Massachusetts
Technical Reference Manual

for Estimating Savings from Energy Efficiency Measures

2025 – 2027 Three-Year Plan Version

October 31, 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, Low-Income, 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.

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

a. 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:
  - changes in baseline equipment or practices, affecting measure savings
  - changes in efficient equipment or practices, affecting measure savings
  - changes to deemed savings due the revised assumptions for algorithm parameter values (e.g., due to new market research or evaluation studies)
  - 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

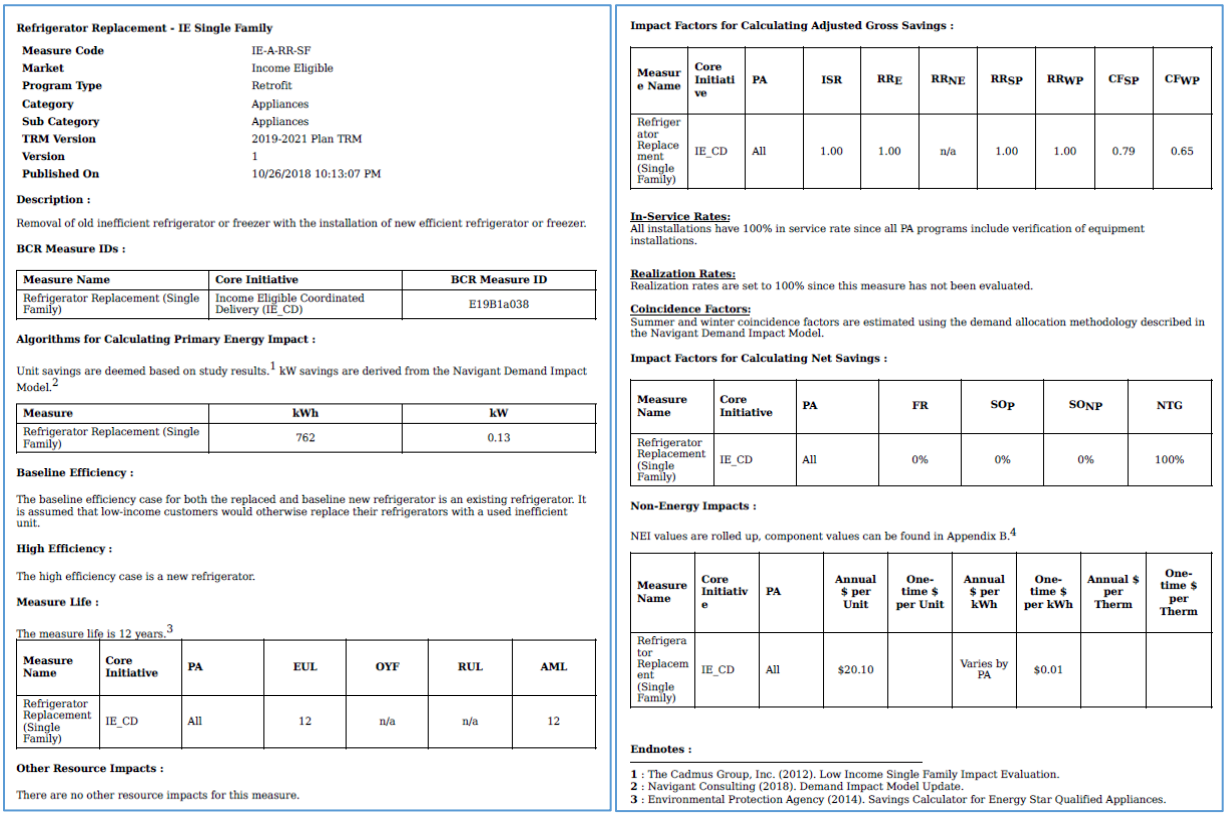
Per the Department, starting in 2022, new evaluation results will be applied on a prospective only basis instead of being applied both retrospectively and prospectively. The PAs will update gross savings assumptions and net and gross impact factors each year based on the latest evaluation studies and 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]

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

b. 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.



