summer and winter coincidence factors are estimated using the demand allocation methodology described in the Demand Impact Model which is developed based on the Residential Baseline Study.[5]

Impact Factors for Calculating Net Savings:

NTG values from 2021 Omnibus NTG study

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Electric Lawnmower	CI_EQUIP	All	0.25	0.002	0.085	0.837
Electric Leafblower	CI_EQUIP	All	0.25	0.002	0.085	0.837
Electric Trimmer	CI_EQUIP	All	0.25	0.002	0.085	0.837
Electric Chainsaw	CI_EQUIP	All	0.25	0.002	0.085	0.837
Electric Forklift	CI_EQUIP	All	0.25	0.002	0.085	0.837

Non-Energy Impacts:

There are no non-energy impacts for this measure.

Endnotes:

1 : Vermont Act 56 Tier III Technical Advisory Group 2020 Annual Report
2 : Guidehouse (2020). Residential Baseline Study Phase 4
2020_Guidehouse_Residential_Baseline_Phase_4
3 : Vermont Act 56 Tier III Technical Advisory Group 2020 Annual Report
4 : Vermont Act 56 Tier III Technical Advisory Group 2020 Annual Report
5 : Guidehouse (2020). Residential Baseline Study Phase 4
2020_Guidehouse_Residential_Baseline_Phase_4

3.100   Plug Load - Advanced Power Strip

Measure Code	COM-PL-APS
Market	Commercial
Program Type	Retrofit
Category	Behavior

Measure Description:

Advanced power strips can automatically eliminate standby power loads of electronic peripheral devices that are not needed (DVD player, computer printer, scanner, etc.) either automatically or when an electronic control device (typically a television or personal computer) is in standby or off mode.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Smart Strip (Residential End Use)	C&I Exisiting Building Retrofit (CI_RETRO)	EC2a009
Smart Strip, Tier 1 (OMP)	C&I New & Replacement Equipment (CI_EQUIP)	EC2b160
Smart Strip, Tier 2 (OMP)	C&I New & Replacement Equipment (CI_EQUIP)	EC2b161

Algorithms for Calculating Primary Energy Impact:

Unit kWh savings are deemed based on study results.[1] Demand savings are derived from the demand impact model which is developed as part of the Residential Baseline Study.[2]

Measure Name	Core Initiative	kWh	kW
Smart Strip (Residential End Use)	CI_RETRO	105	0.010
Smart Strip, Tier 1 (OMP)	CI_EQUIP	105	0.010
Smart Strip, Tier 2 (OMP)	CI_EQUIP	207	0.024

Baseline Efficiency:

The baseline efficiency case is the customers' devices as they are currently operating.

High Efficiency:

The high efficiency case is the installation of an Advanced Power Strip.

Measure Life:

The measure life is 5 years.

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Smart Strip (Residential End Use)	CI_RETRO	All	0.73	0.92	0.92	0.92	1.00	1.00
Smart Strip, Tier 1/Tier 2	CI_EQUIP	All	0.83	0.92	0.92	0.92	1.00	1.00

In-Service Rates
In-Service Rates are blended and based on evaluation results.[3] [4]

Realization Rates
Realization rates account for the savings lost due to improper customer set-up/use of devices, as found in the referenced study.[5]

Coincidence Factors
From evaluation study. [6]

Impact Factors for Calculating Net Savings:

PAs use statewide prescriptive net-to-gross values based on the 2021 C&I Omnibus NTG Study. [7]

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Smart Strip (Residential End Use)	CI_EQUIP	All				0.94
Smart Strip, Tier 1/Tier 2	CI_EQUIP	All	0.25	0.00	0.09	0.84

Non-Energy Impacts:

There are no non-energy impacts identified for this measure.

Endnotes:

1 : NMR Group, Inc. (2019). Advanced Power Strip Metering Study.
2019_NMR_APSMeteringReport_Revised

2 : Guidehouse (2020). Residential Baseline Study Phase 4
2020_Guidehouse_Residential_Baseline_Phase_4

3 : Guidehouse (2021). Virtual Home Energy Assessment Study.
2021_Guidehouse_VHEA_Report_FINAL

4 : Guidehouse (2021). RCD ISR Analysis. 2021_Guidehouse_RCD ISR 2020 Analysis_FINAL

5 : NMR Group, Inc. (2019). Advanced Power Strip Metering Study.
2019_NMR_APSMeteringReport_Revised

6 : NMR Group, Inc. (2019). Advanced Power Strip Metering Study.
2019_NMR_APSMeteringReport_Revised

7 : NMR Group, Inc. (2021). C&I Prescriptive and Custom NTG Omnibus Study
2021_NMR_C&I_Omnibus_NTG

3.101   Refrigeration - Case Motor Replacement

Measure Code	COM-R-CMR
Market	Commercial
Program Type	Retrofit
Category	Refrigeration

Measure Description:

Installation of electronically commutated motors (ECMs) in multi-deck and freestanding coolers and freezers, typically on the retail floor of convenience stores, liquor stores, and grocery stores.[1]

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Case Motor Replacement	C&I Existing Building Retrofit (CI_RETRO)	EC2a037
Case Motor Replacement (Turnkey)	C&I Existing Building Retrofit (CI_RETRO)	EC2a156

Algorithms for Calculating Primary Energy Impact:

$\Delta kWh = \Delta kWh_{Motor} + \Delta kWh_{Heat}$
$\Delta kWh_{Motor} = kW_{Motor} \times LRF \times Hours$
$\Delta kWh_{Heat} = \Delta kWh_{Motor} \times 0.28 \times Eff_{rs}$
$\Delta kW = \Delta kWh/8760$

Where:
ΔkWh_{Motor} = Energy savings due to increased efficiency of case motor
ΔkWh_{Heat} = Energy savings due to reduced heat from evaporator fans
kW_{motor} = Metered load of case motor
LRF = Load reduction factor: 53% when shaded pole motors are replaced, 29% when PSC motors are replaced.[2]
Hours = Average runtime of case motors (8,500 hours)[3]
0.28 = Conversion of kW to tons: 3,413 Btuh/kW divided by 12,000 Btuh/ton.
Eff_{rs} = Efficiency of typical refrigeration system (1.6 kW/ton)[4]
ΔkW = Average demand savings
8,760 = Hours per year

Baseline Efficiency:

The baseline efficiency case is the existing case motor.

High Efficiency:

The high efficiency case is the replacement of the existing case motor with an ECM.

Measure Life:

This measure is determined to have an add on single baseline in retrofit scenarios.[5] [6]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Refrigeration - Case Motor Replacement	CI_RETRO	All	15	1	n/a	15

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E[7]	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Refrigeration - Case Motor Replacement	CI_RETRO	ES, Unitil	1.00	0.95	1.00	1.27	1.42	0.90	0.90
Refrigeration - Case Motor Replacement	CI_RETRO	NGRID, CLC	1.00	1.05	1.00	0.94	1.17	0.90	0.90

In-Service Rates:

All installations have 100% in service rate since all PAs' programs include verification of equipment installations.

Realization Rates:

Values based on small business non-lighting study (2019)

Coincidence Factors:

Coincidence factors are representative of C&I Refrigeration

Impact Factors for Calculating Net Savings:

All PAs use statewide prescriptive net-to-gross results.[8]

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Refrigeration - Case Motor Replacement	CI_RETRO	All	0.18	0.00	0.05	0.88
Refrigeration - Case Motor Replacement (Turnkey)	CI_RETRO	All	0.08	0.01	0.00	0.94

Non-Energy Impacts:

Prescriptive refrigeration measures in retrofit applications have an annual $/kWh NEI.[9]

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per kWh	Annual $ per Therm	One-time $ per Therm
Refrigeration - Case Motor Replacement	CI_RETRO	All			$0.001			

Endnotes:

1 : The assumptions and algorithms used in this section are specific to NRM products.

2 : Load factor is an estimate by NRM based on several pre- and post-meter readings of installations

3 : Conservative value based on 15 years of NRM field observations and experience.

4 : Assumed average refrigeration efficiency for typical installations. Conservative value based on 15 years of NRM field observations and experience. Value supported by Select Energy (2004). Cooler Control Measure Impact Spreadsheet Users' Manual. Prepared for NSTAR.
Select_Energy_2004_Cooler_Control_Measure_Impact_Spreadsheet_Users_Manual

5 : Baseline Categories and preliminary Out Year Factors are described at a high level in DNV GL, ERS (2018). Portfolio Model Companion Sheet. Additional background on the baseline categorization given in DNV GL, ERS (2018). Portfolio Model Methods and Assumptions – Electric and Natural Gas Memo.
2018_DNVGL_ERS_Portfolio_Model_Companion_Sheet

6 : Energy & Resource Solutions (2005). Measure Life Study. Prepared for The Massachusetts Joint Utilities; 15-year measure life for retrofit motor installations. ERS_2005_Measure_Life_Study

7 : DNV GL. (2019). Impact Evaluation of PY 2017 Small Business Initiative Non-lighting measures. Final Report MA19C03-E-SBIMPCT 03202020

8 : NMR Group, Inc. (2021). Prescriptive and Custom NTG Omnibus Study.
2021_NMR_C&I_Omnibus_NTG

9 : NMR Group, Inc. (2021). MA C&I O&M and Non-O&M NEI Study. 2021_NMR_CIOM and NonOM NEI Study

3.102   Refrigeration - Door Heater Controls

Measure Code	COM-R-DHC
Market	Commercial
Program Type	Retrofit
Category	Refrigeration

Measure Description:

Installation of controls to reduce the run time of door and frame heaters for freezers and walk-in or reach-in coolers. The reduced heating results in a reduced cooling load.[1]

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Door Heater Controls	C&I Existing Building Retrofit (CI_RETRO)	EC2a034
Door Heater Controls (Turnkey)	C&I Existing Building Retrofit (CI_RETRO)	EC2a153

Algorithms for Calculating Primary Energy Impact:

$\Delta kWh = kW_{DH} * \%OFF * 8760$
$\Delta kW = kW_{DH} * \%OFF$

Where:
kW_{DH} = Total demand of the door heater, calculated as Volts * Amps / 1000
8760 = Door heater annual run hours before controls
%OFF Door heater Off time: 46% for freezer door heaters or 74% for cooler door heaters)[2]

Baseline Efficiency:

The baseline efficiency case is a cooler or freezer door heater that operates 8,760 hours per year without any controls.

High Efficiency:

The high efficiency case is a cooler or freezer door heater connected to a heater control system, which controls the door heaters by measuring the ambient humidity and temperature of the store, calculating the dew point, and using pulse width modulation (PWM) to control the anti-sweat heater based on specific algorithms for freezer and cooler doors. Door temperature is typically maintained about 5°F above the store air dew point temperature.[3]

Measure Life:

This measure was determined to have an add on single baseline for retrofit scenarios [4]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Refrigeration - Door Heater Controls	CI_RETRO	All	10	1	n/a	10

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E[5]	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Refrigeration -Door Heater Controls	CI_RETRO	Eversource, Unitil	1.00	0.95	1.00	1.27	1.42	0.90	0.90
Refrigeration -Door Heater Controls	CI_RETRO	National Grid, CLC	1.00	1.05	1.00	0.94	1.17	0.90	0.90

In-Service Rates:

All installations have 100% in-service rates since all PAs' programs include verification of equipment installations.

Realization Rates:

Values based on small business non-lighting study (2019)

Coincidence Factors:

Coincidence factors are representative of C&I Refrigeration

Impact Factors for Calculating Net Savings:

All PAs use statewide prescriptive net-to-gross results.[6]

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Refrigeration - Door Heater Controls (Turnkey)	CI_RETRO	All	0.08	0.01	0.00	0.94
Refrigeration - Door Heater Controls	CI_RETRO	All	0.18	0.00	0.05	0.88

Non-Energy Impacts:

Prescriptive refrigeration measures in retrofit applications have an annual $/kWh NEI.[7]

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per KWh	Annual $ per Therm	One-time $ per Therm
Refrigeration - Door Heater Controls (Turnkey)	CI_RETRO	All			$0.001			
Refrigeration - Door Heater Controls	CI_RETRO	All			$0.001			

Endnotes:

1 : The assumptions and algorithms used in this section are specific to NRM products.

2 : The value is an estimate by NRM based on hundreds of downloads of hours of use data from Door Heater controllers. These values are also supported by Select Energy Services, Inc. (2004). Cooler Control Measure Impact Spreadsheet User's Manual. Prepared for NSTAR.
Select_Energy_2004_Cooler_Control_Measure_Impact_Spreadsheet_Users_Manual

3 : Select Energy Services, Inc. (2004). Analysis of Cooler Control Energy Conservation Measures. Prepared for NSTAR.
Select_Energy_2004_Analysis_of_Cooler_Control_Energy_Conservation_Measures

4 : Energy & Resource Solutions (2005). Measure Life Study. ERS_2005_Measure_Life_Study

5 : DNV GL. (2019). Impact Evaluation of PY 2017 Small Business Initiative Non-lighting measures. Final Report MA19C03-E-SBIMPCT 03202020

6 : NMR Group, Inc. (2021). Prescriptive and Custom NTG Omnibus Study.
2021_NMR_C&I_Omnibus_NTG

7 : NMR Group Inc (2021). O&M and Non-O&M NEI Study. 2021_NMR_CIOM and NonOM NEI Study

3.103 Refrigeration - ECM Evaporator Fan Motors for Walk-in Cooler/Freezer

Measure Code	COM-R-ECMEFM
Market	Commercial
Program Type	Retrofit
Category	Refrigeration

Measure Description:

Installation of various sizes of electronically commutated motors (ECMs) in walkin coolers and freezers to replace existing evaporator fan motors.[1]

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
ECM Evaporator Fan Motors for Walk–in Coolers	C&I Existing Building Retrofit (CI_RETRO)	EC2a036
ECM Evaporator Fan Motors for Walk–in Coolers (Turnkey)	C&I Existing Building Retrofit (CI_RETRO)	EC2a155

Algorithms for Calculating Primary Energy Impact:

$\Delta kWh = \Delta kWh_{Fan} + \Delta kWh_{Heat}$
$\Delta kWh_{Fan} = kW_{Fan} * LRF * Hours$
$\Delta kWh_{Heat} = \Delta kWh_{Fan} * 0.28 * Eff_{RS}$
$\Delta kW = \Delta kWh / 8760$

Where:
ΔkWh_{Fan} = Energy savings due to increased efficiency of evaporator fan motor
ΔkWh_{Heat} = Energy savings due to reduced heat from the evaporator fans
kW_{Fan} = Power demand of evaporator fan calculated from equipment nameplate data and estimated
0.55 power factor/adjustment[1] : Amps x Voltage x PF x √Phase
LRF = Load reduction factor for motor replacement (65%)[2]
Hours = Annual fan operating hours.
0.28 = Conversion factor between kW and tons: 3,413 Btuh/kW divided by 12,000 Btuh/ton
Eff_{RS} = Efficiency of typical refrigeration system: 1.6 kW/ton[3]
ΔkW = Average demand savings
8,760 = Hours per year

Baseline Efficiency:

The baseline efficiency case is an existing evaporator fan motor.

High Efficiency:

The high efficiency case is the replacement of existing evaporator fan motors with ECMs.

Measure Life:

This measure is determined to be an add on single baseline measure for retrofit scenarios.[4][5]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Refrigeration - ECM Evaporator Fan Motors for Walk-in Coolers and Freezers	CI_RETRO	All	9	1	n/a	9

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}[7]	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Refrigeration - ECM Evaporator Fan Motors for Walk-in Coolers and Freezers	CI_RETRO	Eversource, Unitil	1.00	0.95	n/a	1.27	1.42	0.90	0.90
Refrigeration - ECM Evaporator Fan Motors for Walk-in Coolers and Freezers	CI_RETRO	National Grid, CLC	1.00	1.05	n/a	0.94	1.17	0.90	0.90

In-Service Rates:
Assume 100% in service rate until evaluated.

Realization Rates:
Values based on small business non-lighting study (2019)

Coincidence Factors:
Coincidence factors are representative of C&I Refrigeration

Impact Factors for Calculating Net Savings:

All PAs use statewide prescriptive net-to-gross results.[6]

Measure Name	Core Initiative	PA	FR	SO$_P$	SO$_{NP}$	NTG
Refrigeration - ECM Evaporator Fan Motors for Walk-in Coolers and Freezers	CI_RETRO	All	0.18	0.00	0.05	0.88
Refrigeration - ECM Evaporator Fan Motors for Walk-in Coolers and Freezers (Turnkey)	CI_RETRO	All	0.08	0.01	0.00	0.94

Non-Energy Impacts:

Prescriptive refrigeration measures in retrofit applications have an annual $/kWh NEI.[7]

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per KWh	Annual $ per Therm	One-time $ per Therm
Refrigeration - ECM Evaporator Fan Motors for Walk-in Coolers and Freezers	CI_RETRO	All			$0.001			

Endnotes:

1 : The assumptions and algorithms used in this section are specific to NRM products.

1 : Conservative value based on 15 years of NRM field observations and experience.

2 : Load factor is an estimate by NRM based on several pre- and post-meter readings of installations; the value is supported by RLW Analytics (2007). Small Business Services Custom Measure Impact Evaluation. Prepared for National Grid.
RLW_2007_Small_Business_Services_Custom_Measure_Impact_Evaluation

3 : Assumed average refrigeration efficiency for typical installations. Conservative value based on 15 years of NRM field observations and experience. Value supported by Select Energy (2004). Cooler Control Measure Impact Spreadsheet Users' Manual. Prepared for NSTAR.
Select_Energy_2004_Cooler_Control_Measure_Impact_Spreadsheet_Users_Manual

4 : Baseline Categories and preliminary Out Year Factors are described at a high level in DNV GL, ERS (2018). Portfolio Model Companion Sheet. Additional background on the baseline categorization given in DNV GL, ERS (2018). Portfolio Model Methods and Assumptions – Electric and Natural Gas Memo.
2018_DNVGL_ERS_Portfolio_Model_Companion_Sheet

5 : Energy & Resource Solutions (2005). Measure Life Study. Prepared for The Massachusetts Joint Utilities; 15-year measure life for retrofit motor installations. ERS_2005_Measure_Life_Study

7 : DNV GL. (2019). Impact Evaluation of PY 2017 Small Business Initiative Non-lighting measures.
Final Report MA19C03-E-SBIMPCT 03202020

6 : NMR Group, Inc. (2021). Prescriptive and Custom NTG Omnibus Study.
2021_NMR_C&I_Omnibus_NTG

7 : NMR Group Inc (2021). O&M and Non-O&M NEI Study. 2021_NMR_CIOM and NonOM NEI Study

3.104   Refrigeration - Electric Deck Oven

Measure Code	COM-R-EDO
Market	Commercial
Program Type	Early Replacement
Category	Refrigeration

BCR Measure IDs:

Measure	Core Initiative	BCR Measure ID
Midstream - Electric Deck Oven	C&I New & Replacement Equipment (CI_EQUIP)	EC2b113

Algorithms for Calculating Primary Energy Impact:

kWH = (Daily energy consumption * Operating days per year= Annual Energy Consumption(kWh))

Annual Energy Consumption(kWh) standard model - Annual Energy Consumption(kWh) = Energy savings kWh/year.

kW = Average Demand kW * Coincidence Factor

Medium Tier Savings	**Standard Model**	**Efficient Model**
Preheat Time (min)	30	30
Preheat Energy (kWh)	6.50	3.00
Deck Idle Energy Rate (kW)	1.90000	1.30000
Deck Cooking-Energy Efficiency (%)	40%	60%
Deck Production Capacity (lb/h)	60	60
Operating Hours/Day	12	12
Operating Days/Year	365	365
Pounds of Food Cooked per Day	200	200
ASTM Conv Mode Energy to Food (kWh/lb)	0.0732	0.0732
Deck Mode Energy (kWh/d)	52.1	35.0

Medium Tier Savings	Standard Model	Efficient Model
Daily Energy Consumption (kWh)	58.62	38.02
Average Demand (kW)	4.88472	3.16806
Coincidence Factor	0.90000	0.90000
Estimated Demand Reduction (kW)	--	1.54500
Annual Energy Consumption (kWh)	21,395.08	13,876.08
Estimated Energy Savings (kWh/yr)	--	7,519.00
% Savings		35%

Savings are deemed based on above algorithms.

Measure	Core Initiative	PA	kWh	kW
Electric Deck Oven	CI_EQUIP	ALL	7,519	1.545

Baseline Efficiency:

40% Efficiency & 1.9 kW idle energy rate.[1]

High Efficiency:

Food Service Technology Center (FSTC) pre-approved list
https://caenergywise.com/rebates/

Measure Life:

Measure Name	Core Initiative	PA	EUL[2]	OYF	RUL	AML
Electric Deck Oven	CI_EQUIP	All	12	n/a	n/a	12

Other Resource Impacts:

There are no other resource impact.

Impact Factors for Calculating Adjusted Gross Savings:

Measure	Core Initiative	PA	ISR	SPF	RR$_E$	RR$_{NE}$	RR$_{SP}$	RR$_{WP}$	CF$_{SP}$	CF$_{WP}$

Electric Deck Oven	CI_EQUIP	All	1.00	1.00	1.00	n/a	1.00	1.00	0.90	0.90

In-Service Rates:

All installations have 100% in service rate since programs include verification of equipment installations.

Realization Rates:

100% realization rates are assumed because savings are based on researched assumptions.

Coincidence Factors:

Coincidence factors are 0.9 for both summer and winter seasons to account for the fact that some restaurants close one day per week and some may not serve both lunch and dinner on weekdays.

Impact Factors for Calculating Net Savings:

All PA's use statewide NTG from study results. [3]

Measure	Initiative	PA	FR	SO	NPSO	NTG
Electric Deck Oven	CI_EQUIP	All	25.0%	0.2%	8.5%	83.7%

Non-Energy Impacts:

Non-energy impacts are based on study results.[4]

Measure Name	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per kWh	Annual $ per Therm	One-time$ per Therm
Electric Deck Oven	All	$0.00	$0.00	$0.005	$0.00	0.00	0.00

Endnotes:

1 : California eTRM. (2020). https://www.caetrm.com/measure/SWFS016/01/
2 : California eTRM. (2020). https://www.caetrm.com/measure/SWFS016/01/
3 : NMR Group, Inc. (2021). Prescriptive and Custom Net-to-Gross Omnibus Study. 2021_NMR_C&I_Omnibus_NTG
4 : NMR Group, Inc. (2021). O&M and Non-O&M NEI Study. 2021_NMR_CIOM and NonOM NEI Study

3.105   Refrigeration - Electronic Defrost Control

Measure Code	COM-R-EDC
Market	Commercial
Program Type	Retrofit
Category	Refrigeration

Measure Description:

A control mechanism to skip defrost cycles when defrost is unnecessary.[1]

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Electronic Defrost Control	C&I Existing Building Retrofit (CI_RETRO)	EC2a039
Electronic Defrost Control (Turnkey)	C&I Existing Building Retrofit (CI_RETRO)	EC2a158

Algorithms for Calculating Primary Energy Impact:

$\Delta kWh_{Defrost} = kW_{Defrost} \times Hours \times DRF$
$\Delta kWh_{Heat} = \Delta kWh_{Defrost} \times 0.28 \times Eff_{RS}$
$\Delta kWh = \Delta kWh_{Defrost} + \Delta kWh_{Heat}$
$\Delta kW = \Delta kWh/8760$

Where:
$\Delta kWh_{Defrost}$ = Energy savings resulting from an increase in operating efficiency due to the addition of electronic defrost controls.
ΔkWh_{Heat} = Energy savings due to reduced heat from reduced number of defrosts.
$kW_{Defrost}$ = Load of electric defrost.
Hours = Number of hours defrost occurs over a year without the defrost controls.
DRF = Defrost reduction factor- percent reduction in defrosts required per year (35%)[1]
0.28 = Conversion of kW to tons: 3,413 Btuh/kW divided by 12,000 Btuh/ton.
Eff_{RS} = Efficiency of typical refrigeration system (1.6 kW/ton)[2]
ΔkW = Average demand savings
8,760 = Hours per year

Baseline Efficiency:

The baseline efficiency case is an evaporator fan electric defrost system that uses a time clock mechanism to initiate defrost.

High Efficiency:

The high efficiency case is an evaporator fan defrost system with electric defrost controls.

Measure Life:

This measure is determined to have an add on single baseline in retrofit scenarios.[3] [4]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Refrigeration - Electronic Defrost Control	CI_RETRO	All	10	1	n/a	10

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E[5]	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Refrigeration - Electronic Defrost Control	CI_RETRO	Eversource Unitil	1.00	0.95	1.00	1.27	1.42	0.90	0.90
Refrigeration - Electronic Defrost Control	CI_RETRO	National Grid CLC	1.00	1.05	1.00	0.94	1.17	0.90	0.90

In-Service Rates:
Assume 100% in-service rates until evaluated.

Realization Rates:
Values based on small business non-lighting study (2019)

Coincidence Factors:
Coincidence factors are representative of C&I Refrigeration.

Impact Factors for Calculating Net Savings:

All PAs use statewide prescriptive net-to-gross results.[6]

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Refrigeration - Electronic Defrost Control (Turnkey)	CI_RETRO	All	0.08	0.01	0.00	0.94
Refrigeration - Electronic Defrost Control	CI_RETRO	All	0.18	0.00	0.05	0.88

Non-Energy Impacts:

Prescriptive refrigeration measures in retrofit applications have an annual $/kWh NEI.[7]

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per KWh	Annual $ per Therm	One-time $ per Therm
Refrigeration - Electronic Defrost Control	CI_RETRO	All			$0.001			

Endnotes:

1 : The assumptions and algorithms used in this section are specific to NRM products.

1 : Supported by 3rd party evaluation: Independent Testing was performed by Intertek Testing Service on a Walk-in Freezer that was retrofitted with Smart Electric Defrost capability.

2 : Assumed average refrigeration efficiency for typical installations. Conservative value based on 15 years of NRM field observations and experience. Value supported by Select Energy (2004). Cooler Control Measure Impact Spreadsheet Users' Manual. Prepared for NSTAR.
Select_Energy_2004_Cooler_Control_Measure_Impact_Spreadsheet_Users_Manual

3 : Baseline Categories and preliminary Out Year Factors are described at a high level in DNV GL, ERS (2018). Portfolio Model Companion Sheet. Additional background on the baseline categorization given in DNV GL, ERS (2018). Portfolio Model Methods and Assumptions – Electric and Natural Gas Memo.
2018_DNVGL_ERS_Portfolio_Model_Companion_Sheet

4 : Energy & Resource Solutions (2005). Measure Life Study. Prepared for The Massachusetts Joint Utilities. ERS_2005_Measure_Life_Study

5 : DNV GL. (2019). Impact Evaluation of PY 2017 Small Business Initiative Non-lighting measures.
Final Report MA19C03-E-SBIMPCT 03202020

6 : NMR Group, Inc. (2021). Prescriptive and Custom NTG Omnibus Study.
2021_NMR_C&I_Omnibus_NTG

7 : NMR Group Inc (2021). O&M and Non-O&M NEI Study. 2021_NMR_CIOM and NonOM NEI Study

3.106   Refrigeration - Evaporator Fan Control

Measure Code	COM-R-EFC
Market	Commercial
Program Type	New Construction
Category	Refrigeration

Measure Description:

Installation of controls to modulate the evaporator fans based on temperature control. Energy savings include: fan energy savings from reduced fan operating hours, refrigeration energy savings from reduced waste heat, and compressor energy savings resulting from the electronic temperature control. Electronic controls allow less fluctuation in temperature, thereby creating savings.[1]

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Evaporator Fan Controls	C&I Existing Building Retrofit (CI_RETRO)	EC2a040
Evaporator Fan Controls (Turnkey)	C&I Existing Building Retrofit (CI_RETRO)	EC2a159

Algorithms for Calculating Primary Energy Impact:

$\Delta kWh = \Delta kWh_{Fan} + \Delta kWh_{Heat} + \Delta kWh_{Control}$
$\Delta kWh_{Fan} = kW_{Fan} * 8760 * \%OFF$
$\Delta kWh_{Heat} = \Delta kWh_{Fan} * 0.28 * Eff_{RS}$
$\Delta kWh_{Control} = [kW_{CP} * Hours_{CP} + kW_{Fan} * 8760 * (1-\%OFF)] * 5\%$
$\Delta kW = \Delta kWh/8760$

Where :
ΔkWh_{Fan} = Energy savings due to evaporator being shut off
ΔkWh_{Heat} = Energy savings due to reduced heat from the evaporator fans
$\Delta kWh_{Control}$ = Energy savings due to the electronic controls on compressor and evaporator
kW_{Fan} = Power demand of evaporator fan calculated from equipment nameplate data and estimated 0.55 power factor/ adjustment[2] : Amps x Voltage x PF x √Phase
$\%OFF$ = Percent of annual hours that the evaporator is turned off: 46%[3]
0.28 = Conversion of kW to tons: 3,413 Btuh/kW divided by 12,000 Btuh/ton.
Eff_{RS} = Efficiency of typical refrigeration system: 1.6 kW/ton[4]
kW_{CP} = Total power demand of compressor motor and condenser fan calculated from equipment nameplate data and estimated 0.85 power factor[5] : Amps x Voltage x PF x √Phase
$Hours_{CP}$ = Equivalent annual full load hours of compressor operation: 4,072 hours[6]
5% = Reduced run-time of compressor and evaporator due to electronic temperature controls[7]
ΔkW = Average demand savings

8,760 = Hours per year

Baseline Efficiency:

The baseline efficiency case assumes evaporator fans that run 8,760 annual hours with no temperature control.

High Efficiency:

The high efficiency case is the use of an energy management system to control evaporator fan and compressor operation based on temperature.

Measure Life:

This measures is determined to have an add on single baseline for retrofit scenarios.[8] [9]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Refrigeration - Evaporator Fan Controls	CI_RETRO	All	10	1	n/a	10

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_{E10}[1]	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Refrigeration - Evaporator Fan Controls	CI_RETRO	Eversource Unitil	1.00	0.95	1.00	1.27	1.42	0.90	0.90
Refrigeration - Evaporator Fan Controls	CI_RETRO	National Grid CLC	1.00	1.05	1.00	0.94	1.17	1.00	1.00

In-Service Rates:
Assume 100% in service rate until evaluated.

Realization Rates:
Values based on small business non-lighting study (2019)

Coincidence Factors:
CFs representative of C&I Refrigeration.

Impact Factors for Calculating Net Savings:

All PAs use statewide prescriptive net-to-gross results.[11]

Measure Name	Core Initiative	PA	FR	SO$_P$	SO$_{NP}$	NTG
Refrigeration - Evaporator Fan Controls	CI_RETRO	All	0.18	0.00	0.05	0.88
Refrigeration - Evaporator Fan Controls (Turnkey)	CI_RETRO	All	0.08	0.01	0.00	0.94

Non-Energy Impacts:

Prescriptive refrigeration measures in retrofit applications have an annual $/kwh NEI.[12]

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per KWh	Annual $ per Therm	One-time $ per Therm
Refrigeration - Evaporator Fan Controls	CI_RETRO	All			$0.001			

Endnotes:

1 : The assumptions and algorithms used in this section are specific to NRM products.

2 : Conservative value based on 15 years of NRM field observations and experience.

3 : The value is an estimate by NRM based on hundreds of downloads of hours of use data. These values are also supported by Select Energy Services, Inc. (2004). Cooler Control Measure Impact Spreadsheet User's Manual. Prepared for NSTAR

Select_Energy_2004_Cooler_Control_Measure_Impact_Spreadsheet_Users_Manual

4 : Assumed average refrigeration efficiency for typical installations. Conservative value based on 15 years of NRM field observations and experience. Value supported by Select Energy (2004). Cooler Control Measure Impact Spreadsheet Users' Manual. Prepared for NSTAR.

Select_Energy_2004_Cooler_Control_Measure_Impact_Spreadsheet_Users_Manual

5 : This value is an estimate by NRM based on hundreds of downloads of hours of use data from the electronic controller.

6 : Conservative value based on 15 years of NRM field observations and experience.

7 : Conservative estimate supported by less conservative values given by several utility-sponsored 3rd Party studies including: Select Energy Services, Inc. (2004). Analysis of Cooler Control Energy Conservation Measures. Prepared for NSTAR.

Select_Energy_2004_Analysis_of_Cooler_Control_Energy_Conservation_Measures

8 : Baseline Categories and preliminary Out Year Factors are described at a high level in DNV GL, ERS (2018). Portfolio Model Companion Sheet. Additional background on the baseline categorization given in DNV GL, ERS (2018). Portfolio Model Methods and Assumptions – Electric and Natural Gas Memo.

2018_DNVGL_ERS_Portfolio_Model_Companion_Sheet

9 : Energy & Resource Solutions (2005). Measure Life Study. ERS_2005_Measure_Life_Study

10 : DNV GL. (2019). Impact Evaluation of PY 2017 Small Business Initiative Non-lighting measures. Final Report MA19C03-E-SBIMPCT 03202020

11 : NMR Group, Inc. (2021). Prescriptive and Custom NTG Omnibus Study. 2021_NMR_C&I_Omnibus_NTG

12 : NMR Group Inc (2021). O&M and Non-O&M NEI Study. 2021_NMR_CIOM and NonOM NEI Study

3.107   Refrigeration - Hand Wrapper

Measure Code	COM-R-HR
Market	Commercial
Program Type	Early Replacement
Category	Refrigeration

BCR Measure IDs:

Measure	Core Initiative	BCR Measure ID
Midstream - Hand Wrapper	C&I New & Replacement Equipment (CI_EQUIP)	EC2b114

Algorithms for Calculating Primary Energy Impact:

Savings are deemed using the assumptions below:

Measure Name	Core Initiative	PA	kWh	kW
Hand Wrapper	CI_EQUIP	ALL	1,565	0.181

Annual Energy

Hand-Wrap Case	SUPERMARKET CHAIN 1 (kWh/yr)	SUPERMARKET CHAIN 2 (kWh/yr)	SUPERMARKET CHAIN 3 (kWh/yr)	SUPERMARKET CHAIN 4 (kWh/yr)	Annual Energy Consumption (kWh/yr)
Baseline	2,310.55	1,809.70	1,776.20	1,983.14	1,969.90
Efficient Case	411.64	395.10	452.30	361.21	405.06
Annual Savings	1898.91	1414.60	1323.90	1621.93	1564.84

Demand

Hand-Wrap Case	SUPERMARKET CHAIN 1 (kW)	SUPERMARKET CHAIN 2 (kW)	SUPERMARKET CHAIN 3 (kW)	SUPERMARKET CHAIN 4 (kW)	Demand Savings (kW)
Baseline	0.267	0.227	0.201	0.229	0.231
Efficient Case	0.054	0.043	0.059	0.043	0.050
Annual Savings	0.21	0.18	0.14	0.19	0.181

Baseline Efficiency:

The baseline is a Commercial Electric Hand-wrap Machine Always On

High Efficiency:

On-demand Hand-wrap Machine with Mechanical or Optical Control System

Measure Life:

Measure life is 10 years per the 2020 CA eTRM.

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Hand Wrapper	CI_EQUIP	All	10	n/a	n/a	10

Other Resource Impacts:

There are no other Resource Impacts

Impact Factors for Calculating Adjusted Gross Savings:

Measure	Core Initiative	PA	ISR	SPF	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Hand Wrapper	CI_EQUIP	All	1.00	1.00	1.00	n/a	1.00	1.00	0.90	0.90

In-Service Rates:

All installations have 100% in service rate since programs include verification of equipment installations.

Realization Rates:

100% realization rates are assumed because savings are based on researched assumptions.

Coincidence Factors:

Coincidence factors are 0.9 for both summer and winter seasons to account for the fact that some restaurants close one day per week and some may not serve both lunch and dinner on weekdays.

Impact Factors for Calculating Net Savings:

Net-to-gross assumptions are from study results.[1]

Measure	Initiative	PA	FR	SO	NPSO	NTG
Hand Wrapper	CI_EQUIP	All	25.0%	0.2%	8.5%	83.7%

Non-Energy Impacts:

Non-energy Impacts are based on study results.[2]

Measure Name	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per kWh	Annual $ per Therm	One-time$ per Therm
Hand Wrapper	All	$0.00	$0.00	$0.005	$0.00	0.00	0.00

Endnotes:

1 : NMR Group, Inc. (2021) Prescriptive and Custom Net-to-Gross Omnibus Study.
2021_NMR_C&I_Omnibus_NTG
2 : NMR Group Inc (2021). O&M and Non-O&M NEI Study. 2021_NMR_CIOM and NonOM NEI Study

3.108 Refrigeration - Lab-Grade Cold Storage

Measure Code	COM-R-LGCS
Market	Commercial
Program Type	Early Replacement
Category	Refrigeration

BCR Measure IDs:

Measure	Core Initiative	BCR Measure ID
Midstream - Lab-Grade Cold Storage	C&I New & Replacement Equipment (CI_EQUIP)	EC2b098

Algorithms for Calculating Primary Energy Impact:

Savings are deemed (average across all equipment types) per the Covid Lab Equipment 2021 MA-RI Forecast by Percentage of Sales 111523.[1][2]

Measure Name	Core Initiative	PA	kWh	kW
Lab Grade Cold Storage	CI_EQUIP	ALL	2,712	0.310

Baseline Efficiency:

The baseline is 40% more energy use than ENERGY STAR unit provided in the Cold Storage Forecast Assumptions Word Document.

High Efficiency:

Equipment Category	Eligibility
Laboratory Grade High Performance Refrigerators, 6≤V<25 cu. ft.	≤ 0.184*V + 3.5 kWh/day, V=unit volume
Laboratory Grade High Performance Refrigerators, 25≤V<44 cu. ft.	≤ 0.153*V + 4.28 kWh/day
Laboratory Grade High Performance Refrigerators, ≥44 cu. ft.	≤ 0.125*V + 5.5 kWh/day
Laboratory Grade High Performance Freezers, 6≤V<22 cu. ft.	≤ 0.09*V + 10 kWh/day
Laboratory Grade High Performance Freezers, ≥22 cu. ft.	≤ 0.426*V + 2.63 kWh/day
Ultra Low Temperature Freezer (-80 C)	0.55 kWh / cu. ft. / day

Measure Life:

The Measure Life is 10 years per and Assumed value agreed upon with EEAC Consultants

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Lab Grade Cold Storage	CI_EQUIP	All	10	0	n/a	10

Other Resource Impacts:

There are no other Resource Impacts associated with this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure	Core Initiative	PA	ISR	SPF	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Lab Grade Cold Storage	CI_EQUIP	All	1.00	1.00	1.00	n/a	1.00	1.00	0.90	0.90

In-Service Rates:

All installations have 100% in service rate since programs include verification of equipment installations.

Realization Rates:

100% realization rates are assumed because savings are based on researched assumptions.