Refrigerator Replacement - IE Single Family

Measure Code	IE-A-RR-SF
Market	Income Eligible
Program Type	Retrofit
Category	Appliances
Sub Category	Appliances
TRM Version	2019-2021 Plan TRM
Version	1
Published On	10/26/2018 10:13:07 PM

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)	E19B1a038

Algorithms for Calculating Primary Energy Impact :

Unit savings are deemed based on study results.[1] kW savings are derived from the Navigant Demand Impact Model.[2]

Measure	kWh	kW
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 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 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	0.79	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 Navigant Demand Impact Model.

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%	0%	0%	100%

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
Refrigerator Replacement (Single Family)	IE_CD	All	$20.10		Varies by PA	$0.01		

Endnotes :

1 : The Cadmus Group, Inc. (2012). Low Income Single Family Impact Evaluation.
2 : Navigant Consulting (2018). Demand Impact Model Update.
3 : Environmental Protection Agency (2014). Savings Calculator for Energy Star Qualified Appliances.

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, Low-Income 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 like the following:
$\Delta kW = \left(Watts_{BASE} - Watts_{EE}\right)/1000$

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
	A1b - Residential Turnkey Solutions (1-4 units)	RES_TSSF
	A1c - Residential Turnkey Solutions (5+ units)	RES_TSMF
	A1d - Residential Rebates	RES_REB
	A1e - Residential Behavior	RES_BEHVR
	A1f - Residential ConnectedSolutions	RES_CS
Low-Income	B1a - Low Income - Single Family (1-4 units)	LI_SF
	B1b - Low Income - Multifamily (5+ units)	LI_MF
C&I	C1a - C&I New Buildings & Major Renovations	CI_NB&MR
	C1b - C&I Existing Buildings	CI_EXST
	C1c - C&I Small Business Turnkey Retrofit	CI_SBTR

c. 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	Residential Rebates (RES_REB)	EA1d056

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.[5]

Measure Name	ΔkWh	ΔkW
Clothes Dryer	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.[6]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Clothes Dryer	RES_REB	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}
Clothes Dryer	RES_REB	All	0.99	1.00	n/a	1.00	1.00	0.42	0.60

In-Service Rates:
The in-service rate is 99% based on evaluation results.[7]

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.[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
Clothes Dryer	RES_REB	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 (2023). MA RBUECS Demand Impact Model
2023_Guidehouse_MA_RBUECS_Demand_Impact_Model
6 : Guidehouse (2021). Comprehensive TRM Review. 2021_Guidehouse_TRM_Final_Report
7 : NMR Group, Inc. (2021). Residential Products NTG Report.
2021_NMR_Res_Products_NTG_Report
8 : Guidehouse (2023). MA RBUECS Demand Impact Model
2023_Guidehouse_MA_RBUECS_Demand_Impact_Model
9 : NMR Group, Inc. (2021). Residential Products NTG Report.
2021_NMR_Res_Products_NTG_Report

1.2 Appliance - Dehumidifier Recycling

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 Recycling	Residential Retail (RES_REB)	EA1d077

Algorithms for Calculating Primary Energy Impact:

Dehumidifier Recycling savings is from an evaluation 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
Dehumidifier Recycling	1,020	0.26

Baseline Efficiency:

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).[3]

High Efficiency:

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 4 years for dehumidifier recycling. [4]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Dehumidifier Recycling	RES_REB	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 Recycling	RES_REB	All	1.00	1.00	n/a	1.00	1.00	0.87	0.22

In-Service Rates:
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.[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
Dehumidifier Recycling	RES_REB	All	0.59	0.00	0.00	0.41

Non-Energy Impacts:

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

Endnotes:

1 : Guidehouse (2021). Appliance Recycling Impact Study
2021_Guidehouse_Appliance_Recycling_2019_Impact_Report
2 : Guidehouse (2023). MA RBUECS Demand Impact Model
2023_Guidehouse_MA_RBUECS_Demand_Impact_Model
3 : 2012 Federal Standard
4 : Guidehouse (2021). Comprehensive TRM Review. 2021_Guidehouse_TRM_Final_Report
5 : Guidehouse (2023). MA RBUECS Demand Impact Model
2023_Guidehouse_MA_RBUECS_Demand_Impact_Model
6 : 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
CW Electric & Dryer Electric	Residential Rebates (RES_REB)	EA1d060
CW Gas & Dryer Electric	Residential Rebates (RES_REB)	EA1d061
CW Electric & Dryer Gas	Residential Rebates (RES_REB)	EA1d062
CW Oil & Dryer Electric	Residential Rebates (RES_REB)	EA1d063
CW Gas & Dryer Gas	Residential Rebates (RES_REB)	EA1d064
CW Propane & Dryer Electric	Residential Rebates (RES_REB)	EA1d065
CW Gas & Dryer Electric	Residential Rebates (RES_REB)	GA1d023
CW Electric & Dryer Gas	Residential Rebates (RES_REB)	GA1d024
CW Gas & Dryer Gas	Residential Rebates (RES_REB)	GA1d025

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 = 295 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 = 0.85; recovery energy factor used to account for the difference in recovery efficiencies of electric and gas/oil/propane hot water heaters.
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 (for fossil fuel DHW)	8%	32%	60%	1.29	8.40	3.38
Existing-Top Loading CW (for electric DHW)	9%	26%	65%	1.29	8.40	3.38
New-Federal Standard	3%	40%	56%	1.57	6.47	3.90
New-Energy Star Standard	4%	31%	65%	2.06	3.20	3.90

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	40	0.01	0
Early Retirement CW (EE) Elec DHW & Elec Dryer	174	0.05	0
Early Retirement CW (Retire) Gas DHW & Elec Dryer	88.5	0.03	-0.14
Early Retirement CW (EE) Gas DHW & Elec Dryer	51.8	0.02	0.36
Early Retirement CW (Retire) Elec DHW & Gas Dryer	-49.6	-0.02	0.31
Early Retirement CW (EE) Elec DHW & Gas Dryer	124.7	0.03	0.17
Early Retirement CW (Retire) Gas DHW & Gas Dryer	37.4	0.01	0.03

Measure Name	ΔkWh	ΔkW	ΔMMBtu
Early Retirement CW (EE) Gas DHW & Gas Dryer	2.1	0	0.53
Early Retirement CW (Retire) Oil DHW & Elec Dryer	88.5	0.03	-0.14
Early Retirement CW (EE) Oil DHW & Elec Dryer	51.8	0.02	0.36
Early Retirement CW (Retire) Propane DHW & Elec Dryer	88.5	0.03	-0.14
Early Retirement CW (EE) Propane DHW & Elec Dryer	51.8	0.02	0.36

Weighted Average = ((Retire Savings * Retire Lifetime)+(EE savings * EE Lifetime))/EE Lifetime

For Electric BC Model

	BCR ID	ΔkWh	ΔkW	ΔMMBtu Oil	ΔMMBtu Propane	Water (Gallons)
CW Electric & Dryer Electric	EA1d060	187	0.08	-	-	4,069
CW Gas & Dryer Electric	EA1d061	81	0.03	-	-	4,069
CW Electric & Dryer Gas	EA1d062	108	0.03	-	-	4,069
CW Oil & Dryer Electric	EA1d063	81	0.03	0.31	-	4,069
CW Gas & Dryer Gas	EA1d064	15	0.00	-	-	4,069
CW Propane & Dryer Electric	EA1d065	81	0.03	-	0.31	4,069

For Gas BC model

	BCR ID	ΔkWh	ΔkW	ΔMMBtu Gas	Water (Gallons)
CW Gas & Dryer Electric	GA1d023	-	-	0.31	-
CW Electric & Dryer Gas	GA1d024	-	-	0.27	-
CW Gas & Dryer Gas	GA1d025	-	-	0.54	-