Coincidence Factors:

Coincidence factors are 0.9 for both summer and winter seasons to account for the fact that some restaurants close one day per week and some may not serve both lunch and dinner on weekdays.

Impact Factors for Calculating Net Savings:

Net-to-Gross are based on study results.[3]

Measure	Initiative	PA	FR	SO	NPSO	NTG
Lab Grade Storage	CI_EQUIP	All	25.0%	0.2%	8.5%	83.7%

Non-Energy Impacts:

Measure Name	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per kWh	Annual $ per Therm	One-time$ per Therm
Lab Grade Storage	All	$0.00	$0.00	$0.001	$0.00	0.00	0.00

Endnotes:

1 : Covid Lab Equipment 2021 MA-RI Forecast by Percentage of Sales 111523

2 : DNV (2023). ISP Recommendations: Ultra-Low Temperature Freezers (MA23C02-B-ISPREPOS). 2023_DNV_MA23C02-B-ISPREPOS_ULT_Freezers

3 : NMR Group, Inc. (2021). C&I Prescriptive and Custom Net-to-Gross Omnibus Study. 2021_NMR_C&I_Omnibus_NTG

3.109   Refrigeration - Novelty Cooler Shutoff

Measure Code	COM-R-NCS
Market	Commercial
Program Type	Retrofit
Category	Refrigeration

Measure Description:

Installation of controls to shut off a facility's novelty coolers for non-perishable goods based on pre-programmed store hours. Energy savings occur as coolers cycle off during facility unoccupied hours.[1]

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Novelty Cooler Shutoff	C&I Existing Building Retrofit (CI_RETRO)	EC2a035
Novelty Cooler Shutoff (Turnkey)	C&I Existing Building Retrofit (CI_RETRO)	EC2a154

Algorithms for Calculating Primary Energy Impact:

$\Delta kWh = kW_{NC} * DC_{AVG} * Hours_{OFF}$
$\Delta kW = 0$

Where:
$\Delta kW = 0$ since savings are assumed to occur during evening hours and are therefore not coincident with either summer or winter peak periods.
kW_{NC} = Power demand of novelty cooler calculated from equipment nameplate data and estimated 0.85 power factor[1]
$Hours_{OFF}$ = Potential hours off every night per year, estimated as one less than the number of hours the store is closed per day
DC_{AVG} = Weighted average annual duty cycle: 48.75%[2]

Baseline Efficiency:

The baseline efficiency case is the novelty coolers operating 8,760 hours per year.

High Efficiency:

The high efficiency case is the novelty coolers operating fewer than 8,760 hours per year since they are controlled to cycle each night based on pre-programmed facility unoccupied hours.

Measure Life:

This measures is determined to have an add on single baseline for retrofit scenarios.[3] [4]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Refrigeration - Novelty Cooler Shutoff	CI_RETRO	All	10	1	n/a	10

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E[5]	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Refrigeration - Novelty Cooler Shutoff	CI_RETRO	Eversource Unitil	1.00	0.95	1.00	1.27	1.42	0.90	0.90
Refrigeration - Novelty Cooler Shutoff	CI Retro	National Grid CLC	1.00	1.05	1.00	0.94	1.17	0.90	0.90

In-Service Rates:
Assume 100% in service rate since until evaluated.

Realization Rates:
Realization rates are set to 100% until evaluated.

Coincidence Factors:
Coincidence factors representative of C&I Refrigeration.

Impact Factors for Calculating Net Savings:

All PAs use statewide prescriptive net-to-gross results.[6]

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Refrigeration - Novelty Cooler Shutoff	CI_RETRO	All	0.18	0.00	0.05	0.88
Refrigeration - Novelty Cooler Shutoff (Turnkey)	CI_RETRO	All	0.08	0.01	0.00	0.94

Non-Energy Impacts:

Prescriptive refrigeration measures in retrofit applications have an annual $/kWh NEI.[7]

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per KWh	Annual $ per Therm	One-time $ per Therm
Refrigeration - Novelty Cooler Shutoff	CI_RETRO	All			$0.001			

Endnotes:

1 : The assumptions and algorithms used in this section are specific to NRM products

1 : Conservative value based on 15 years of NRM field observations and experience.

2 : The estimated duty cycles for Novelty Coolers are supported by Select Energy Services, Inc. (2004). Cooler Control Measure Impact Spreadsheet Users' Manual. Prepared for NSTAR. The study gives a less conservative value than used by NRM.
Select_Energy_2004_Cooler_Control_Measure_Impact_Spreadsheet_Users_Manual

3 : Baseline Categories and preliminary Out Year Factors are described at a high level in DNV GL, ERS (2018). Portfolio Model Companion Sheet. Additional background on the baseline categorization given in DNV GL, ERS (2018). Portfolio Model Methods and Assumptions – Electric and Natural Gas Memo.
2018_DNVGL_ERS_Portfolio_Model_Companion_Sheet

4 : Energy & Resource Solutions (2005). Measure Life Study. Prepared for The Massachusetts Joint Utilities; Table 1-1. ERS_2005_Measure_Life_Study

5 : DNV GL. (2019). Impact Evaluation of PY 2017 Small Business Initiative Non-lighting measures.
Final Report MA19C03-E-SBIMPCT 03202020

6 : NMR Group, Inc. (2021). Prescriptive and Custom NTG Omnibus Study.
2021_NMR_C&I_Omnibus_NTG

7 : NMR Group, Inc. (2021). O&M and Non-O&M NEI Study. 2021_NMR_CIOM and NonOM NEI Study

3.110 Refrigeration - Refrigerated Chef Base

Measure Code	COM-R-RCB
Market	Commercial
Program Type	Early Replacement
Category	Refrigeration

BCR Measure IDs:

Measure	Core Initiative	BCR Measure ID
Midstream - Refrigerated Chef Base, 35-54"	C&I New & Replacement Equipment (CI_EQUIP)	EC2b109
Midstream - Refrigerated Chef Base, 55-73"	C&I New & Replacement Equipment (CI_EQUIP)	EC2b110
Midstream - Refrigerated Chef Base, 74-89"	C&I New & Replacement Equipment (CI_EQUIP)	EC2b111
Midstream - Refrigerated Chef Base, 90-120"	C&I New & Replacement Equipment (CI_EQUIP)	EC2b112

Algorithms for Calculating Primary Energy Impact:

Chef Base Daily Energy Use kWh/day/ft3 * 365 (# 0f days) = Annual Energy Consumption (kWh)/ft3

(Annual Energy Consumption Standard - Annual Energy Consumption Efficient) x Refrigerated Volume = kWh/yr

(Peak demand Intensity kW/ft3 Standard - Efficient) x Refrigerated Volume = Peak Demand Savings kW

Measure	Core Initiative	PA	kWh	kW
Refrigerated Chef Base, 35-54"	CI_EQUIP	ALL	1,051	0.1152
Refrigerated Chef Base, 55-73"	CI_EQUIP	ALL	1,637	0.1770
Refrigerated Chef Base, 74-89"	CI_EQUIP	ALL	1,985	0.2142
Refrigerated Chef Base, 90-120"	CI_EQUIP	ALL	2,673	0.2885

Baseline Efficiency:

Baseline Efficiency from the 2020 CA eTRM[1]

> Exterior Length between 35 – 54 inches and Daily Energy Use Intensity of 0.6000 kWh/day/ft3
> Exterior Length between 55 – 73 inches and Daily Energy Use Intensity of 0.5400 kWh/day/ft3
> Exterior Length between 74 – 89 inches and Daily Energy Use Intensity of 0.4751 kWh/day/ft3
> Exterior Length between 90 – 120 inches and Daily Energy Use Intensity of 0.4700 kWh/day/ft3

High Efficiency:

Measure Eligibility/Qualifications[2]

> Exterior Length between 35 – 54 inches and Daily Energy Use Intensity <=0.1800 kWh/day/ft3
> Exterior Length between 55 – 73 inches and Daily Energy Use Intensity <=0.1600 kWh/day/ft3
> Exterior Length between 74 – 89 inches and Daily Energy Use Intensity <=0.1400 kWh/day/ft3
> Exterior Length between 90 – 120 inches and Daily Energy Use Intensity <=0.1400 kWh/day/ft3

Measure Life:

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Refrigerated Chef Base	CI_EQUIP	All	12	n/a	n/a	12

Other Resource Impacts:

There are no other Resource Impacts.

Impact Factors for Calculating Adjusted Gross Savings:

Measure	Core Initiative	PA	ISR	SPF	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Refrigerated Chef Base	CI_EQUIP	All	1.00	1.00	1.00	n/a	1.00	1.00	0.90	0.90

<u>In-Service Rates:</u>

All installations have 100% in service rate since all PAs' programs include verification of equipment installations.

<u>Realization Rates:</u>

100% realization rates are assumed until evaluated

<u>Coincidence Factors:</u>

Coincidence factors are 0.0. for both summer and winter seasons..

Impact Factors for Calculating Net Savings:

All PA's use evaluated Statewide Results. [3]

Measure	Initiative	PA	FR	SO	SO_{NP}	NTG
Refrigerated Chef Base	CI_EQUIP	All	25.0%	0.2%	8.5%	83.7%

Non-Energy Impacts:

Non-energy Impacts are based on study results. [4]

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per KWh	Annual $ per Therm	One-time $ per Therm
Refrigerated Chef Base	CI_Equip	ALL	$0.00	$0.00	$0.005	$0.00	$0.00	$0.00

Endnotes:

1 : California eTRM. (2020). https://www.caetrm.com/measure/SWFS016/01/

2 : California eTRM. (2020). https://www.caetrm.com/measure/SWFS016/01/

3 : NMR Group, Inc. (2021). C&I Prescriptive and Custom Net-to-Gross Omnibus Study. 2021_NMR_C&I_Omnibus_NTG

4 : NMR Group, Inc. (2021). O&M And NON-O&M NEI Study. 2021_NMR_CIOM and NonOM NEI Study

3.111   Refrigeration - Vending Miser

Measure Code	COM-R-VM
Market	Commercial
Program Type	Retrofit
Category	Refrigeration

Measure Description:

Controls can significantly reduce the energy consumption of vending machine lighting and refrigeration systems. Qualifying controls must power down these systems during periods of inactivity but, in the case of refrigerated machines, must always maintain a cool product that meets customer expectations. This measure applies to refrigerated beverage vending machines, non-refrigerated snack vending machines, and glass front refrigerated coolers. This measure should not be applied to ENERGY STAR® qualified vending machines, as they already have built-in controls.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Vending Miser - Refrigerated Beverage Vending Machines	C&I Existing Building Retrofit (CI_RETRO)	EC2a031
Vending Miser - Non-Refrigerated Beverage Vending Machines	C&I Existing Building Retrofit (CI_RETRO)	EC2a032
Vending Miser - Glass Front Refrigerated Coolers	C&I Existing Building Retrofit (CI_RETRO)	EC2a033
Vending Miser (Residential End Use)	C&I Existing Building Retrofit (CI_RETRO)	EC2a107
Vending Miser - Refrigerated Beverage Vending Machines (Turnkey)	C&I Existing Building Retrofit (CI_RETRO)	EC2a160
Vending Miser - Non-Refrigerated Beverage Vending Machines (Turnkey)	C&I Existing Building Retrofit (CI_RETRO)	EC2a161
Vending Miser - Glass Front Refrigerated Coolers (Turnkey)	C&I Existing Building Retrofit (CI_RETRO)	EC2a162

Algorithms for Calculating Primary Energy Impact:

$\Delta kWh = (kW_{rated})(Hours)(SAVE)$

$\Delta kW = \Delta kWh / Hours$

Where:

kW_{rated} = Rated kW of connected equipment. See table below for default rated kW by connected equipment type.

Hours = Operating hours of the connected equipment: default of 8,760 hours

SAVE = Percent savings factor for the connected equipment. See table below for values.

Vending Machine and Cooler Controls Savings Factors[1]

Equipment Type	kW_{rated}	SAVE (%)	ΔkW	ΔkWh
Refrigerated Beverage Vending Machines	0.40	46	0.184	1612
Non-Refrigerated Snack Vending Machines	0.085	46	0.039	343
Glass Front Refrigerated Coolers	0.46	30	0.138	1208

Baseline Efficiency:

The baseline efficiency case is a standard efficiency refrigerated beverage vending machine, nonrefrigerated snack vending machine,or glass front refrigerated cooler without a control system capable of powering down lighting and refrigeration systems during periods of inactivity.

High Efficiency:

The high efficiency case is a standard efficiency refrigerated beverage vending machine, non-refrigerated snack vending machine, or glass front refrigerated cooler with a control system capable of powering down lighting and refrigeration systems during periods of inactivity.

Measure Life:

This measure is determined to be an add on single baseline measure for retrofit scenarios.[2] [3]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
All Vending Misers	CI_RETRO	All	5	1	n/a	5

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	PA	ISR	RR_E[4]	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
All Vending	CI_RETRO	National Grid Unitil	1.00	0.95	1.00	1.27	1.42	0.90	0.90

Misers									
All Vending Misers	CI_RETRO	Eversource CLC	1.00	1.05	1.00	0.94	1.17	0.90	0.90

In-Service Rates:
Assume 100% in service rate until evaluated.

Realization Rates:
Realization rates are set to 100% until evaluated.

Coincidence Factors:
Coincidence factors representative of C&I Refrigeration.

Impact Factors for Calculating Net Savings:

All PAs use statewide prescriptive net-to-gross results for non-residential end uses.[5] PAs use results from a multi family evaluation for the residential end use.[6]

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Vending Misers	CI_RETRO	All	0.18	0.00	0.05	0.88
Vending Misers (Turnkey)	CI_RETRO	All	0.08	0.01	0.00	0.94
Vending Miser (Residential End Use)	CI_RETRO	All	0.14	0.00	0.00	0.86

Non-Energy Impacts:

Prescriptive refrigeration measures in retrofit applications have an annual $/kWh NEI. [7]

Measure Name	Core Initiative	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per KWh	Annual $ per Therm	One-time $ per Therm
All Vending Misers	CI_RETRO	All			$0.001			

Endnotes:

1 : USA Technologies Energy Management Product Sheets (2006).
USA_Tech_2006_Energy_Management_Product_Sheets
2 : Baseline Categories and preliminary Out Year Factors are described at a high level in DNV GL, ERS (2018). Portfolio Model Companion Sheet.. Additional background on the baseline categorization given in DNV GL, ERS (2018). Portfolio Model Methods and Assumptions – Electric and Natural Gas Memo.

2018_DNVGL_ERS_Portfolio_Model_Companion_Sheet

3 : Energy & Resource Solutions (2005). Measure Life Study. Prepared for The Massachusetts Joint Utilities; Table 1-1 ERS_2005_Measure_Life_Study

4 : DNV GL. (2019). Impact Evaluation of PY 2017 Small Business Initiative Non-lighting measures. Final Report MA19C03-E-SBIMPCT 03202020

5 : NMR Group, Inc. (2021). C&I Prescriptive and Custom Omnibus NTG Study. 2021_NMR_C&I_Omnibus_NTG

6 : Guidehouse (2021). Massachusetts Residential Programs Net-to-Gross Research of RCD and Select Products Measures. 2021_Guidehouse_MA_Res_NTG_Final_Report

7 : NMR Group, Inc. (2021). O&M and Non-O&M NEI Study. 2021_NMR_CIOM and NonOM NEI Study

3.112   Whole Building - C&I Metered Residential New Construction

Measure Code	COM-BE-RNC
Market	Commercial
Program Type	New Construction
Category	Heating Ventilation and Air Conditioning, Lighting, Water Heating

BCR Measure IDs:

Measure	Core Initiative	BCR Measure ID
Multifamily Heating (High Rise)	C&I New Buildings & Major Renovations (CI_NB&MR)	EC1a056
Multifamily Cooling (High Rise)	C&I New Buildings & Major Renovations (CI_NB&MR)	EC1a057
Multifamily Water Heating (High Rise)	C&I New Buildings & Major Renovations (CI_NB&MR)	EC1a058
Multifamily Lighting (High Rise)	C&I New Buildings & Major Renovations (CI_NB&MR)	EC1a059
Multifamily Heating (Passive House)	C&I New Buildings & Major Renovations (CI_NB&MR)	EC1a060
Multifamily Cooling (Passive House)	C&I New Buildings & Major Renovations (CI_NB&MR)	EC1a061
Multifamily Water Heating (Passive House)	C&I New Buildings & Major Renovations (CI_NB&MR)	EC1a062
Multifamily Lighting (Passive House)	C&I New Buildings & Major Renovations (CI_NB&MR)	EC1a063
Heating (High Rise)	C&I New Buildings & Major Renovations (CI_NB&MR)	GC1a036
Cooling (High Rise)	C&I New Buildings & Major Renovations (CI_NB&MR)	GC1a037
Water Heating (High Rise)	C&I New Buildings & Major Renovations (CI_NB&MR)	GC1a038
Lighting (High Rise)	C&I New Buildings & Major	GC1a039

Measure	Core Initiative	BCR Measure ID
	Renovations (CI_NB&MR)	
Heating (Passive House)	C&I New Buildings & Major Renovations (CI_NB&MR)	GC1a040
Cooling (Passive House)	C&I New Buildings & Major Renovations (CI_NB&MR)	GC1a041
Water Heating (Passive House)	C&I New Buildings & Major Renovations (CI_NB&MR)	GC1a042
Lighting (Passive House)	C&I New Buildings & Major Renovations (CI_NB&MR)	GC1a043

Algorithms for Calculating Primary Energy Impact:

Savings are derived from two modelling pathways within this initiative: the Low-Rise Performance Path, and the Multifamily High-Rise Performance Path.

The Program Administrators currently use vendor calculated energy savings for Low-Rise Performance Path projects.   These savings are calculated using a RESNET accredited Rating Software Tool (Ekotrope) where a user inputs a detailed set of technical data about a project, comparing as-built projected energy consumption to that of a baseline home, the User-Defined Reference Home (UDRH). This process is used to calculate electric and fossil fuel energy savings due to heating, cooling, and water heating for all homes, both single family and multifamily buildings (three stories and below).

For homes participating in the Multifamily High-Rise Path, the vendor models savings using a proprietary software. The software models the consumption of the as-built efficient building and compares that consumption to an architecturally similar building with baseline efficient equipment. The difference in consumption yields Heating, Cooling, Water Heating, and Lighting savings.

Measure	kW-per-kWh
Heating	0.00073
Cooling	0.00143
Water Heating	0.00025
Lighting	0.00025

Baseline Efficiency:

The User-Defined Reference Home (UDRH) is used for low-rise projects. It was updated in early 2020[1] and adjustments were made for low-rise multifamily in starting in 2022.[2]

The Multifamily High-Rise baseline is evaluated separately.[3]

Starting in 2020, renovation project savings use an Industry Standard Practice (ISP) baseline, per the recommendation provided by NMR in the R&A Market Characterization Study.[4]

High Efficiency:

The high-efficiency case is represented by the specific energy characteristics of each "as-built" home completed through the program.

Measure Life:

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Heating	CI_NB&MR	All	25	n/a	n/a	25
Cooling	CI_NB&MR	All	25	n/a	n/a	25
Water Heating	CI_NB&MR	All	15	n/a	n/a	15
Lighting	CI_NB&MR	All	1	n/a	n/a	1

Other Resource Impacts:

There are no other resource impacts identified for this measure.

Impact Factors for Calculating Adjusted Gross Savings:

Measure	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Heating	CI_NB&MR	All	1.00	1.00	1.00	1.00	1.00	0.00	0.43
Cooling	CI_NB&MR	All	1.00	1.00	1.00	1.00	1.00	0.37	0.00
Water Heating	CI_NB&MR	All	1.00	1.00	1.00	1.00	1.00	0.31	0.84
Lighting	CI_NB&MR	All	1.00	1.00	1.00	1.00	1.00	0.55	0.85

In-Service Rates:
All installations have 100% in-service rate because all PA programs include verification of equipment installations.

Realization Rates:
Realization rates are 100% because energy and demand savings are custom-calculated based on project-specific detail.

Coincidence Factors:
Summer and winter coincidence factors are estimated using the demand allocation methodology described in the Demand Impact Model which is developed based on the Residential Baseline Study.[5]

National Grid uses custom calculated coincidence factors based on vendor-calculated project-specific detail.

Impact Factors for Calculating Net Savings:

Net to gross factors are based on evaluation results.[6]

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
RNC High Rise	CI_NB&MR	All	n/a	n/a	n/a	0.83
RNC Passive House	CI_NB&MR	All	n/a	n/a	n/a	0.90

Non-Energy Impacts:

There are no non-energy impacts identified for this measure.

Endnotes:

1 : NMR Group, Inc. (2019). 2019 Residential New Construction Baseline/Compliance Study.
2019_NMR_RNC-LowRise-UDRH_Baseline
2 : NMR Group Inc. (2022). Massachusetts Multifamily Low-Rise New Construction Baseline Study.
2022_NMR_RNC MF LowRise Baseline Study
3 : NMR Group Inc. (2017). Massachusetts Multifamily High Rise Baseline Study.
NMR_2017_MA_MFHR_Baseline
4 : NMR Group, Inc. (2019). Renovations and Additions Market Characterization and Potential Savings Study. 2019_NMR_R&A-Market-Potential
5 : Guidehouse (2020). Residential Baseline Study Phase 4.
2020_Guidehouse_Residential_Baseline_Phase_4
6 : NMR Group, Inc. (2021). Non Residential New Construction NTG Report.
2021_NMR_Non_Residential_New_Construction_NTG_Report

Appendices

Appendix A: Common Lookup Tables

Table A-1: Lighting Power Densities Using the Building Area Method[3]

Building Type	2018 IECC LPD (W/ft^2)	2018 IECC w/ MA enhancements LPD (W/ft^2)
Automotive Facility	0.71	0.75
Convention Center	0.76	0.64
Courthouse	0.9	0.79
Dining: bar lounge/leisure	0.9	0.8
Dining: cafeteria/fast food	0.79	0.76
Dining: family	0.78	0.71
Dormitory	0.61	0.53
Exercise center	0.65	0.72
Fire station	0.53	0.56
Gymnasium	0.68	0.76
Health care clinic	0.82	0.81
Hospital	1.05	0.96
Hotel/Motel	0.75	0.56
Laboratory in a Classroom	1.2	1.11
Laboratory Otherwise	1.45	1.33
Library	0.78	0.83
Manufacturing facility	0.9	0.82
Motion picture theater	0.83	0.44

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[3] IECC 2018 Interior Lighting Power Allowances: Building Area method, adapted from Table C405.3.2(1) with adjustments for MA code enhancements

Multifamily	0.68	0.45
Museum	1.06	0.55
Office	0.79	0.64
Parking garage	0.15	0.18
Penitentiary	0.75	0.69
Performing arts theater	1.18	0.84
Police station	0.8	0.66
Post office	0.67	0.65
Religious	0.94	0.67
Retail	1.06	0.84
School/university	0.81	0.72
Sports arena	0.87	0.76
Town hall	0.8	0.69
Transportation	0.61	0.5
Warehouse	0.48	0.45
Workshop	0.9	0.91

Table A-2: Interior Lighting Power Allowances: Space-by-Space Method[4]

Common Space Types	LPD Allowances, W/ft2
Atrium	
<20 ft in height	0.03/ft total height
≥20 ft and ≥40 ft in height	0.03/ft total height
>40 ft in height	0.40 + 0.02/ft total height
Audience Seating Area	
Auditorium	0.63
Convention center	0.82
Gymnasium	0.65
Motion picture theater	1.14
Penitentiary	0.28
Performing arts theater	2.03
Religious facility	1.53
Sports arena	0.43
All other audience seating areas	0.43
Banking Activity Area	0.86
Breakroom (See Lounge/Breakroom)	
Classroom/Lecture Hall/Training Room	
Penitentiary	1.34
All other classrooms/lecture halls/training rooms	0.92
Conference/Meeting/Multipurpose Room	1.07
Confinement Cells	0.81

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[4] IECC 2018 Interior Lighting Power Allowances: Space-by-Space Method, Table C405.3.2(2)

Copy/Print Room	0.56
Corridor[2]	
Facility for the visually impaired (and not used primarily by the staff)[3]	0.92
Hospital	0.92
Manufacturing facility	0.29
All other corridors	0.66
Courtroom	1.39
Computer Room	1.33
Dining Area	
Penitentiary	0.96
Facility for the visually impaired (and not used primarily by staff)[3]	2
Bar/lounge or leisure dining	0.93
Cafeteria or fast food dining	0.63
Family dining	0.71
All other dining areas	0.63
Electrical/Mechanical Room[7]	0.43
Emergency Vehicle Garage	0.41
Food Preparation Area	1.06
Guest Room	0.77
Laboratory	
In or as a classroom	1.2
All other laboratories	1.45
Laundry/Washing Area	0.43
Loading Dock, Interior	0.58
Lobby	

Facility for the visually impaired (and not used primarily by the staff)[3]	2.03
Elevator	0.69
Hotel	1.06
Motion picture theater	0.45
Performing arts theater	1.7
All other lobbies	1
Locker Room	0.48
Lounge/Breakroom	
Healthcare facility	0.78
All other lounges/breakrooms	0.62
Office	
Enclosed and ≤250 ft^2	0.93
Enclosed and >250 ft^2	0.93
Open plan	0.81
Parking Area, Interior	0.14
Pharmacy Area	1.34
Restroom	
Facility for the visually impaired (and not used primarily by the staff)[3]	0.96
All other restrooms	0.85
Sales Area[4]	1.22
Seating Area, General	0.42
Stairway	The *space* containing the stairway shall determine the *LPD* and *control* requirements for the stairway.

Stairwell	0.58
Storage Room	
<50 ft^2	0.97
≥50 ft^2 and ≤ 1000 ft^2	0.46
All other storage rooms	0.46
Vehicular Maintenance Area	0.56
Workshop	1.14
Facility for the Visually Impaired[3]	
Chapel (used primarily by residents)	1.06
Recreation room/common living room (and not used primarily by staff)	1.8
Automotive (See "Vehicular Maintenance Area")	
Convention Center—Exhibit Space	0.88
Dormitory—Living Quarters	0.54
Fire Station—Sleeping Quarters	0.2
Gymnasium/Fitness Center	
Exercise area	0.5
Playing area	0.82
Healthcare Facility	
Exam/treatment room	1.68
Imaging room	1.06
Medical supply room	0.54
Nursery	1
Nurse's station	0.81
Operating room	2.17
Patient room	0.62

Physical therapy room	0.84
Recovery room	1.03
Library	
Reading area	0.82
Stacks	1.2
Manufacturing Facility	
Detailed manufacturing area	0.93
Equipment room	0.65
Extra high bay area (>50 ft floor-to-ceiling height)	1.05
High bay area (25 to 50 ft floor-to-ceiling height)	0.75
Low bay area (<25 ft floor-to-ceiling height)	0.96
Museum	
General exhibition area	1.05
Restoration room	0.85
Performing Arts Theater—Dressing Room	0.36
Post Office—Sorting Area	0.68
Religious Facility	
Fellowship hall	0.55
Worship/pulpit/choir area	1.53
Retail Facilities	
Dressing/fitting room	0.5
Mall concourse	0.9
Sports Arena—Playing Area[8]	
Class I facility	2.47

Class II facility	1.96
Class III facility	1.7
Class IV facility	1.13
Transportation Facility	
Baggage/carousel area	0.45
Airport concourse	0.31
Terminal ticket counter	0.62
Warehouse—Storage Area	
Medium to bulky, palletized items	0.35
Smaller, hand-carried items[5]	0.69

C405.4.2.1 Building Area Method.

For the Building Area Method, the interior lighting power allowance is the floor area for each building area type listed in Table C405.4.2(1) times the value from Table C405.4.2(1) for that area. For the purposes of this method, an "area" shall be defined as all contiguous spaces that accommodate or are associated with a single building area type, as listed in Table C405.4.2(1). Where this method is used to calculate the total interior lighting power for an entire building, each building area type shall be treated as a separate area.

C405.4.2.2 Space-by-Space Method.

For the Space-by-Space Method, the interior lighting power allowance is determined by multiplying the floor area of each space times the value for the space type in Table C405.4.2(2) that most closely represents the proposed use of the space, and then summing the lighting power allowances for all spaces. Trade-offs among spaces are permitted.

Table A-3: Mass Save New Construction Proposed Lighting Wattage Tables

2018 Mass Save C&I Lighting Rated Wattage Tables developed by Lighting Worksheet Team

Device Code	Device Description	Rated Watts	Device Code	Device Description	Rated Watts
	LED Lighting Fixtures		1L025	25 WATT LED	25
			1L026	26 WATT LED	26
1L002	2 WATT LED	2	1L027	27 WATT LED	27
1L003	3 WATT LED	3	1L028	28 WATT LED	28
1L004	4 WATT LED	04	1L029	29 WATT LED	29
1L005	5 WATT LED	05	1L030	30 WATT LED	30
1L006	6 WATT LED	06	1L031	31 WATT LED	31
1L007	7 WATT LED	07	1L032	32 WATT LED	32
1L008	8 WATT LED	08	1L033	33 WATT LED	33
1L009	9 WATT LED	09	1L034	34 WATT LED	34
1L010	10 WATT LED	10	1L035	35 WATT LED	35
1L011	11 WATT LED	11	1L036	36 WATT LED	36
1L012	12 WATT LED	12	1L037	37 WATT LED	37
1L013	13 WATT LED	13	1L038	38 WATT LED	38
1L014	14 WATT LED	14	1L039	39 WATT LED	39
1L015	15 WATT LED	15	1L040	40 WATT LED	40
1L016	16 WATT LED	16	1L041	41 WATT LED	41
1L017	17 WATT LED	17	1L042	42 WATT LED	42
1L018	18 WATT LED	18	1L043	43 WATT LED	43
1L019	19 WATT LED	19	1L044	44 WATT LED	44
1L020	20 WATT LED	20	1L045	45 WATT LED	45
1L021	21 WATT LED	21	1L046	46 WATT LED	46
1L022	22 WATT LED	22	1L047	47 WATT LED	47
1L023	23 WATT LED	23	1L048	48 WATT LED	48
1L024	24 WATT LED	24	1L049	49 WATT LED	49
			1L050	50 WATT LED	50

1L053	53 WATT LED	53	1L150	150 WATT LED	150
1L055	55 WATT LED	55	1L155	155 WATT LED	155
1L060	60 WATT LED	60	1L160	160 WATT LED	160
1L063	63 WATT LED	63	1L164	164 WATT LED	164
1L071	71 WATT LED	71	1L165	165 WATT LED	165
1L070	70 WATT LED	70	1L170	170 WATT LED	170
1L073	73 WATT LED	73	1L175	175 WATT LED	175
1L075	75 WATT LED	75	1L180	180 WATT LED	180
1L080	80 WATT LED	90	1L185	185 WATT LED	185
1L085	85 WATT LED	85	1L186	186 WATT LED	186
1L090	90 WATT LED	90	1L190	190 WATT LED	190
1L095	95 WATT LED	95	1L200	200 WATT LED	200
1L100	100 WATT LED	100	1L204	204 WATT LED	204
1L101	101 WATT LED	101	1L205	205 WATT LED	205
1L106	106 WATT LED	106	1L210	210 WATT LED	210
1L107	107 WATT LED	107	1L211	211 WATT LED	211
1L116	116 WATT LED	116	1L220	220 WATT LED	220
1L120	120 WATT LED	120	1L233	233 WATT LED	233
1L125	125 WATT LED	125	1L235	235 WATT LED	235
1L130	130 WATT LED	130	1L237	237 WATT LED	237
1L131	131 WATT LED	131	1L240	240 WATT LED	240
1L135	135 WATT LED	135	1L256	256 WATT LED	256
1L139	139 WATT LED	139	1L279	279 WATT LED	279
1L140	140 WATT LED	140			
1L145	145 WATT LED	145			

Table A-4: Mass Save Retrofit Existing/Proposed Lighting Wattage Tables

2016 Mass Save C&I Lighting Rated Wattage Tables developed by Lighting Worksheet Team

Device Code	Device Description	Rated Watts
LED Exit Signs		
1E0002	2.0 WATT LED	2
1E0003	3.0 WATT LED	3
1E0005	5.0 WLED	5
1E0005C	0.5 WATT LEC	0.5
1E0008	8.0 WLED	8
1E0015	1.5 WATT LED	1.5
1E0105	10.5 WATT LED	10.5
T5 Systems		
1F14SSE	1L2' 14W T5/ELIG	16
1F21SSE	1L3' 21W T5/ELIG	24
1F24HSE	1L2' 24W T5HO/ELIG	29
1F28SSE	1L4' 28W T5/ELIG	32
1F39HSE	1L3' 39W T5HO/ELIG	42
1F47HSE	1L4' 47W T5HO/ELIG	53
1F50HSE	1L4' 50W T5HO/ELIG	58
1F54HSE	1L4' 54W T5HO/ELIG	59
2F14SSE	2L2' 14W T5/ELIG	32
2F21SSE	2L3' 21W T5/ELIG	47
2F24HSE	2L2' 24W T5HO/ELIG	52
2F28SSE	2L4' 28W T5/ELIG	63
2F39HSE	2L3' 39W T5HO/ELIG	85
2F47HSE	2L4' 47W T5HO/ELIG	103

2F50HSE	2L4' 50W T5HO/ELIG	110
2F54HSE	2L4' 54W T5HO/ELIG	117
3F14SSE	3L2' 14W T5/ELIG	50
3F24HSE	3L4' T5HO/ELIG	80
3F28SSE	3L4' 28W T5/ELIG	95
3F47HSE	3L4' 47W T5HO/ELIG	157
3F50HSE	3L4' 50W T5HO/ELIG	168
3F54HSE	3L4' 54W T5HO/ELIG	177
4F14SSE	4L2' 14W T5/ELIG	68
4F28SSE	4L4' 28W T5/ELIG	126
4F47HSE	4L4' 47W T5HO/ELIG	200
4F50HSE	4L4' 50W T5HO/ELIG	215
4F54ESH	4L4' 54W T5HO/ELEE	218
4F54HSE	4L4' 54W T5HO/ELIG	234
5F47HSE	5L4' 47W T5HO/ELIG	260
5F50HSE	5L4' 50W T5HO/ELIG	278
5F54HSE	5L4' 54W T5HO/ELIG	294
6F28SSE	6L4' 28W T5/ELIG	189
6F47HSE	6L4' 47W T5HO/ELIG	303
6F50HSE	6L4' 50W T5HO/ELIG	325
6F54HSE	6L4' 54W T5HO/ELIG	351
8F54HSE	8L4' 54W T5HO/ELIG	468
10F54HSE	10L4' 54W T5HO/ELIG	585

Two-Foot-High Efficient T8 Systems		
1F17ESL	1L2' 17W T8EE/ELEE LOW PWR	14
1F17ESN	1L2' 17W T8EE/ELEE	17
1F17ESH	1L2' 17W T8EE/ELEE HIGH PWR	20
1F28BXE	1L2' F28BX/ELIG	32
2F17ESL	2L2' 17W T8EE/ELEE LOW PWR	27
2F17ESN	2L2' 17W T8EE/ELEE	32
2F17ESH	2L2' 17W T8EE/ELEE HIGH PWR	40
2F28BXE	2L2' F28BX/ELIG	63
3F17ESL	3L2' 17W T8EE/ELEE LOW PWR	39
3F17ESN	3L2' 17W T8EE/ELEE	46
3F17ESH	3L2' 17W T8EE/ELEE HIGH PWR	61
3F28BXE	3L2' F28BX/ELIG	94
Three-Foot-High Efficient T8 Systems		
1F25ESL	1L3' 25W T8EE/ELEE LOW PWR	21
1F25ESN	1L3' 25W T8EE/ELEE	24
1F25ESH	1L3' 25W T8EE/ELEE HIGH PWR	30
2F25ESL	2L3' 25W T8EE/ELEE LOW PWR	40
2F25ESN	2L3' 25W T8EE/ELEE	45
2F25ESH	2L3' 25W T8EE/ELEE HIGH PWR	60
3F25ESL	3L3' 25W T8EE/ELEE LOW PWR	58

3F25ESN	3L3' 25W T8EE/ELEE	67
3F25ESH	3L3' 25W T8EE/ELEE HIGH PWR	90
Four Foot T8 High Efficient / Reduce Wattage Systems		
1F25EEH	1L4' 25W T8EE/ELEE HIGH PWR	30
1F25EEE	1L4' 25W T8EE/ELEE	22
1F25EEL	1L4' 25W T8EE/ELEE LOW PWR	19
2F25EEH	2L4' 25W T8EE/ELEE HIGH PWR	57
2F25EEE	2L4' 25W T8EE/ELEE	43
2F25EEL	2L4' 25W T8EE/ELEE LOW PWR	37
3F25EEH	3L4' 25W T8EE/ELEE HIGH PWR	86
3F25EEE	3L4' 25W T8EE/ELEE	64
3F25EEL	3L4' 25W T8EE/ELEE LOW PWR	57
4F25EEH	4L4' 25W T8EE/ELEE HIGH PWR	111
4F25EEE	4L4' 25W T8EE/ELEE	86
4F25EEL	4L4' 25W T8EE/ELEE LOW PWR	75
1F28EEH	1L4' 28W T8EE/ELEE HIGH PWR	33
1F28EEE	1L4' 28W T8EE/ELEE	24
1F28EEL	1L4' 28W T8EE/ELEE LOW PWR	22
2F28EEH	2L4' 28WT8EE/ELEE HIGH PWR	64