Baseline Efficiency:

It is assumed that the existing top loading clothes washer met the 2015 federal standard which was an IMEF > 1.29 and WF < 8.40. A new standard efficiency clothes washer meets the federal standard as of 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 with a minimum IMEF > 2.06 and IWF < 3.2.[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_REB	All	4	n/a	n/a	4
Early Retirement CW (EE)	RES_REB	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 937 gallons and 3,757 gallons for the EE portion. Total water savings are 4,694 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_REB	All	1.00	1.00	n/a	1.00	1.00	0.42	0.60
Early Retirement CW (EE)	RES_REB	All	1.00	1.00	n/a	1.00	1.00	0.42	0.60

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_REB	All	0.00	0.00	0.00	1.00
Early Retirement CW (EE)	RES_REB	All	0.00	0.00	0.00	1.00

Non-Energy Impacts:

There are no NEIs associated with this measure.

Endnotes:

1 : DOE (2012). Technical Support Document: Energy Efficiency Program for Consumer Products and Commercial and Industrial Equipment: Residential Clothes Washers.
DOE_2012_Technical_Support_Document_Clothes_Washers
2 : DOE (2012). Residential Clothes Washers Direct Final Rule Technical Support Document; Chapter 7. DOE_2012_Technical_Support_Document_Clothes_Washers
3 : Guidehouse (2023). MA RBUECS Demand Impact Model
2023_Guidehouse_MA_RBUECS_Demand_Impact_Model
4 : New Energy Star standard 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 (2023). MA RBUECS Demand Impact Model
2023_Guidehouse_MA_RBUECS_Demand_Impact_Model

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
HP Dryer - Compact	Residential Rebates (RES_REB)	EA1d066
HP Dryer - Standard	Residential Rebates (RES_REB)	EA1d067

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.[5]

Measure Name	ΔkWh	ΔkW	ΔTherms	ΔMMBTU (propane)
Heat Pump Dryer - Standard	161	0.05	5.1	0.02
Heat Pump Dryer - Compact	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.[6]

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.[7]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
HP Dryer - Compact HP Dryer - Standard	RES_REB	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}
HP Dryer - Compact HP Dryer - Standard	RES_REB	All	0.99	1.00	n/a	1.00	1.00	0.42	0.60

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.[8]

Impact Factors for Calculating Net Savings:

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
HP Dryer - Compact HP Dryer - Standard	RES_REB	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 : Guidehouse (2023). MA RBUECS Demand Impact Model 2023_Guidehouse_MA_RBUECS_Demand_Impact_Model
6 : https://www.govinfo.gov/content/pkg/CFR-2012-title10-vol3/pdf/CFR-2012-title10-vol3-sec430-32.pdf
7 : Guidehouse (2021). Comprehensive TRM Review. 2021_Guidehouse_TRM_Final_Report
8 : Guidehouse (2023). MA RBUECS Demand Impact Model 2023_Guidehouse_MA_RBUECS_Demand_Impact_Model

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 Rebates (RES_REB)	EA1d078
Refrigerator Recycling	Residential Rebates (RES_REB)	EA1d079

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	0.14
Refrigerator Recycling	1005	0.19

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_REB	All	4	n/a	n/a	4
Refrigerator Recycling	RES_REB	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_REB	All	1.00	0.83	0.83	0.83	0.83	0.70	0.90
Refrigerator Recycling	RES_REB	All	1.00	0.88	0.88	0.88	0.88	0.70	0.90

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_REB	All	0.50	0.00	0.00	0.50
Refrigerator Recycling	RES_REB	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 (2023). MA RBUECS Demand Impact Model
2023_Guidehouse_MA_RBUECS_Demand_Impact_Model
3 : Guidehouse (2021). Appliance Recycling Impact Study
2021_Guidehouse_Appliance_Recycling_2019_Impact_Report
4 : Guidehouse (2023). MA RBUECS Demand Impact Model
2023_Guidehouse_MA_RBUECS_Demand_Impact_Model
5 : NMR Group, Inc. (2021). Appliance Recycling NTG Report.
2021_NMR_Appliance_Recycling_NTG_Report

1.6 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 to change customers' energy-use behavior.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Home Energy Reports	Residential Behavior (RES_BEHVR)	GA1e001
Home Energy Reports	Residential Behavior (RES_BEHVR)	EA1e001

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.