2F28EEE	2L4' 28W T8EE/ELEE	48	1F32EEH	1L4' 32W T8EE/ELEE HIGH PWR	38
2F28EEL	2L4' 28W T8EE/ELEE LOW PWR	42	1F32EEE	1L4' 32W T8EE/ELEE	28
3F28EEH	3L4' 28W T8EE/ELEE HIGH PWR	96	1F32EEL	1L4' 32W T8EE/ELEE LOW PWR	25
3F28EEE	3L4' 28W T8EE/ELEE	72	2F32EEH	2L4' 32W T8EE/ELEE HIGH PWR	73
3F28EEL	3L4' 28W T8EE/ELEE LOW PWR	63	2F32EEE	2L4' 32W T8EE/ELEE	53
4F28EEH	4L4' 28W T8EE/ELEE HIGH PWR	126	2F32EEL	2L4' 32W T8EE/ELEE LOW PWR	47
4F28EEE	4L4' 28W T8EE/ELEE	94	3F32EEH	3L4' 32W T8EE/ELEE HIGH PWR	109
4F28EEL	4L4' 28W T8EE/ELEE LOW PWR	83	3F32EEE	3L4' 32W T8EE/ELEE	82
1F30EEH	1L4' 30W T8EE/ELEE HIGH PWR	36	3F32EEL	3L4' 32W T8EE/ELEE LOW PWR	72
1F30EEE	1L4' 30W T8EE/ELEE	26	4F32EEH	4L4' 32W T8EE/ELEE HIGH PWR	141
1F30EEL	1L4' 30W T8EE/ELEE LOW PWR	24	4F32EEE	4L4' 32W T8EE/ELEE	107
2F30EEH	2L4' 30WT8EE/ELEE HIGH PWR	69	4F32EEL	4L4' 32W T8EE/ELEE LOW PWR	95
2F30EEE	2L4' 30W T8EE/ELEE	52	5F32EEH	5L4' 32W T8EE/ELEE HIGH PWR	182
2F30EEL	2L4' 30W T8EE/ELEE LOW PWR	45	6F28EEE	6L4' 28W T8EE/ELEE	144
3F30EEH	3L4' 30W T8EE/ELEE HIGH PWR	103	6F28EEH	6L4' 28W T8EE/ELEE HIGH PWR	192
3F30EEE	3L4' 30W T8EE/ELEE	77	6F28EEL	6L4' 28W T8EE/ELEE LOW PWR	126
3F30EEL	3L4' 30W T8EE/ELEE LOW PWR	68	6F30EEE	6L4' 30W T8EE/ELEE	154
4F30EEH	4L4' 30W T8EE/ELEE HIGH PWR	133	6F30EEL	6L4' 30W T8EE/ELEE LOW PWR	136
4F30EEE	4L4' 30W T8EE/ELEE	101	6F32EEH	6L4' 32W T8EE/ELEE HIGH PWR	218
4F30EEL	4L4' 30W T8EE/ELEE LOW PWR	89	6F32EEE	6L4' 32W T8EE/ELEE	168

6F32EEL	6L4' 32W T8EE/ELEE LOW PWR	146	2W96SEE	2L8' TW EE/ELIG	55
7F32EEH	7L4' 32W T8EE/ELEE HIGH PWR	250	2W96SSE	2L8' TW STD/ELIG	67
Eight Foot T8 Systems			3W32SSE	3L4' TW T8/ELIG	29
1F59SSE	1L8' T8/ELIG	60	4D17SSE	4L2' TW T8/ELIG	31
1F80SSE	1L8' T8 HO/ELIG	85	4D32EEE	4L4' DTW T8EE/ELIG	51
2F59SSE	2L8' T8/ELIG	109	4D32EEL	4L4' DTW T8EE/ELEE LOW PWR	45
2F59SSL	2L8' T8/ELIG LOW PWR	100	4D32SSE	4L4' DTW T8/ELIG	53
2F80SSE	2L8' T8 HO/ELIG	160	4D32SSL	4L4 DTWT8/ELIG LOW POWER	49
Tandem Wired T8 High Efficient			4W32SSE	4L4' TW T8/ELIG	27
2W32EEE	2L4' TW T8EE/ELIG	27	4W32SSL	4L4 TWT8/ELIG LOW POWER	25
2W32EEL	2L4' TW T8EE/ELEE LOW PWR	24	*LED Lighting Fixtures*		
3W32EEE	3L4' TW T8EE/ELIG	39	1L002	2 WATT LED	2
3W32EEL	3L4' TW T8EE/ELEE LOW PWR	34	1L003	3 WATT LED	3
4W32EEE	4L4' TW T8EE/ELIG	51	1L004	4 WATT LED	4
4W32EEL	4L4' TW T8EE/ELEE LOW PWR	45	1L005	5 WATT LED	5
Tandem-Wired Fluorescent Systems			1L006	6 WATT LED	6
2W32SSE	2L4' TW T8/ELIG	30	1L007	7 WATT LED	7
2W32SSH	2L4' TW T8/HI-LUM	39	1L008	8 WATT LED	8
2W40SEE	2L4' TW EE/ELIG	30	1L009	9 WATT LED	9
2W40SSE	2L4' TW STD/ELIG	36	1L010	10 WATT LED	10
2W59HSE	2L8' TW T8 HO/ELIG	80	1L011	11 WATT LED	11
2W59SSE	2L8' TW T8/ELIG	55	1L012	12 WATT LED	12
2W96HEE	2L8' TW HO-EE/ELIG	85	1L013	13 WATT LED	13
2W96HSE	2L8' TW HO-STD/ELIG	98	1L014	14 WATT LED	14
			1L015	15 WATT LED	15

1L016	16 WATT LED	16		*LED Lighting Fixtures*	
1L017	17 WATT LED	17	1L043	43 WATT LED	43
1L018	18 WATT LED	18	1L044	44 WATT LED	44
1L019	19 WATT LED	19	1L045	45 WATT LED	45
1L020	20 WATT LED	20	1L046	46 WATT LED	46
1L021	21 WATT LED	21	1L047	47 WATT LED	47
1L022	22 WATT LED	22	1L048	48 WATT LED	48
1L023	23 WATT LED	23	1L049	49 WATT LED	49
1L024	24 WATT LED	24	1L050	50 WATT LED	50
1L025	25 WATT LED	25	1L053	53 WATT LED	53
1L026	26 WATT LED	26	1L055	55 WATT LED	55
1L027	27 WATT LED	27	1L060	60 WATT LED	60
1L028	28 WATT LED	28	1L063	63 WATT LED	63
1L029	29 WATT LED	29	1L070	70 WATT LED	70
1L030	30 WATT LED	30	1L071	71 WATT LED	71
1L031	31 WATT LED	31	1L073	73 WATT LED	73
1L032	32 WATT LED	32	1L075	75 WATT LED	75
1L033	33 WATT LED	33	1L080	90 WATT LED	90
1L034	34 WATT LED	34	1L085	85 WATT LED	85
1L035	35 WATT LED	35	1L090	90 WATT LED	90
1L036	36 WATT LED	36	1L095	95 WATT LED	95
1L037	37 WATT LED	37	1L100	100 WATT LED	100
1L038	38 WATT LED	38	1L101	101 WATT LED	101
1L039	39 WATT LED	39	1L106	106 WATT LED	106
1L040	40 WATT LED	40	1L107	107 WATT LED	107
1L041	41 WATT LED	41	1L116	116 WATT LED	116
1L042	42 WATT LED	42	1L120	120 WATT LED	120

1L125	125 WATT LED	125		1L240	240 WATT LED	240
1L130	130 WATT LED	130		1L256	256 WATT LED	256
1L131	131 WATT LED	131		1L279	279 WATT LED	279
1L135	135 WATT LED	135		1LED015	15 Watt LED	15
1L139	139 WATT LED	139				
1L140	140 WATT LED	140				
1L145	145 WATT LED	145				
1L150	150 WATT LED	150				
1L155	155 WATT LED	155				
1L160	160 WATT LED	160				
1L164	164 WATT LED	164				
1L165	165 WATT LED	165				
1L170	170 WATT LED	170				
1L175	175 WATT LED	175				
1L180	180 WATT LED	180				
1L185	185 WATT LED	185				
1L186	186 WATT LED	186				
1L190	190 WATT LED	190				
1L200	200 WATT LED	200				
1L204	204 WATT LED	204				
1L205	205 WATT LED	205				
1L210	210 WATT LED	210				
1L211	211 WATT LED	211				
1L220	220 WATT LED	220				
1L233	233 WATT LED	233				
1L235	235 WATT LED	235				
1L237	237 WATT LED	237				

Table A-5: Default Effective Lighting Hours by Building Type[5]

Building Type	Annual Operating Hours
College & University	4,132
Grocery/Food Sales	5,920
Hospital	5,601
Industrial/Manufacturing	5,229
K-12 School	2,902
Lodging	4,194
Medical Office	3,673
Office Building	4,171
Other	4,141
Parking Garage	8,263
Restaurant/Food Service	4,891
Retail	4,957

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[5] DNV GL (2018). *Lighting Hours of Use Study, Table 3-1.* Prepared for MA Program Administrators and EEAC.

Table A-6: Cooling and Heating Equivalent Full Load Hours

Building (or Space) Type	Annual Cooling Hours (Hours$_{cool}$)	Cooling Full Load Hours (EFLH$_{cool}$)	Heating Full Load Hours (EFLH$_{heat}$)
Average – CLC	3,027	1,172	530
Average – NSTAR	3,027	1,172	N/A
Average – National Grid	2,539	935	984
Average – Unitil	1,896	755	1,329
Average – WMECO	1,896	755	1,329
Site Specific - NSTAR	800, 1000-6000 at 1000-hour increments	800, 1000-6000 at 1000-hour increments	N/A

- Average Cooling EFLHs from the 2010 NEEP HVAC Loadshape study.[6] Regional EFLHs from the NEEP study are determined for each PA by applying weights based on ISO-NE load zones.
- Average Cooling Hours derived from the 2010 NEEP HVAC Loadshape study data.[7]
- Average Heating EFLHs derived from 2010 NEEP HVAC Loadshape study[8] and the Connecticut Program Savings Document for 2011 Program Year. [9]

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[6] KEMA (2011). C&I Unitary AC LoadShape Project – Final Report. Prepared for the Regional Evaluation, Measurement & Verification Forum.

[7] DNV GL (2014). *Memo – Develop Modified Runtime from NEEP HVAC Loadshape Study*. Prepared for National Grid and Northeast Utilities. August 20, 2014.

[8] Ibid.

[9] United Illuminating Company, Connecticut Light & Power Company (2010). *UI and CL&P Program Savings Documentation for 2011 Program Year*.

Appendix B: Non-Energy Impacts

Table B-1: Residential and Income Eligible Non-Energy Impacts (NEIs)

Sector	NEI Description	NEI Category	Annual per Unit	One time per Unit	Annual per kWh	One time per KWh	Annual per Therm
Residential	Residential Bulb	Lighting Quality and Lifetime		$3.00			
Residential	Residential Fixture	Lighting Quality and Lifetime		$3.50			
Residential	RNC Heating		$22.77				
Residential	RNC Heating	Thermal Comfort	$91.50				
Residential	RNC Heating	Noise Reduction	$47.53				
Residential	RNC Heating	Health Benefits	$3.30				
Residential	RNC Heating, R&A		$22.77				
Residential	RNC Heating, R&A	Thermal Comfort	$91.50				
Residential	RNC Heating, R&A	Noise Reduction	$47.53				
Residential	RNC Heating, R&A	Health Benefits	$3.30				
Residential	Residential Air Sealing		$19.28				
Residential	Residential Air Sealing	Thermal Comfort	$10.13				
Residential	Residential Air Sealing	Noise Reduction	$4.88				
Residential	Residential Air Sealing	Home Durability	$3.95				
Residential	Residential Air Sealing	Health Benefits	$0.32				
Residential	Residential Insulation		$47.31				
Residential	Residential Insulation	Thermal Comfort	$25.15				
Residential	Residential Insulation	Noise Reduction	$11.54				
Residential	Residential Insulation	Home Durability	$9.82				
Residential	Residential Insulation	Health Benefits	$0.80				

Sector	NEI Description	NEI Category	Annual per Unit	One time per Unit	Annual per kWh	One time per KWh	Annual per Therm
Residential	Residential Duct Sealing		$0.23				
Residential	Residential Duct Sealing	Thermal Comfort	$0.16				
Residential	Residential Duct Sealing	Home Durability	$0.06				
Residential	Residential Duct Sealing	Health Benefits	$0.01				
Residential	Residential Showerhead	Property Value Increase		$0.03			
Residential	Residential Thermostats		$3.63				
Residential	Residential Thermostats	Thermal Comfort	$3.99				
Residential	Residential Thermostats	Home Durability	$1.33				
Residential	Residential Thermostats	Health Benefits	$0.13				
Residential	Residential Refrigerator	Property Value Increase		$1.44			
Residential	Residential Furnace		$30.85				
Residential	Residential Furnace	Thermal Comfort	$24.32				
Residential	Residential Furnace	Home Durability	$5.75				
Residential	Residential Furnace	Health Benefits	$0.78				
Residential	Residential Boiler		$30.85				
Residential	Residential Boiler	Thermal Comfort	$24.32				
Residential	Residential Boiler	Home Durability	$5.75				
Residential	Residential Boiler	Health Benefits	$0.78				
Residential	Residential Water Heater Replacement	Home Durability	$0.70				
Residential	Residential Combo		$30.85				

Sector	NEI Description	NEI Category	Annual per Unit	One time per Unit	Annual per kWh	One time per KWh	Annual per Therm
	Boiler						
Residential	Residential Combo Boiler	Thermal Comfort	$24.32				
Residential	Residential Combo Boiler	Home Durability	$5.75				
Residential	Residential Combo Boiler	Health Benefits	$0.78				
Residential	Residential MF Air Sealing		$19.35				
Residential	Residential MF Air Sealing	Thermal Comfort	$10.13				
Residential	Residential MF Air Sealing	Noise Reduction	$4.88				
Residential	Residential MF Air Sealing	Health Benefits	$0.32				
Residential	Residential MF Air Sealing	Rental Units Marketability	$0.07				
Residential	Residential MF Air Sealing	Reduced Tenant Complaints	$1.37				
Residential	Residential MF Air Sealing	Property Durability	$2.58				
Residential	Residential MF Insulation		$47.31				
Residential	Residential MF Insulation	Thermal Comfort	$25.15				
Residential	Residential MF Insulation	Noise Reduction	$11.54				
Residential	Residential MF Insulation	Home Durability	$9.82				
Residential	Residential MF	Health Benefits	$0.80				

Sector	NEI Description	NEI Category	Annual per Unit	One time per Unit	Annual per kWh	One time per KWh	Annual per Therm
	Insulation						
Residential	**Residential MF Showerhead**		$0.58				
Residential	Residential MF Showerhead	Rental Units Marketability	$0.01				
Residential	Residential MF Showerhead	Reduced Tenant Complaints	$0.20				
Residential	Residential MF Showerhead	Property Durability	$0.37				
Residential	**Residential MF Aerator**		$0.58				
Residential	Residential MF Aerator	Rental Units Marketability	$0.01				
Residential	Residential MF Aerator	Reduced Tenant Complaints	$0.20				
Residential	Residential MF Aerator	Property Durability	$0.37				
Residential	**Residential MF Thermostat**		$14.35				
Residential	Residential MF Thermostat	Thermal Comfort	$3.99				
Residential	Residential MF Thermostat	Health Benefits	$0.13				
Residential	Residential MF Thermostat	Rental Unit Marketability	$0.11				
Residential	Residential MF Thermostat	Equipment Maintenance Reliability Due to Thermostats	$3.91				
Residential	Residential MF Thermostat	Property Durability	$4.05				
Residential	Residential MF	Reduced Tenant	$2.16				

Sector	NEI Description	NEI Category	Annual per Unit	One time per Unit	Annual per kWh	One time per KWh	Annual per Therm
	Thermostat	Complaints					
Residential	Residential MF Refrigerator		$20.10				
Residential	Residential MF Refrigerator	Rental Units Marketability	$0.34				
Residential	Residential MF Refrigerator	Reduced Tenant Complaints	$12.90				
Residential	Residential MF Refrigerator	Property Durability	$6.86				
Residential	Residential MF Common-Area Lighting	O&M	$26.00		$0.03		
Residential	Residential MF Heat Pump		$5.70				
Residential	Residential MF Heat Pump	Noise Reduction	$2.50				
Residential	Residential MF Heat Pump	Home Durability	$1.17				
Residential	Residential MF Heat Pump	Thermal Comfort	$1.96				
Residential	Residential MF Heat Pump	Health Benefits	$0.07				
Residential	Residential MF DMSHP		$5.98				
Residential	Residential MF DMSHP	Noise Reduction	$1.41				
Residential	Residential MF DMSHP	Home Durability	$1.96				
Residential	Residential MF DMSHP	Thermal Comfort	$2.53				
Residential	Residential MF	Health Benefits	$0.08				

Sector	NEI Description	NEI Category	Annual per Unit	One time per Unit	Annual per kWh	One time per KWh	Annual per Therm
	DMSHP						
Residential	Residential Retail Thermostats		$3.63				
Residential	Residential Retail Thermostats	Thermal Comfort	$3.99				
Residential	Residential Retail Thermostats	Home Durability	$1.33				
Residential	Residential Retail Thermostats	Health Benefits	$0.13				
Residential	Residential Retail Air Conditioner		$8.98				
Residential	Residential Retail Air Conditioner	Thermal Comfort					
Residential	Residential Retail Air Conditioner	Noise Reduction					
Residential	Residential Retail Air Conditioner	Home Durability					
Residential	Residential Retail Air Conditioner	Equipment Maintenance					
Residential	Residential Retail Air Conditioner	Health Benefits					
Residential	Residential Retail Heat Pump		$-				
Residential	Residential Retail Heat Pump	Thermal Comfort					
Residential	Residential Retail Heat Pump	Home Durability					
Residential	Residential Retail Heat Pump	Equipment Maintenance					
Residential	Residential Retail Heat	Health Benefits					

Sector	NEI Description	NEI Category	Annual per Unit	One time per Unit	Annual per kWh	One time per KWh	Annual per Therm
	Pump						
Residential	Residential Retail Mini Split Heat Pump		$-				
Residential	Residential Retail Mini Split Heat Pump	Thermal Comfort					
Residential	Residential Retail Mini Split Heat Pump	Home Durability					
Residential	Residential Retail Mini Split Heat Pump	Equipment Maintenance					
Residential	Residential Retail Mini Split Heat Pump	Health Benefits					
Residential	Residential Retail Duct Sealing		$0.23				
Residential	Residential Retail Down size 1/2 ton		$0.64				
Residential	Residential Retail Down size 1/2 ton	Thermal Comfort	$0.19				
Residential	Residential Retail Down size 1/2 ton	Home Durability	$0.07				
Residential	Residential Retail Down size 1/2 ton	Equipment Maintenance	$0.37				
Residential	Residential Retail Down size 1/2 ton	Health Benefits	$0.01				
Residential	Residential Retail Digital Check up/tune up		$1.53				
Residential	Residential Retail Digital Check up/tune up	Thermal Comfort	$0.47				
Residential	Residential Retail	Home Durability	$0.18				

Sector	NEI Description	NEI Category	Annual per Unit	One time per Unit	Annual per kWh	One time per KWh	Annual per Therm
	Digital Check up/tune up						
Residential	Residential Retail Digital Check up/tune up	Equipment Maintenance	$0.87				
Residential	Residential Retail Digital Check up/tune up	Health Benefits	$0.01				
Residential	Residential Retail QIV		$1.53				
Residential	Residential Retail QIV	Thermal Comfort	$0.47				
Residential	Residential Retail QIV	Home Durability	$0.18				
Residential	Residential Retail QIV	Equipment Maintenance	$0.87				
Residential	Residential Retail QIV	Health Benefits	$0.01				
Residential	Residential - Moderate Income Boiler/Furnace		$170.01				
Residential	Residential - Moderate Income Boiler/Furnace	Thermal Comfort	$48.63				
Residential	Residential - Moderate Income Boiler/Furnace	Home Durability	$17.42				
Residential	Residential - Moderate Income Boiler/Furnace	Equipment Maintenance	$102.40				
Residential	Residential - Moderate Income Boiler/Furnace	Health Benefits	$1.56				
Residential	Residential - Moderate Income CAC/HP		$15.96				
Residential	Residential - Moderate Income CAC/HP	Thermal Comfort	$3.92				
Residential	Residential - Moderate Income CAC/HP	Home Durability	$1.54				

Sector	NEI Description	NEI Category	Annual per Unit	One time per Unit	Annual per kWh	One time per KWh	Annual per Therm
Residential	Residential - Moderate Income CAC/HP	Equipment Maintenance	$7.54				
Residential	Residential - Moderate Income CAC/HP	Health Benefits	$0.13				
Residential	Residential - Moderate Income CAC/HP	Noise Reduction	$2.83				
Residential	Residential - MSHP Displacing Electric Heat		$52.69				
Residential	Residential - MSHP Displacing Electric Heat						
Residential	Residential - MSHP Displacing Electric Heat						
Residential	Residential - MSHP Displacing Electric Heat						
Residential	Residential - MSHP Displacing Electric Heat						
Residential	Residential - MSHP Displacing Electric Heat						
Residential	Residential - Windows	Property Value Increase	$6.72				
Residential	Residential - Cooking Induction Stove		$105.95				
Residential	Residential - MSHP Integrated Controls Retrofit		$66.82				
Residential	Residential - Central		$15.91				

Sector	NEI Description	NEI Category	Annual per Unit	One time per Unit	Annual per kWh	One time per KWh	Annual per Therm
	HP partial displacement						
Residential	Residential - MSHP partial displacement		$23.86				
Residential	Residential - Central HP full displacement		$23.13				
Residential	Residential - MSHP full displacement		$27.02				
Residential	Residential - Air-to-Water displacement		$24.10				
Residential	Residential - GSHP displacement		$27.18				
Income Eligible	IE Rate-Discount Only		$-	$-	$0.05	$0.01	$-
Income Eligible	IE Rate-Discount Only	Rate Discounts			$0.05		$-
Income Eligible	IE Rate-Discount Only	Price Hedging				$0.01	
Income Eligible	IE SF Participant		$10.37	$56.00	$0.05	$0.01	$-
Income Eligible	IE SF Participant	Arrearages	$2.61				
Income Eligible	IE SF Participant	Bad Debt Write-offs	$3.74				
Income Eligible	IE SF Participant	Terminations and Reconnections	$0.43				
Income Eligible	IE SF Participant	Customer Calls and Collections	$0.58				
Income Eligible	IE SF Participant	Notices	$0.34				
Income	IE SF Participant	Improved Safety	$2.67				

Sector	NEI Description	NEI Category	Annual per Unit	One time per Unit	Annual per kWh	One time per KWh	Annual per Therm
Eligible							
Income Eligible	IE SF Participant	Lighting Quality and Lifetime		$56.00			
Income Eligible	IE SF Participant	Rate Discounts			$0.05		$-
Income Eligible	IE SF Participant	Price Hedging				$0.01	
Income Eligible	**IE SF Weatherization**		$558.21	$-	$0.05	$0.01	$-
Income Eligible	IE SF Weatherization	Thermal Comfort	$66.02				
Income Eligible	IE SF Weatherization	Noise Reduction	$29.95				
Income Eligible	IE SF Weatherization	Home Durability	$19.37				
Income Eligible	IE SF Weatherization	Health Benefits	$423.23				
Income Eligible	IE SF Weatherization	Improved Safety	$19.64				
Income Eligible	IE SF Weatherization	Rate Discounts			$0.05		$-
Income Eligible	IE SF Weatherization	Price Hedging				$0.01	
Income Eligible	**IE SF Air Sealing**		$295.21	$-	$0.05	$0.01	$-
Income Eligible	IE SF Air Sealing	Thermal Comfort	$35.89				
Income Eligible	IE SF Air Sealing	Noise Reduction	$16.39				
Income	IE SF Air Sealing	Home Durability	$10.61				

Sector	NEI Description	NEI Category	Annual per Unit	One time per Unit	Annual per kWh	One time per KWh	Annual per Therm
Eligible							
Income Eligible	IE SF Air Sealing	Health Benefits	$230.08				
Income Eligible	IE SF Air Sealing	Improved Safety	$2.24				
Income Eligible	IE SF Air Sealing	Rate Discounts			$0.05		$-
Income Eligible	IE SF Air Sealing	Price Hedging				$0.01	
Income Eligible	IE SF Insulation		$263.00	$-	$0.05	$0.01	$-
Income Eligible	IE SF Insulation	Thermal Comfort	$30.13				
Income Eligible	IE SF Insulation	Noise Reduction	$13.56				
Income Eligible	IE SF Insulation	Home Durability	$8.76				
Income Eligible	IE SF Insulation	Health Benefits	$193.15				
Income Eligible	IE SF Insulation	Improved Safety	$17.40				
Income Eligible	IE SF Insulation	Rate Discounts			$0.05		$-
Income Eligible	IE SF Insulation	Price Hedging				$0.01	
Income Eligible	IE Windows		$7.96				
Income Eligible	IE SF Heating System Retrofit		$310.82	$-	$0.05	$0.01	$-
Income	IE SF Heating System	Safety Related	$8.43				

Sector	NEI Description	NEI Category	Annual per Unit	One time per Unit	Annual per kWh	One time per KWh	Annual per Therm
Eligible	Retrofit	Emergency Calls					
Income Eligible	IE SF Heating System Retrofit	Thermal Comfort	$33.24				
Income Eligible	IE SF Heating System Retrofit	Equipment Maintenance	$9.72				
Income Eligible	IE SF Heating System Retrofit	Home Durability	$27.43				
Income Eligible	IE SF Heating System Retrofit	Health Benefits	$213.13				
Income Eligible	IE SF Heating System Retrofit	Improved Safety	$18.87				
Income Eligible	IE SF Heating System Retrofit	Rate Discounts			$0.05		$-
Income Eligible	IE SF Heating System Retrofit	Price Hedging	$-			$0.01	
Income Eligible	**IE SF Heat Pump**		$310.82	$-	$0.05	$0.01	$-
Income Eligible	IE SF Heat Pump	Home Durability	$9.72				
Income Eligible	IE SF Heat Pump	Thermal Comfort	$33.24				
Income Eligible	IE SF Heat Pump	Health Benefits	$213.13				
Income Eligible	IE SF Heat Pump	Equipment Maintenance	$27.43				
Income Eligible	IE SF Heat Pump	Improved Safety	$18.87				
Income Eligible	IE SF Heat Pump	Safety Related Emergency Calls	$8.43				
Income	IE SF Heat Pump	Rate Discounts			$0.05		$-

Sector	NEI Description	NEI Category	Annual per Unit	One time per Unit	Annual per kWh	One time per KWh	Annual per Therm
Eligible							
Income Eligible	IE SF Heat Pump	Price Hedging	$-			$0.01	
Income Eligible	IE SF HP Water Heater		$4.64	$-	$0.05	$0.01	$-
Income Eligible	IE SF HP Water Heater	Home Durability	$0.20				
Income Eligible	IE SF HP Water Heater	Improved Safety	$4.44				
Income Eligible	IE SF HP Water Heater	Rate Discounts			$0.05		$-
Income Eligible	IE SF HP Water Heater	Price Hedging				$0.01	
Income Eligible	IE SF Duct Sealing		$6.21	$-	$0.05	$0.01	$-
Income Eligible	IE SF Duct Sealing	Thermal Comfort	$0.81				
Income Eligible	IE SF Duct Sealing	Home Durability	$0.23				
Income Eligible	IE SF Duct Sealing	Health Benefits	$5.17				
Income Eligible	IE SF Duct Sealing	Rate Discounts			$0.05		$-
Income Eligible	IE SF Duct Sealing	Price Hedging				$0.01	
Income Eligible	IE SF Pipe Wrap		$48.94	$-	$0.05	$0.01	$-
Income Eligible	IE SF Pipe Wrap	Thermal Comfort	$6.60				
Income	IE SF Pipe Wrap	Health Benefits	$42.34				

Sector	NEI Description	NEI Category	Annual per Unit	One time per Unit	Annual per kWh	One time per KWh	Annual per Therm
Eligible							
Income Eligible	IE SF Pipe Wrap	Rate Discounts			$0.05		$-
Income Eligible	IE SF Pipe Wrap	Price Hedging				$0.01	
Income Eligible	IE SF Showerhead		$-	$1.72	$0.05	$0.01	$-
Income Eligible	IE SF Showerhead	Property Value Increase		$1.72			
Income Eligible	IE SF Showerhead	Rate Discounts			$0.05		$-
Income Eligible	IE SF Showerhead	Price Hedging				$0.01	
Income Eligible	IE SF Replacement Freezer		$1.40	$-	$0.05	$0.01	$-
Income Eligible	IE SF Replacement Freezer	Improved Safety	$1.40				
Income Eligible	IE SF Replacement Freezer	Property Value Increase		$26.61			
Income Eligible	IE SF Replacement Freezer	Rate Discounts			$0.05		$-
Income Eligible	IE SF Replacement Freezer	Price Hedging				$0.01	
Income Eligible	IE SF Refrigerator		$1.40	$-	$0.05	$0.01	$-
Income Eligible	IE SF Refrigerator	Improved Safety	$1.40				
Income Eligible	IE SF Refrigerator	Property Value Increase		$26.61			
Income	IE SF Refrigerator	Rate Discounts			$0.05		$-

Sector	NEI Description	NEI Category	Annual per Unit	One time per Unit	Annual per kWh	One time per KWh	Annual per Therm
Eligible							
Income Eligible	IE SF Refrigerator	Price Hedging				$0.01	
Income Eligible	**IE SF Thermostat**		44.53	0	$0.05	$0.01	$-
Income Eligible	IE SF Thermostat	Thermal Comfort	$5.78				
Income Eligible	IE SF Thermostat	Home Durability	$1.68				
Income Eligible	IE SF Thermostat	Health Benefits	$37.07				
Income Eligible	IE SF Thermostat	Rate Discounts			$0.05		$-
Income Eligible	IE SF Thermostat	Price Hedging				$0.01	
Income Eligible	**IE SF Window AC Replacement**		$49.50	$-	$0.05	$0.01	$-
Income Eligible	IE SF Window AC Replacement	Window Air Conditioner Replacement	$49.50				
Income Eligible	IE SF Window AC Replacement	Rate Discounts			$0.05		$-
Income Eligible	IE SF Window AC Replacement	Price Hedging				$0.01	
Income Eligible	**IE MF Participant**		$7.70	$56.00	$0.05	$0.01	$-
Income Eligible	IE MF Participant NEI	Arrearages	$2.61				
Income Eligible	IE MF Participant NEI	Bad Debt Write-offs	$3.74				

Sector	NEI Description	NEI Category	Annual per Unit	One time per Unit	Annual per kWh	One time per KWh	Annual per Therm
Income Eligible	IE MF Participant NEI	Terminations and Reconnections	$0.43				
Income Eligible	IE MF Participant NEI	Customer Calls and Collections	$0.58				
Income Eligible	IE MF Participant NEI	Notices	$0.34				
Income Eligible	IE MF Participant NEI	Lighting Quality and Lifetime		$56.00			
Income Eligible	IE MF Participant NEI	Rate Discounts			$0.05		$-
Income Eligible	IE MF Participant NEI	Price Hedging				$0.01	
Income Eligible	**IE MF Weatherization**		$771.73	$-	$0.05	$0.01	$-
Income Eligible	IE MF Weatherization	Thermal Comfort	$684.48				
Income Eligible	IE MF Weatherization	Health Benefits	$23.52				
Income Eligible	IE MF Weatherization	Home Productivity	$23.52				
Income Eligible	IE MF Weatherization	Improved Safety	$6.24				
Income Eligible	IE MF Weatherization	Noise Reduction	$29.95				
Income Eligible	IE MF Weatherization	Property Durability	$2.58				
Income Eligible	IE MF Weatherization	Rental Units Marketability	$0.07				
Income Eligible	IE MF Weatherization	Reduced Tenant Complaints	$1.37				

Sector	NEI Description	NEI Category	Annual per Unit	One time per Unit	Annual per kWh	One time per KWh	Annual per Therm
Income Eligible	IE MF Weatherization	Rate Discounts			$0.05		$-
Income Eligible	IE MF Weatherization	Price Hedging				$0.01	
Income Eligible	IE MF Air Sealing		$389.29	$-	$0.05	$0.01	$-
Income Eligible	IE MF Air Sealing	Thermal Comfort	$342.24				
Income Eligible	IE MF Air Sealing	Health Benefits	$11.76				
Income Eligible	IE MF Air Sealing	Home Productivity	$11.76				
Income Eligible	IE MF Air Sealing	Improved Safety	$3.12				
Income Eligible	IE MF Air Sealing	Noise Reduction	$16.39				
Income Eligible	IE MF Air Sealing	Property Durability	$2.58				
Income Eligible	IE MF Air Sealing	Rental Units Marketability	$0.07				
Income Eligible	IE MF Air Sealing	Reduced Tenant Complaints	$1.37				
Income Eligible	IE MF Air Sealing	Rate Discounts			$0.05		$-
Income Eligible	IE MF Air Sealing	Price Hedging				$0.01	
Income Eligible	IE MF Insulation		$391.20	$-	$0.05	$0.01	$-
Income Eligible	IE MF Insulation	Thermal Comfort	$342.24				

Sector	NEI Description	NEI Category	Annual per Unit	One time per Unit	Annual per kWh	One time per KWh	Annual per Therm
Income Eligible	IE MF Insulation	Health Benefits	$11.76				
Income Eligible	IE MF Insulation	Home Productivity	$11.76				
Income Eligible	IE MF Insulation	Improved Safety	$3.12				
Income Eligible	IE MF Insulation	Noise Reduction	$13.56				
Income Eligible	IE MF Insulation	Home Durability	$8.76				
Income Eligible	IE MF Insulation	Rate Discounts			$0.05		$-
Income Eligible	IE MF Insulation	Price Hedging				$0.01	
Income Eligible	**IE MF Heating**		$836.39	$-	$0.05	$0.01	$-
Income Eligible	IE MF Heating	Thermal Comfort	$741.52				
Income Eligible	IE MF Heating	Health Benefits	$25.48				
Income Eligible	IE MF Heating	Home Productivity	$25.48				
Income Eligible	IE MF Heating	Improved Safety	$6.76				
Income Eligible	IE MF Heating	Equipment Maintenance	$9.72				
Income Eligible	IE MF Heating	Home Durability	$27.43				
Income Eligible	IE MF Heating	Rate Discounts			$0.05		$-

Sector	NEI Description	NEI Category	Annual per Unit	One time per Unit	Annual per kWh	One time per KWh	Annual per Therm
Income Eligible	IE MF Heating	Price Hedging	$-			$0.01	
Income Eligible	**IE MF Heat Pump**		$123.91	$-	$0.05	$0.01	$-
Income Eligible	IE MF Heat Pump	Home Durability	$9.72				
Income Eligible	IE MF Heat Pump	Thermal Comfort	$28.01				
Income Eligible	IE MF Heat Pump	Health Benefits	$5.27				
Income Eligible	IE MF Heat Pump	Equipment Maintenance	$27.43				
Income Eligible	IE MF Heat Pump	Improved Safety	$45.05				
Income Eligible	IE MF Heat Pump	Safety Related Emergency Calls	$8.43				
Income Eligible	IE MF Heat Pump	Rate Discounts			$0.05		$-
Income Eligible	IE MF Heat Pump	Price Hedging	$-			$0.01	
Income Eligible	**IE MF Duct Sealing**		$1.04	$-	$0.05	$0.01	$-
Income Eligible	IE MF Duct Sealing	Thermal Comfort	$0.68				
Income Eligible	IE MF Duct Sealing	Home Durability	$0.23				
Income Eligible	IE MF Duct Sealing	Health Benefits	$0.13				
Income Eligible	IE MF Duct Sealing	Rate Discounts			$0.05		$-

Sector	NEI Description	NEI Category	Annual per Unit	One time per Unit	Annual per kWh	One time per KWh	Annual per Therm
Income Eligible	IE MF Duct Sealing	Price Hedging				$0.01	
Income Eligible	**IE MF Pipe Wrap**		**$6.61**	**$-**	**$0.05**	**$0.01**	**$-**
Income Eligible	IE MF Pipe Wrap	Thermal Comfort	$5.56				
Income Eligible	IE MF Pipe Wrap	Health Benefits	$1.05				
Income Eligible	IE MF Pipe Wrap	Rate Discounts			$0.05		$-
Income Eligible	IE MF Pipe Wrap	Price Hedging				$0.01	
Income Eligible	**IE MF Water Heater**		**$1.19**	**$-**	**$0.05**	**$0.01**	**$-**
Income Eligible	IE MF Water Heater	Rate Discounts			$0.05		$-
Income Eligible	IE MF Water Heater	Price Hedging				$0.01	
Income Eligible	IE MF Water Heater	Improved Safety	$0.61				
Income Eligible	IE MF Water Heater	Rental Units Marketability	$0.01				
Income Eligible	IE MF Water Heater	Property Durability	$0.37				
Income Eligible	IE MF Water Heater	Reduced Tenant Complaints	$0.20				
Income Eligible	**IE MF Showerhead**		**$0.58**	**$-**	**$0.05**	**$0.01**	**$-**
Income Eligible	IE MF Showerhead	Rate Discounts			$0.05		$-

Sector	NEI Description	NEI Category	Annual per Unit	One time per Unit	Annual per kWh	One time per KWh	Annual per Therm
Income Eligible	IE MF Showerhead	Price Hedging				$0.01	
Income Eligible	IE MF Showerhead	Rental Units Marketability	$0.01				
Income Eligible	IE MF Showerhead	Home Durability	$0.37				
Income Eligible	IE MF Showerhead	Reduced Tenant Complaints	$0.20				
Income Eligible	**IE MF Aerator**		$0.58	$-	$0.05	$0.01	$-
Income Eligible	IE MF Aerator	Rate Discounts			$0.05		$-
Income Eligible	IE MF Aerator	Price Hedging				$0.01	
Income Eligible	IE MF Aerator	Rental Units Marketability	$0.01				
Income Eligible	IE MF Aerator	Home Durability	$0.37				
Income Eligible	IE MF Aerator	Reduced Tenant Complaints	$0.20				
Income Eligible	**IE MF Thermostat**		$16.02	$-	$0.05	$0.01	$-
Income Eligible	IE MF Thermostat	Thermal Comfort	$4.87				
Income Eligible	IE MF Thermostat	Health Benefits	$0.92				
Income Eligible	IE MF Thermostat	Rental Unit Marketability	$0.11				
Income Eligible	IE MF Thermostat	Equipment Maintenance	$3.91				

Sector	NEI Description	NEI Category	Annual per Unit	One time per Unit	Annual per kWh	One time per KWh	Annual per Therm
		Reliability Due to Thermostats					
Income Eligible	IE MF Thermostat	Property Durability	$4.05				
Income Eligible	IE MF Thermostat	Reduced Tenant Complaints	$2.16				
Income Eligible	IE MF Thermostat	Rate Discounts			$0.05		$-
Income Eligible	IE MF Thermostat	Price Hedging				$0.01	
Income Eligible	IE MF Common Area Lighting		$29.64	$-	$0.08	$0.01	$-
Income Eligible	IE MF Common Area Lighting	Rate Discounts			$0.05		$-
Income Eligible	IE MF Common Area Lighting	Price Hedging				$0.01	
Income Eligible	IE MF Common Area Lighting	Lighting Quality and Lifetime	$29.64		$0.03		
Income Eligible	IE MF Freezer		$20.29	$-	$0.05	$0.01	$-
Income Eligible	IE MF Freezer	Rental Units Marketability	$0.34				
Income Eligible	IE MF Freezer	Property Durability	$12.90				
Income Eligible	IE MF Freezer	Reduced Tenant Complaints	$6.86				
Income Eligible	IE MF Freezer	Improved Safety	$0.19				
Income Eligible	IE MF Freezer	Rate Discounts			$0.05		$-

Sector	NEI Description	NEI Category	Annual per Unit	One time per Unit	Annual per kWh	One time per KWh	Annual per Therm
Income Eligible	IE MF Freezer	Price Hedging				$0.01	
Income Eligible	IE MF Refrigerator		$20.29	$-	$0.05	$0.01	$-
Income Eligible	IE MF Refrigerator	Rental Units Marketability	$0.34				
Income Eligible	IE MF Refrigerator	Property Durability	$12.90				
Income Eligible	IE MF Refrigerator	Reduced Tenant Complaints	$6.86				
Income Eligible	IE MF Refrigerator	Improved Safety	$0.19				
Income Eligible	IE MF Refrigerator	Rate Discounts			$0.05		$-
Income Eligible	IE MF Refrigerator	Price Hedging				$0.01	
Income Eligible	IE MF Window AC Replacement		$49.50	$-	$0.05	$0.01	$-
Income Eligible	IE MF Window AC Replacement	Window Air Conditioner Replacement	$49.50				
Income Eligible	IE MF Window AC Replacement	Rate Discounts			$0.05		$-
Income Eligible	IE MF Window AC Replacement	Price Hedging				$0.01	
Income Eligible	IE - MSHP Displacing Electric Heat		$52.69		$0.05	$0.01	
Income Eligible	IE - MSHP Displacing Electric Heat	Rate Discounts			$0.05		$-
Income	IE - MSHP Displacing	Price Hedging				$0.01	

Sector	NEI Description	NEI Category	Annual per Unit	One time per Unit	Annual per kWh	One time per KWh	Annual per Therm
Eligible	Electric Heat						
Income Eligible	IE - Central HP partial displacement		$15.91		`	$0.01	
Income Eligible	IE - Central HP partial displacement	Rate Discounts			`		$-
Income Eligible	IE - Central HP partial displacement	Price Hedging				$0.01	
Income Eligible	IE - MSHP partial displacement		$23.86		$0.05	$0.01	
Income Eligible	IE - MSHP partial displacement	Rate Discounts			$0.05		$-
Income Eligible	IE - MSHP partial displacement	Price Hedging				$0.01	
Income Eligible	IE - Central HP full displacement		$23.13		$0.05	$0.01	
Income Eligible	IE - Central HP full displacement	Rate Discounts			$0.05		$-
Income Eligible	IE - Central HP full displacement	Price Hedging				$0.01	
Income Eligible	IE - MSHP full displacement		$27.02		$0.05	$0.01	
Income Eligible	IE - MSHP full displacement	Rate Discounts			$0.05		$-
Income Eligible	IE - MSHP full displacement	Price Hedging				$0.01	

Sources:

Residential and Income Eligible NEIs are based on the following reports:

NMR Group, Inc., Tetra Tech (2011). *Massachusetts Special and Cross-Sector Studies Area, Residential and Low-Income Non-Energy Impacts (NEI) Evaluation.* Prepared for the Massachusetts Program Administrators.