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	RES_BEHVR	National Grid	Elec	1.00	0.95	n/a	0.95	0.95	0.55	0.85
Home Energy Reports	RES_BEHVR	CLC	Elec	1.00	1.04	n/a	1.00	1.00	0.55	0.85
Home Energy Reports	RES_BEHVR	Unitil	Elec	1.00	1.00	n/a	1.00	1.00	0.55	0.85
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	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:

PA realization rates are based on 2015 evaluation results.[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:

The PAs assume 100% net-to-gross.

Non-Energy Impacts:

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

Endnotes:

1 : Navigant Consulting and Illume Advising (2015). Behavior Program Evaluation Opower Results. Navigant_Illume_2014_Behavior_Program_Impact_Evaluation
2 : Guidehouse (2023). MA RBUECS Demand Impact Model
2023_Guidehouse_MA_RBUECS_Demand_Impact_Model

1.7 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	Residential Turnkey Solutions (1-4 units) (RES_TSSF)	EA1b001
Air Sealing, Gas	Residential Turnkey Solutions (1-4 units) (RES_TSSF)	EA1b002
Air Sealing, Oil	Residential Turnkey Solutions (1-4 units) (RES_TSSF)	EA1b003
Air Sealing, Other	Residential Turnkey Solutions (1-4 units) (RES_TSSF)	EA1b004
Moderate Income Qualified - Air Sealing, Electric	Residential Turnkey Solutions (1-4 units) (RES_TSSF)	EA1b009
Moderate Income Qualified - Air Sealing, Gas	Residential Turnkey Solutions (1-4 units) (RES_TSSF)	EA1b010
Moderate Income Qualified - Air Sealing, Oil	Residential Turnkey Solutions (1-4 units) (RES_TSSF)	EA1b011
Moderate Income Qualified - Air Sealing, Other	Residential Turnkey Solutions (1-4 units) (RES_TSSF)	EA1b012
Air Sealing, Gas	Residential Turnkey Solutions (1-4 units) (RES_TSSF)	GA1b001
Moderate Income Qualified - Air Sealing, Gas	Residential Turnkey Solutions (1-4 units) (RES_TSSF)	GA1b003
Air Sealing, Electric	Residential Turnkey Solutions (5+ units) (RES_TSMF)	EA1c001
Air Sealing, Gas	Residential Turnkey Solutions (5+ units) (RES_TSMF)	EA1c002
Air Sealing, Oil	Residential Turnkey Solutions (5+ units) (RES_TSMF)	EA1c003
Air Sealing, Other	Residential Turnkey Solutions (5+ units) (RES_TSMF)	EA1c004
Moderate Income Qualified - Air Sealing, Electric	Residential Turnkey Solutions (5+ units) (RES_TSMF)	EA1c042

Measure Name	Core Initiative	BCR Measure ID
Moderate Income Qualified - Air Sealing, Gas	Residential Turnkey Solutions (5+ units) (RES_TSMF)	EA1c043
Moderate Income Qualified - Air Sealing, Oil	Residential Turnkey Solutions (5+ units) (RES_TSMF)	EA1c044
Moderate Income Qualified - Air Sealing, Other	Residential Turnkey Solutions (5+ units) (RES_TSMF)	EA1c045
Air Sealing, Gas	Residential Turnkey Solutions (5+ units) (RES_TSMF)	GA1c001
Moderate Income Qualified - Air Sealing, Gas	Residential Turnkey Solutions (5+ units) (RES_TSMF)	GA1c027

Algorithms for Calculating Primary Energy Impact:

Residential Turnkey Solutions 1-4 Units:

The Program Administrators currently use vendor calculated gross energy savings for these measures in the Residential Turnkey Solutions 1-4 units 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, considering 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 0.00049.[1]

Electric kWh savings associated with cooling and distribution systems in fossil fuel heated homes is deemed and based on evaluation results.[2] Demand savings are derived from the demand impact model which is developed as part of the Residential Baseline Study.[3]

Measure Name	kWh	kW
Air Sealing, Gas	14	0.01
Air Sealing, Oil	12	0.01
Air Sealing, Other	7	0.00

Residential Turnkey Solutions 5+ Units:

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-to-ceiling 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[4] 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: 0.00049 kW/kWh[5]

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

TMYx - City/Station	HDD	CDH
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.[6] 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 multifamily, 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 5+ Units, 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.[7]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Air Sealing	RES_TSSF RES_TSMF	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	RES_TSSF	National Grid	1.00	0.13	n/a	0.13	0.13	0.00	0.58
Air Sealing, Gas	RES_TSSF	National Grid	1.00	1.00	0.47	1.00	1.00	0.54	0.19
Air Sealing, Oil	RES_TSSF	National Grid	1.00	1.00	0.42	1.00	1.00	0.54	0.19
Air Sealing, Other	RES_TSSF	National Grid	1.00	1.00	0.43	1.00	1.00	0.54	0.19
Air Sealing, Electric	RES_TSSF	Eversource	1.00	0.13	n/a	0.13	0.13	0.00	0.58
Air Sealing, Gas	RES_TSSF	Eversource	1.00	1.00	0.47	1.00	1.00	0.54	0.19
Air Sealing, Oil	RES_TSSF	Eversource	1.00	1.00	0.42	1.00	1.00	0.54	0.19
Air Sealing, Other	RES_TSSF	Eversource	1.00	1.00	0.43	1.00	1.00	0.54	0.19
Air Sealing, Electric	RES_TSSF	Unitil	1.00	0.13	n/a	0.13	0.13	0.00	0.58
Air Sealing, Gas	RES_TSSF	Unitil	1.00	1.00	0.47	1.00	1.00	0.54	0.19
Air Sealing, Oil	RES_TSSF	Unitil	1.00	1.00	0.42	1.00	1.00	0.54	0.19
Air Sealing, Other	RES_TSSF	Unitil	1.00	1.00	0.43	1.00	1.00	0.54	0.19
Air Sealing, Electric	RES_TSSF	CLC	1.00	0.13	1.00	0.13	0.13	0.00	0.58
Air Sealing, Gas	RES_TSSF	CLC	1.00	1.00	0.47	1.00	1.00	0.54	0.19
Air Sealing, Oil	RES_TSSF	CLC	1.00	1.00	0.42	1.00	1.00	0.54	0.19
Air Sealing, Other	RES_TSSF	CLC	1.00	1.00	0.43	1.00	1.00	0.54	0.19
Air Sealing, Gas	RES_TSSF	Berkshire	1.00	1.00	0.47	1.00	1.00	0.54	0.19
Air Sealing, Gas	RES_TSSF	Liberty	1.00	1.00	0.47	1.00	1.00	0.54	0.19
Air Sealing, Electric	RES_TSMF	All	1.00	0.86	1.00	0.86	0.86	0.00	0.43
Air Sealing, Oil	RES_TSMF	All	1.00	1.00	0.86	1.00	1.00	0.54	0.19
Air Sealing, Other	RES_TSMF	All	1.00	1.00	0.86	1.00	1.00	0.54	0.19
Air Sealing, Gas	RES_TSMF	All	1.00	1.00	0.86	1.00	1.00	0.54	0.19
Moderate Income Qualified - Air Sealing, Electric	RES_TSMF	All	1.00	0.86	1.00	0.86	0.86	0.00	0.43
Moderate Income Qualified - Air Sealing, Oil	RES_TSMF	All	1.00	1.00	0.86	1.00	1.00	0.54	0.19

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Moderate Income Qualified - Air Sealing, Other	RES_TSMF	All	1.00	1.00	0.86	1.00	1.00	0.54	0.19
Moderate Income Qualified - Air Sealing, Gas	RES_TSMF	All	1.00	1.00	0.86	1.00	1.00	0.54	0.19

In-Service Rates:

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

Realization Rates:

Realization rates for Single Family[8] and Multifamily[9] are based on evaluation results and are applied to the vendor estimated savings.