NMR, ThreeCubed (2021). *Low-Income Multifamily Health- and Safety-Related NEIs Study.*

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ThreeCubed, NMR (2016). *Low-Income Single-Family Health- and Safety-Related Non-Energy Impacts (NEIs) Study*

NMR Group, Inc. (2018). *Market-Rate Multifamily NEI – Phase I Final Memo.*

NMR. (2022). [MA21X21-E-RHPNEI_Residential Heat Pump NEIs Study Interim Report_Final_2022](#)

NMR. (2022). [MA22X03-E-GSCNEI_Gas-to-Electric Stovetop NEIs Study Interim Report_Final_2022](#)

Source for lighting quality and price hedging NEIs for Low Income is *EMC (2012). Additional Non-Energy Impacts for Low Income Programs.*

Residential HVAC NEIs are based on NMR Group, Inc. (2011) but adjusted based on *NMR Group, Inc. (2013) Massachusetts Residential Non-Energy Impacts (NEIs): Deemed NEI Values Addressing Differences in NEIs for Heating, Cooling, and Water Heating Equipment that is Early Replacement Compared to Replace on Failure.*

Table B-2: Electric C&I Non-Energy Impacts

Sector	NEI Description	NEI Category	Annual per kWh
Commercial & Industrial	C&I New Custom Motors (including compressed air)	Total	$0.018
Commercial & Industrial	C&I New Custom Motors (including compressed air)	O&M	$0.002
Commercial & Industrial	C&I New Custom Motors (including compressed air)	nO&M, nH&S	$0.016
Commercial & Industrial	C&I New Custom Motors (including compressed air)	H&S	$-
Commercial & Industrial	C&I New Prescriptive Compressed Air	Total	$0.043
Commercial & Industrial	C&I New Prescriptive Compressed Air	O&M	$0.042
Commercial & Industrial	C&I New Prescriptive Compressed Air	nO&M, nH&S	$0.001
Commercial & Industrial	C&I New Prescriptive Compressed Air	H&S	$-
Commercial & Industrial	C&I New Custom HVAC	Total	$0.133
Commercial & Industrial	C&I New Custom HVAC	O&M	$(0.003)
Commercial & Industrial	C&I New Custom HVAC	nO&M, nH&S	$0.024
Commercial & Industrial	C&I New Custom HVAC	H&S	$0.112
Commercial & Industrial	C&I New Custom Process	Total	$0.091
Commercial & Industrial	C&I New Custom Process	O&M	$(0.001)
Commercial & Industrial	C&I New Custom Process	nO&M, nH&S	$0.092
Commercial & Industrial	C&I New Custom Process	H&S	$-

Commercial & Industrial	C&I New Custom Refrigeration	Total	$0.070
Commercial & Industrial	C&I New Custom Refrigeration	O&M	$(0.001)
Commercial & Industrial	C&I New Custom Refrigeration	nO&M, nH&S	$0.071
Commercial & Industrial	C&I New Custom Refrigeration	H&S	$-
Commercial & Industrial	C&I Retrofit Custom Motors (including compressed air)	Total	$0.018
Commercial & Industrial	C&I Retrofit Custom Motors (including compressed air)	O&M	$0.002
Commercial & Industrial	C&I Retrofit Custom Motors (including compressed air)	nO&M, nH&S	$0.016
Commercial & Industrial	C&I Retrofit Custom Motors (including compressed air)	H&S	$-
Commercial & Industrial	C&I Retrofit Custom HVAC	Total	$0.149
Commercial & Industrial	C&I Retrofit Custom HVAC	O&M	$0.013
Commercial & Industrial	C&I Retrofit Custom HVAC	nO&M, nH&S	$0.024
Commercial & Industrial	C&I Retrofit Custom HVAC	H&S	$0.112
Commercial & Industrial	C&I - Custom Lighting	Total	$0.096
Commercial & Industrial	C&I - Custom Lighting	O&M	$0.055
Commercial & Industrial	C&I - Custom Lighting	nO&M, nH&S	$0.041
Commercial & Industrial	C&I - Custom Lighting	H&S	$-
Commercial & Industrial	C&I - Prescriptive Lighting	Total	$0.047
Commercial &	C&I - Prescriptive Lighting	O&M	$0.023

Industrial			
Commercial & Industrial	C&I - Prescriptive Lighting	nO&M, nH&S	$0.024
Commercial & Industrial	C&I - Prescriptive Lighting	H&S	$-
Commercial & Industrial	**C&I Retrofit Custom Process**	Total	$0.098
Commercial & Industrial	C&I Retrofit Custom Process	O&M	$0.006
Commercial & Industrial	C&I Retrofit Custom Process	nO&M, nH&S	$0.092
Commercial & Industrial	C&I Retrofit Custom Process	H&S	$-
Commercial & Industrial	**C&I Retrofit Custom Refrigeration**	Total	$0.077
Commercial & Industrial	C&I Retrofit Custom Refrigeration	O&M	$0.006
Commercial & Industrial	C&I Retrofit Custom Refrigeration	nO&M, nH&S	$0.071
Commercial & Industrial	C&I Retrofit Custom Refrigeration	H&S	$-
Commercial & Industrial	**C&I - Prescriptive Refrigeration**	Total	$0.001
Commercial & Industrial	C&I - Prescriptive Refrigeration	O&M	$0.001
Commercial & Industrial	C&I - Prescriptive Refrigeration	nO&M, nH&S	$-
Commercial & Industrial	C&I - Prescriptive Refrigeration	H&S	$-
Commercial & Industrial	**C&I New CHP**	Total	$(0.013)
Commercial & Industrial	C&I New CHP	O&M	$(0.003)
Commercial & Industrial	C&I New CHP	nO&M, nH&S	$(0.010)

Commercial & Industrial	C&I New CHP	H&S	$-
Commercial & Industrial	**C&I Retrofit CHP**	Total	$0.003
Commercial & Industrial	C&I Retrofit CHP	O&M	$0.013
Commercial & Industrial	C&I Retrofit CHP	nO&M, nH&S	$(0.010)
Commercial & Industrial	C&I Retrofit CHP	H&S	$-
Commercial & Industrial	**C&I Comprehensive Design**	Total	$0.104
Commercial & Industrial	C&I Comprehensive Design	O&M	$0.012
Commercial & Industrial	C&I Comprehensive Design	nO&M, nH&S	$0.092
Commercial & Industrial	C&I Comprehensive Design	H&S	$-
Commercial & Industrial	**C&I Comprehensive Retrofit**	Total	$0.113
Commercial & Industrial	C&I Comprehensive Retrofit	O&M	$0.021
Commercial & Industrial	C&I Comprehensive Retrofit	nO&M, nH&S	$0.092
Commercial & Industrial	C&I Comprehensive Retrofit	H&S	$-
Commercial & Industrial	**C&I - Custom Hot Water & Other**	Total	$0.065
Commercial & Industrial	C&I - Custom Hot Water & Other	O&M	$(0.027)
Commercial & Industrial	C&I - Custom Hot Water & Other	nO&M, nH&S	$0.092
Commercial & Industrial	C&I - Custom Hot Water & Other	H&S	$-
Commercial &	**C&I - Foodservice**	Total	$0.005

Industrial			
Commercial & Industrial	C&I - Foodservice	O&M	$0.004
Commercial & Industrial	C&I - Foodservice	nO&M, nH&S	$-
Commercial & Industrial	C&I - Foodservice	H&S	$0.001
Commercial & Industrial	**C&I New Lighting Controls**	Total	$0.116
Commercial & Industrial	C&I New Lighting Controls	O&M	$0.046
Commercial & Industrial	C&I New Lighting Controls	nO&M, nH&S	$0.024
Commercial & Industrial	C&I New Lighting Controls	H&S	$0.046
Commercial & Industrial	**C&I Retrofit Lighting Controls**	Total	$0.130
Commercial & Industrial	C&I Retrofit Lighting Controls	O&M	$0.060
Commercial & Industrial	C&I Retrofit Lighting Controls	nO&M, nH&S	$0.024
Commercial & Industrial	C&I Retrofit Lighting Controls	H&S	$0.046
Commercial & Industrial	**C&I Retrofit Prescriptive Compressed Air**	Total	$0.006
Commercial & Industrial	C&I Retrofit Prescriptive Compressed Air	O&M	$0.005
Commercial & Industrial	C&I Retrofit Prescriptive Compressed Air	nO&M, nH&S	$0.001
Commercial & Industrial	C&I Retrofit Prescriptive Compressed Air	H&S	$-
Commercial & Industrial	**C&I Retrofit Prescriptive HVAC Controls (inc. EMS & Hotel Occ.)**	Total	$0.239
Commercial & Industrial	C&I Retrofit Prescriptive HVAC Controls (inc. EMS & Hotel Occ.)	O&M	$0.013

Commercial & Industrial	C&I Retrofit Prescriptive HVAC Controls (inc. EMS & Hotel Occ.)	nO&M, nH&S	$0.098
Commercial & Industrial	C&I Retrofit Prescriptive HVAC Controls (inc. EMS & Hotel Occ.)	H&S	$0.128
Commercial & Industrial	C&I New Prescriptive HVAC	Total	$0.095
Commercial & Industrial	C&I New Prescriptive HVAC	O&M	$(0.003)
Commercial & Industrial	C&I New Prescriptive HVAC	nO&M, nH&S	$0.098
Commercial & Industrial	C&I New Prescriptive HVAC	H&S	$-
Commercial & Industrial	C&I - Prescriptive Motors (including compressed air)	Total	$0.003
Commercial & Industrial	C&I - Prescriptive Motors (including compressed air)	O&M	$0.002
Commercial & Industrial	C&I - Prescriptive Motors (including compressed air)	nO&M, nH&S	$0.001
Commercial & Industrial	C&I - Prescriptive Motors (including compressed air)	H&S	$-
Commercial & Industrial	C&I Retrofit Prescriptive VFD	Total	$0.003
Commercial & Industrial	C&I Retrofit Prescriptive VFD	O&M	$0.002
Commercial & Industrial	C&I Retrofit Prescriptive VFD	nO&M, nH&S	$0.001
Commercial & Industrial	C&I Retrofit Prescriptive VFD	H&S	$-
Commercial & Industrial	C&I Retrocommissioning	Total	$0.269
Commercial & Industrial	C&I Retrocommissioning	O&M	$0.043
Commercial & Industrial	C&I Retrocommissioning	nO&M, nH&S	$0.098
Commercial &	C&I Retrocommissioning	H&S	$0.128

Industrial			
Commercial & Industrial	C&I Retrofit Showerheads & Building Operator Training	Total	$0.004
Commercial & Industrial	C&I Retrofit Showerheads & Building Operator Training	O&M	$0.004
Commercial & Industrial	C&I Retrofit Showerheads & Building Operator Training	nO&M, nH&S	$-
Commercial & Industrial	C&I Retrofit Showerheads & Building Operator Training	H&S	$-
Commercial & Industrial	C&I Retrofit Thermsotat	Total	$0.246
Commercial & Industrial	C&I Retrofit Thermsotat	O&M	$0.078
Commercial & Industrial	C&I Retrofit Thermsotat	nO&M, nH&S	$0.098
Commercial & Industrial	C&I Retrofit Thermsotat	H&S	$0.070
Commercial & Industrial	C&I New Prescriptive HVAC Controls (inc. EMS & Hotel Occ.)	Total	$0.223
Commercial & Industrial	C&I New Prescriptive HVAC Controls (inc. EMS & Hotel Occ.)	O&M	$(0.003)
Commercial & Industrial	C&I New Prescriptive HVAC Controls (inc. EMS & Hotel Occ.)	nO&M, nH&S	$0.098
Commercial & Industrial	C&I New Prescriptive HVAC Controls (inc. EMS & Hotel Occ.)	H&S	$0.128

Sources:

Commercial & Industrial NEIs are based on the following reports:

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DNV GL (2016). *Commercial and Industrial New Construction Non-Energy Impacts Study.*

NMR, DNV, ThreeCubed (2021). *O&M and Non-O&M NEI Study*

DNV. (2022). MA21X19-B-CIHSNE C&I Health & Safety NEI Study.

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Table B-3: Gas C&I Non-Energy Impacts

Sector	NEI Description	NEI Category	Annual per kWh	Annual per Therm
Commercial & Industrial	C&I - Other, Custom & Building Operator Certification & Codes and Standards	Total		$0.61
Commercial & Industrial	C&I - Other, Custom & Building Operator Certification & Codes and Standards	O&M		$0.61
Commercial & Industrial	C&I - Other, Custom & Building Operator Certification & Codes and Standards	nO&M, nH&S		$-
Commercial & Industrial	C&I - Other, Custom & Building Operator Certification & Codes and Standards	H&S		$-
Commercial & Industrial	C&I - New Bldg - Prescriptive - Commercial Kitchen, Gas	HS&E, Admin costs, material movement, other costs, other labor, O&M, product spoilage, waste disposal		$4.58
Commercial & Industrial	C&I - New Bldg - Prescriptive - Commercial Kitchen, Gas	O&M		$3.40
Commercial & Industrial	C&I - New Bldg - Prescriptive - Commercial Kitchen, Gas	nO&M, nH&S		$-
Commercial & Industrial	C&I - New Bldg - Prescriptive - Commercial Kitchen, Gas	H&S		$1.18
Commercial & Industrial	C&I - New Bldg - Custom - Commercial Kitchen, Gas	Admin costs, material movement, other costs, other labor, O&M, product spoilage, waste disposal		$3.40
Commercial & Industrial	C&I - New Bldg - Custom - Commercial Kitchen, Gas	O&M		$3.40
Commercial & Industrial	C&I - New Bldg - Custom - Commercial Kitchen, Gas	nO&M, nH&S		$-

Sector	NEI Description	NEI Category	Annual per kWh	Annual per Therm
Commercial & Industrial	C&I - New Bldg - Custom - Commercial Kitchen, Gas	H&S		$-
Commercial & Industrial	C&I - Custom Heating Systems & Controls			($0.05)
Commercial & Industrial	C&I - Custom Heating Systems & Controls	O&M		($0.10)
Commercial & Industrial	C&I - Custom Heating Systems & Controls	nO&M, nH&S		$0.03
Commercial & Industrial	C&I - Custom Heating Systems & Controls	H&S		$0.02
Commercial & Industrial	C&I - Custom Process - New	Total		($0.05)
Commercial & Industrial	C&I - Custom Process - New	O&M		($0.05)
Commercial & Industrial	C&I - Custom Process - New	nO&M, nH&S		$-
Commercial & Industrial	C&I - Custom Process - New	H&S		$-
Commercial & Industrial	C&I - Custom Process - Retrofit			($0.05)
Commercial & Industrial	C&I - Custom Process - Retrofit	O&M		($0.05)
Commercial & Industrial	C&I - Custom Process - Retrofit	nO&M, nH&S		$-
Commercial & Industrial	C&I - Custom Process - Retrofit	H&S		$-
Commercial & Industrial	C&I - Water Heating - Midstream	Total		$0.08
Commercial & Industrial	C&I - Water Heating - Midstream	O&M		($0.01)
Commercial & Industrial	C&I - Water Heating - Midstream	nO&M, nH&S		$0.09
Commercial & Industrial	C&I - Water Heating - Midstream	H&S		$-
Commercial & Industrial	C&I - Prescriptive Steam Trap & Pipe Wrap	Total		$0.08
Commercial & Industrial	C&I - Prescriptive Steam Trap & Pipe Wrap	O&M		($0.01)
Commercial & Industrial	C&I - Prescriptive Steam Trap & Pipe Wrap	nO&M, nH&S		$0.09

Sector	NEI Description	NEI Category	Annual per kWh	Annual per Therm
Commercial & Industrial	C&I - Prescriptive Steam Trap & Pipe Wrap	H&S		$-
Commercial & Industrial	C&I - Custom Hot Water - New	Total		$0.35
Commercial & Industrial	C&I - Custom Hot Water - New	O&M		($0.01)
Commercial & Industrial	C&I - Custom Hot Water - New	nO&M, nH&S		$0.36
Commercial & Industrial	C&I - Custom Hot Water - New	H&S		
Commercial & Industrial	C&I - Custom Steam & Hot Water - Retrofit	Total		$0.35
Commercial & Industrial	C&I - Custom Steam & Hot Water - Retrofit	O&M		($0.01)
Commercial & Industrial	C&I - Custom Steam & Hot Water - Retrofit	nO&M, nH&S		$0.36
Commercial & Industrial	C&I - Custom Steam & Hot Water - Retrofit	H&S		$-
Commercial & Industrial	C&I - Showerheads & Aerators - Retrofit	Total		$0.36
Commercial & Industrial	C&I - Showerheads & Aerators - Retrofit	O&M		$0.27
Commercial & Industrial	C&I - Showerheads & Aerators - Retrofit	nO&M, nH&S		$0.09
Commercial & Industrial	C&I - Showerheads & Aerators - Retrofit	H&S		$-
Commercial & Industrial	C&I - Custom Ozonated Laundry	Total		$0.45
Commercial & Industrial	C&I - Custom Ozonated Laundry	O&M		$0.09
Commercial & Industrial	C&I - Custom Ozonated Laundry	nO&M, nH&S		$0.36
Commercial & Industrial	C&I - Custom Ozonated Laundry	H&S		
Commercial & Industrial	C&I - Ductwork - Retrofit	Total		$0.59
Commercial & Industrial	C&I - Ductwork - Retrofit	O&M		($0.08)
Commercial & Industrial	C&I - Ductwork - Retrofit	nO&M, nH&S		$0.68

Sector	NEI Description	NEI Category	Annual per kWh	Annual per Therm
Commercial & Industrial	C&I - Ductwork - Retrofit	H&S		$-
Commercial & Industrial	C&I - Condensing Heating Systems			$0.61
Commercial & Industrial	C&I - Condensing Heating Systems	O&M		($0.10)
Commercial & Industrial	C&I - Condensing Heating Systems	nO&M, nH&S		$0.68
Commercial & Industrial	C&I - Condensing Heating Systems	H&S		$0.03
Commercial & Industrial	C&I - Pipe Wrap & Boiler Reset Controls - Retrofit	Total		$0.62
Commercial & Industrial	C&I - Pipe Wrap & Boiler Reset Controls - Retrofit	O&M		($0.08)
Commercial & Industrial	C&I - Pipe Wrap & Boiler Reset Controls - Retrofit	nO&M, nH&S		$0.68
Commercial & Industrial	C&I - Pipe Wrap & Boiler Reset Controls - Retrofit	H&S		$0.03
Commercial & Industrial	C&I - Prescriptive HVAC, Gas			$2.03
Commercial & Industrial	C&I - Prescriptive HVAC, Gas	O&M		$1.32
Commercial & Industrial	C&I - Prescriptive HVAC, Gas	nO&M, nH&S		$0.68
Commercial & Industrial	C&I - Prescriptive HVAC, Gas	H&S		$0.03
Commercial & Industrial	C&I - HVAC, Electrification		$0.15	
Commercial & Industrial	C&I - HVAC, Electrification	O&M		
Commercial & Industrial	C&I - HVAC, Electrification	nO&M, nH&S		
Commercial & Industrial	C&I - HVAC, Electrification	H&S		
Commercial & Industrial	C&I - Retrocomissioning, Gas	Total		$1.62
Commercial & Industrial	C&I - Retrocomissioning, Gas	O&M		$0.04
Commercial & Industrial	C&I - Retrocomissioning, Gas	nO&M, nH&S		$0.68

Sector	NEI Description	NEI Category	Annual per kWh	Annual per Therm
Commercial & Industrial	C&I - Retrocomissioning, Gas	H&S		$0.90
Commercial & Industrial	C&I - Existing - Custom - HVAC, Gas	Total		($0.04)
Commercial & Industrial	C&I - Existing - Custom - HVAC, Gas	O&M		($0.08)
Commercial & Industrial	C&I - Existing - Custom - HVAC, Gas	nO&M, nH&S		$0.03
Commercial & Industrial	C&I - Existing - Custom - HVAC, Gas	H&S		$0.01
Commercial & Industrial	C&I - Envelope, Comprehensive Design, & Comprehensive Retrofit	Total		$0.32
Commercial & Industrial	C&I - Envelope, Comprehensive Design, & Comprehensive Retrofit	O&M		$-
Commercial & Industrial	C&I - Envelope, Comprehensive Design, & Comprehensive Retrofit	nO&M, nH&S		$0.32
Commercial & Industrial	C&I - Envelope, Comprehensive Design, & Comprehensive Retrofit	H&S		$-
Commercial & Industrial	C&I Lighting - Custom, Gas	Administrative costs, material handling, material movement, other labor costs, O&M, sales revenue, waste disposal	$0.06	
Commercial & Industrial	C&I Lighting - Custom, Gas	O&M		
Commercial & Industrial	C&I Lighting - Custom, Gas	nO&M, nH&S		
Commercial & Industrial	C&I Lighting - Custom, Gas	H&S		
Commercial & Industrial	C&I - Custom Foodservice	Total		$4.58
Commercial & Industrial	C&I - Custom Foodservice	O&M		$3.40

Sector	NEI Description	NEI Category	Annual per kWh	Annual per Therm
Commercial & Industrial	C&I - Custom Foodservice	nO&M, nH&S		$-
Commercial & Industrial	C&I - Custom Foodservice	H&S		$1.18

Sources:

Commercial & Industrial NEIs are based on the following reports:

KEMA, Inc. (2012). *Massachusetts Program Administrators Final Report – Commercial and Industrial Non-Energy Impacts Study*

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NMR, DNV, ThreeCubed (2021). *O&M and Non-O&M NEI Study*

DNV. (2022). MA21X19-B-CIHSNE C&I Health & Safety NEI Study.

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Appendix C: Acronyms

ACRONYM DESCRIPTION

AC	Air Conditioning
AFUE	Annual Fuel Utilization Efficiency (see the Glossary)
AHU	Air Handling Unit
Btu	British Thermal Unit (see the Glossary)
CF	Coincidence Factor (see the Glossary)
CFL	Compact Fluorescent Lamp
CHP	Combined Heat and Power
COP	Coefficient of Performance (see the Glossary)
DCV	Demand Controlled Ventillation
DHW	Domestic Hot Water
DOER	Department of Energy Resources
DSM	Demand Side Management (see the Glossary)
ECM	Electrically Commutated Motor
EER	Energy Efficiency Ratio (see the Glossary)
EF	Efficiency Factor
EFLH	Equivalent Full Load Hours (see the Glossary)
ES	ENERGY STAR® (see the Glossary)
FCM	Forward Capacity Market
FR	Free-Ridership (see the Glossary)
HE	High-Efficiency
HID	High-Intensity Discharge (a lighting technology)
HP	Horse Power (see the Glossary)
HSPF	Heating Seasonal Performance Factor (see the Glossary)
HVAC	Heating, Ventilating, and Air Conditioning
ISO	Independent System Operator
ISR	In-Service Rate (see the Glossary)
kW	Kilowatt, a unit of electric demand equal to 1,000 watts
kWh	Kilowatt-Hour, a unit of energy (1 kilowatt of power supplied for one hour)
LED	Light-Emitting Diode (one type of solid-state lighting)
LCD	Liquid Crystal Display (a technology used for computer monitors and similar displays)
MMBtu	One million British Thermal Units (see "Btu" in the Glossary)
MW	Megawatt – a measure of electric demand equal to 1,000 kilowatts
MWh	Megawatt-hour – a measure of energy equal to 1,000 kilowatt-hours
NEB	Non-Electric Benefit (see the Glossary)
NEI	Non-Energy Impact
NE-ISO	New England Independent System Operator
NTG	Net-to-Gross (see the Glossary)
O&M	Operations and Maintenance
PA	Program Administrator (see the Glossary)
RR	Realization Rate (see the Glossary)
SEER	Seasonal Energy Efficiency Ratio (see the Glossary)
SO	Spillover (see the Glossary)

SPF   Savings Persistence Factor (see the Glossary)
SSL   Solid-State Lighting (e.g., LED lighting)
VSD   Variable-Speed Drive

Appendix D: Glossary

This glossary provides definitions as they are applied in this TRM for Massachusetts' energy efficiency programs. Alternate definitions may be used for some terms in other contexts.

TERM	DESCRIPTION
Adjusted Gross Savings	Gross savings (as calculated by the measure savings algorithms) that have been subsequently adjusted by the application of all impact factors except the net-to-gross factors (free-ridership and spillover). For more detail, see the section on Impact Factors for Calculating Adjusted Gross and Net Savings.
AFUE	Annual Fuel Utilization Efficiency. The measure of seasonal or annual efficiency of a furnace or boiler. AFUE takes into account the cyclic on/off operation and associated energy losses of the heating unit as it responds to changes in the load, which in turn is affected by changes in weather and occupant controls.
Baseline Efficiency	The level of efficiency of the equipment that would have been installed without any influence from the program or, for retrofit cases where site-specific information is available, the actual efficiency of the existing equipment.
Btu	British thermal unit. A Btu is approximately the amount of energy needed to heat one pound of water by one degree Fahrenheit.
Coefficient of Performance (COP)	Coefficient of Performance is a measure of the efficiency of a heat pump, air conditioner, or refrigeration system. A COP value is given as the Btu output of a device divided by the Btu input of the device. The input and output are determined at AHRI testing standards conditions designed to reflect peak load operation.
Coincidence Factor (CF)	Coincidence Factors:represent the fraction of connected load expected to occur concurrent to a particular system peak period; separate CF are found for summer and winter peaks. The CF given in the TRM includes both coincidence and diversity factors multiplied into one number. Coincidence Factors are provided for peak periods defined by the NE-ISO for FCM purposes and calculated consistent with the FCM methodology.
Connected Load kW Savings	The connected load kW savings is the power saved by the equipment while in use. In some cases the savings reflect the maximum power draw of equipment at full load. In other cases the connected load may be variable, which must be accounted for in the savings algorithm.
Deemed Savings	Savings values (electric, fossil fuel and/or non-energy benefits) determined from savings algorithms with assumed values for all algorithm parameters. Alternatively, deemed savings values may be determined from evaluation studies. A measure with deemed savings will have the same savings per unit since all measure assumptions are the same. Deemed savings are used by program administrators to report savings for measures with well-defined performance characteristics relative to baseline

	efficiency cases. Deemed savings can simplify program planning and design, but may lead to over- or under-estimation of savings depending on product performance.
Deemed Calculated Savings	Savings values (electric, fossil fuel and/or non-energy benefits) that depend on a standard savings algorithm and for which at least one of the algorithm parameters (e.g., hours of operation) is project specific.
Demand Savings	The reduction in demand due to installation of an energy efficiency measure, usually expressed as kW and measured at the customer's meter (see Connected Load kW Savings).
Demand Side Management (DSM)	Strategies used to manage energy demand including energy efficiency, load management, fuel substitution, and load building.
Diversity	A characteristic of a variety of electric loads whereby individual maximum demands occur at different times. For example, 50 efficient light fixtures may be installed, but they are not necessarily all on at the same time. See Coincidence Factor.
Diversity Factor	This TRM uses Coincidence Factors:that incorporate diversity (See Coincidence Factor), thus this TRM has no separate diversity factors. A diversity factor is typically calculated as: 1) the percent of maximum demand savings from energy efficiency measures available at the time of the company's peak demand, or 2) the ratio of the sum of the demands of a group of users to their coincident maximum demand.
End Use	Refers to the category of end use or service provided by a measure or technology (e.g., lighting, cooling, etc.). For the purpose of this manual, end uses with their codes include: ALght Lighting HEUBe Behavior HVAC HVAC Ienvl Insulation & Air Sealing CMoDr Motors & Drives JGchp Combined Heat & Power DRefr Refrigeration KSdhw Solar Hot Water EHoWa Hot Water LDmdR Demand Response FComA Compressed Air MPvEl Photovoltaic Panels GProc Process* *For residential measures, "process" is used for products that have low savings, such as consumer electronics, or do not conform to existing end use categories. For commercial and industrial measures, "process" is used for systematic improvements to manufacturing or pump systems, or efficient models of specialty equipment not covered in other end uses.
Energy Efficiency Ratio (EER)	The Energy Efficiency Ratio is a measure of the efficiency of a cooling system at a specified peak, design temperature, or outdoor temperature. In technical terms, EER is the steady-state rate of heat energy removal (i.e. cooling capacity) of a product measured in Btuh output divided by watts input.

ENERGY STAR® (ES)	Brand name for the voluntary energy efficiency labeling initiative sponsored by the U.S. Environmental Protection Agency.
Energy Costing Period	A period of relatively high or low system energy cost, by season. The energy periods defined by ISO-NE are: Summer Peak: 6am–10pm, Monday–Friday (except ISO holidays), June–September Summer Off-Peak: Summer hours not included in the summer peak hours: 10pm–6am, Monday–Friday, all day on Saturday and Sunday, and ISO holidays, June–September Winter Peak: 6am–10pm, Monday–Friday (except ISO holidays), January–May and October–December Winter Off-Peak: Winter hours not included in the sinter peak hours: 10pm–6am, Monday–Friday, all day on Saturday and Sunday, and ISO holidays, January–May and October–December.
Equivalent Full Load Hours (EFLH)	The equivalent hours that equipment would need to operate at its peak capacity in order to consume its estimated annual kWh consumption (annual kWh/connected kW).
Free Rider	A customer who participates in an energy efficiency program, but would have installed some or all of the same measure(s) on their own, with no change in timing of the installation, if the program had not been available.
Free-Ridership Rate	The percentage of savings attributable to participants who would have installed the measures in the absence of program intervention.
Gross kW	Expected demand reduction based on a comparison of standard or replaced equipment and equipment installed through an energy efficiency program.
Gross kWh	Expected kWh reduction based on a comparison of standard or replaced equipment and equipment installed through an energy efficiency program.
Gross Savings	A saving estimate calculated from objective technical factors. In this TRM, "gross savings" are calculated with the measure algorithms and do not include any application of impact factors. Once impact factors are applied, the savings are called "Adjusted Gross Savings". For more detail, see the section on Impact Factors for Calculating Adjusted Gross and Net Savings.
High Efficiency (HE)	Refers to the efficiency measures that are installed and promoted by the energy efficiency programs.
Horsepower (HP)	A unit for measuring the rate of doing work. One horsepower equals about three-fourths of a kilowatt (745.7 watts).
Heating Seasonal Performance Factor (HSPF)	A measure of the seasonal heating mode efficiencies of heat pumps expressed as the ratio of the total heating output to the total seasonal input energy.
Impact Factor	Generic term for a value used to adjust the gross savings estimated by the savings

	algorithms in order to reflect the actual savings attributable to the efficiency program. In this TRM, impact factors include realization rates, in-service rates, savings persistence, peak demand coincidence factors, free-ridership, spillover and net-to-gross factors. See the section on Impact Factors for more detail.
In-Service Rate	The percentage of units that are actually installed. For example, efficient lamps may have an in-service rate less than 100% since some lamps are purchased as replacement units and are not immediately installed. The in-service rate for most measures is 100%.
Measure Life	The number of years that an efficiency measure is expected to garner savings. These are generally based on engineering lives, but sometimes adjusted based on observations of market conditions.
Lost Opportunity	Refers to a measure being installed at the time of planned investment in new equipment or systems. Often this reflects either new construction, renovation, remodeling, planned expansion or replacement, or replacement of failure.
Measure	A product (a piece of equipment), combination of products, or process designed to provide energy and/or demand savings. Measure can also refer to a service or a practice that provides savings. Measure can also refer to a specific combination of technology and market/customer/practice/strategy (e.g., direct install low income CFL).
Net Savings	The final value of savings that is attributable to a program or measure. Net savings differs from gross savings (or adjusted gross savings) because it includes adjustments due to free-ridership and/or spillover. Net savings is sometimes referred to as "verified" or "final" savings. For more detail see the section on Impact Factors for Calculating Adjusted Gross and Net Savings.
Net-to-Gross Ratio	The ratio of net savings to the adjusted gross savings (for a measure or program). The adjusted gross savings include any adjustment by the impact factors other than free-ridership or spillover. Net-to-gross is usually expressed as a percent.
Non-Electric Benefits (NEBs)	Quantifiable benefits (beyond electric savings) that are the result of the installation of a measure. Fossil fuel, water, and maintenance are examples of non-electric benefits. Non-electric benefits can be negative (i.e. increased maintenance or increased fossil fuel usage which results from a measure) and therefore are sometimes referred to as "non-electric impacts".
Non-Participant	A customer who is eligible to participate in a program, but does not. A non-participant may install a measure because of a program, but the installation of the measure is not through regular program channels; as a result, their actions are normally only detected through evaluations.
On-Peak kW	See Summer/Winter On-peak kW
Operating Hours	Hours that a piece of equipment is expected to be in operation, not necessarily at full load (typically expressed per year).

Participant	A customer who installs a measure through regular program channels and receives any benefit (i.e. incentive) that is available through the program because of their participation. Free-riders are a subset of this group.
Prescriptive Measure	A prescriptive measure is generally offered by use of a prescriptive form with a prescribed incentive based on the parameters of the efficient equipment or practice.
Program Administrator (PA)	Massachusetts electric and natural gas distribution companies and municipal aggregators with certified energy plans. The Massachusetts PAs are The Berkshire Gas Company, Cape Light Compact JPE, Fitchburg Gas & Electric Light Company d/b/a Unitil, Liberty Utilities (New England Natural Gas Company) Corp. d/b/a Liberty, Massachusetts Electric Company, Nantucket Electric Company, Boston Gas Company and former Colonial Gas Company, each d/b/a National Grid, and NSTAR Electric Company, NSTAR Gas Company and Eversource Gas Company of Massachusetts, each d/b/a Eversource Energy.
Realization Rate (RR)	The ratio of measure savings developed from impact evaluations to the estimated measure savings derived from the TRM savings algorithms. This factor is used to adjust the estimated savings when significant justification for such adjustment exists. The components of the realization rate are described in detail in the section on Impact Factors.
Retrofit	The replacement of a piece of equipment or device before the end of its useful or planned life for the purpose of achieving energy savings. "Retrofit" measures are sometimes referred to as "early retirement" when the removal of the old equipment is aggressively pursued.
Savings Persistence Factor (SPF)	Percentage of first-year energy or demand savings expected to persist over the life of the installed energy efficiency equipment. The SPF is developed by conducting surveys of installed equipment several years after installation to determine the operational capability of the equipment. In contrast, *measure persistence* takes into account business turnover, early retirement of installed equipment, and other reasons the installed equipment might be removed or discontinued. Measure persistence is generally incorporated as part of the measure life, and therefore is not included as a separate impact factor.
Seasonal Energy Efficiency Ratio (SEER)	A measurement of the efficiency of a central air conditioner over an entire season. In technical terms, SEER is a measure of equipment the total cooling of a central air conditioner or heat pump (in Btu) during the normal cooling season as compared to the total electric energy input (in watt-hours) consumed during the same period.
Seasonal Peak kW	See Summer/Winter Seasonal Peak kW, and Summer/Winter On-Peak Peak kW.
Sector	A system for grouping customers with similar characteristics. For the purpose of this manual, the sectors are Commercial and Industrial (C&I), Small Business, Residential, and Low Income.
Spillover Rate	The percentage of savings attributable to the program, but additional to the gross

	(tracked) savings of a program. Spillover includes the effects of (a) participants in the program who install additional energy efficient measures outside of the program as a result of hearing about the program and (b) non-participants who install or influence the installation of energy efficient measures as a result of being aware of the program.
Summer/Winter On-Peak kW	The average demand reduction during the summer/winter on-peak period. The summer on-peak period is 1pm-5pm on non-holiday weekdays in June, July and August; the winter on-peak period is 5pm-7pm on non-holiday weekdays in December and January.
Summer/Winter Seasonal Peak kW	The demand reduction occurring when the actual, real-time hourly load for Monday through Friday on non-holidays, during the months of June, July, August, December, and January, as determined by the ISO, is equal to or greater than 90% of the most recent 50/50 system peak load forecast, as determined by the ISO, for the applicable summer or winter season.
Ton	Unit of measure for determining cooling capacity. One ton equals 12,000 Btu.
Watt	A unit of electrical power. Equal to 1/1000 of a kilowatt.