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.[10]

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	RES_TSSF	All	0.12	0.12	0.04	1.04
Air Sealing, Gas	RES_TSSF	All	0.19	0.12	0.04	0.97
Air Sealing, Oil	RES_TSSF	All	0.12	0.12	0.04	1.04
Air Sealing, Other	RES_TSSF	All	0.12	0.12	0.04	1.04
Moderate Income Qualified - Air Sealing, Electric	RES_TSSF	All	0.12	0.12	0.04	1.04
Moderate Income Qualified - Air Sealing, Gas	RES_TSSF	All	0.12	0.12	0.04	1.04
Moderate Income Qualified - Air Sealing, Oil	RES_TSSF	All	0.12	0.12	0.04	1.04
Moderate Income Qualified -	RES_TSSF	All	0.12	0.12	0.04	1.04

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Air Sealing, Other						
Air Sealing, Electric	RES_TSMF	All	0.14	0.0	0.0	0.86
Air Sealing, Gas	RES_TSMF	All	0.14	0.0	0.0	0.86
Air Sealing, Oil	RES_TSMF	All	0.14	0.0	0.0	0.86
Air Sealing, Other	RES_TSMF	All	0.14	0.0	0.0	0.86
Moderate Income Qualified - Air Sealing, Electric	RES_TSMF	All	0.14	0.0	0.0	0.86
Moderate Income Qualified - Air Sealing, Gas	RES_TSMF	All	0.14	0.0	0.0	0.86
Moderate Income Qualified - Air Sealing, Oil	RES_TSMF	All	0.14	0.0	0.0	0.86
Moderate Income Qualified - Air Sealing, Other	RES_TSMF	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. Moderate Income uses Low Income NEIs per agreement with DOER.

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	RES_TSMF	All	$19.35	$0.00	$0.00	$0.00	$0.00	$0.00
Air Sealing	RES_TSSF	All	$19.28	$0.00	$0.00	$0.00	$0.00	$0.00
Air Sealing Moderate Income	RES_TSSF	All	$295.21	$0.00	$0.00	$0.00	$0.00	$0.00
Air Sealing Moderate Income	RES_TSMF	All	$389.29	$0.00	$0.00	$0.00	$0.00	$0.00

Endnotes:

1 : Guidehouse (2023). MA RBUECS Demand Impact Model
2023_Guidehouse_MA_RBUECS_Demand_Impact_Model
2 : Guidehouse (2024). Massachusetts Residential Coordinated Delivery Single Family Impact Evaluation 2024_Guidehouse_RCD_SF_Impact_Eval
3 : Guidehouse (2023). MA RBUECS Demand Impact Model
2023_Guidehouse_MA_RBUECS_Demand_Impact_Model

4 : The Cadmus Group (2012). MARR Multifamily Impacts Analysis Report. CADMUS_2012_Multifamily_Impacts_Analysis_Report
5 : Guidehouse (2023). MA RBUECS Demand Impact Model 2023_Guidehouse_MA_RBUECS_Demand_Impact_Model
6 : DNV (2023). Massachusetts Typical Weather – Research and Dataset Development Study. 2023_DNV_MA_TMYx-Final_Report
7 : GDS_2007_Measure_Life_Report_Residential_and_CI_Lighting_and_HVAC_Measures GDS_2007_Measure_Life_Report_Residential_and_CI_Lighting_and_HVAC_Measures
8 : Guidehouse (2024). Massachusetts Residential Coordinated Delivery Single Family Impact Evaluation 2024_Guidehouse_RCD_SF_Impact_Eval
9 : Navigant Consulting (2018). Multi-Family Program Impact and Net-to-Gross Evaluation 2018_Navigant_Multifamily_Program_Impact_Evaluation
10 : Guidehouse (2023). MA RBUECS Demand Impact Model 2023_Guidehouse_MA_RBUECS_Demand_Impact_Model
11 : Guidehouse (2021). Residential Programs Net-to-Gross Research of RCD and Select Products Measures: Results Workbook 2021_Guidehouse_MA_Res_NTG_Final_Results_Workbook

1.8 Building Shell - Air Sealing Products

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 Products	Residential Rebates (RES_REB)	GA1d013
Air Sealing Products - Self Install	Residential Rebates (RES_REB)	EA1d083

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.[1]

Air Sealing, Electric	253	kWh	x 1%	2.74
Air Sealing, Gas	4.3	MMBtu	x 1%	0.043
Air Sealing, Oil	4.4	MMBtu	x 1%	0.044
Air Sealing, Other	3.2	MMBtu	x 1%	0.032

Electric, Oil and Other savings are weighted based on household heating fuel type from 2023 ACS data.[2]

Measure	Fuel Type	Savings	Savings	Savings
Air Sealing Products - Self Install	Electric	1.11 kWh	0.021 Oil MMBTUs	0.003 Other MMBTUs
Air Sealing Products	Gas	0.043 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 Products - Self Install Air Sealing Products	RES_REB	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_REB	All	0.50	1.00	1.00	1.00	1.00	0.00	0.58

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.[3]

Impact Factors for Calculating Net Savings:

NTG factors are assumed.

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Air Sealing Products - Self Install Air Sealing Products	RES_REB	All	0.50	0.00	0.00	0.50

Non-Energy Impacts:

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

Endnotes:

1 : Guidehouse (2024). Massachusetts Residential Coordinated Delivery Single Family Impact Evaluation 2024_Guidehouse_RCD_SF_Impact_Eval
2 : https://www.mass.gov/info-details/how-massachusetts-households-heat-their-homes#:~:text=How%20Massachusetts%20Heats%20Natural%20gas%20is%20currently%20the,with%20air%20source%20heat%20pumps%20leading%20the%20way.
3 : Guidehouse (2023). MA RBUECS Demand Impact Model
2023_Guidehouse_MA_RBUECS_Demand_Impact_Model

1.9 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	Residential Turnkey Solutions (1-4 units) (RES_TSSF)	EA1b005
Insulation, Gas	Residential Turnkey Solutions (1-4 units) (RES_TSSF)	EA1b006
Insulation, Oil	Residential Turnkey Solutions (1-4 units) (RES_TSSF)	EA1b007
Insulation, Other	Residential Turnkey Solutions (1-4 units) (RES_TSSF)	EA1b008
Moderate Income Qualified - Insulation, Electric	Residential Turnkey Solutions (1-4 units) (RES_TSSF)	EA1b013
Moderate Income Qualified - Insulation, Gas	Residential Turnkey Solutions (1-4 units) (RES_TSSF)	EA1b014
Moderate Income Qualified - Insulation, Oil	Residential Turnkey Solutions (1-4 units) (RES_TSSF)	EA1b015
Moderate Income Qualified - Insulation, Other	Residential Turnkey Solutions (1-4 units) (RES_TSSF)	EA1b016
Insulation, Gas	Residential Turnkey Solutions (1-4 units) (RES_TSSF)	GA1b002
Moderate Income Qualified - Insulation, Gas	Residential Turnkey Solutions (1-4 units) (RES_TSSF)	GA1b004
Insulation, Electric	Residential Turnkey Solutions (5+ units) (RES_TSMF)	EA1c005
Insulation, Gas	Residential Turnkey Solutions (5+ units) (RES_TSMF)	EA1c006
Insulation, Oil	Residential Turnkey Solutions (5+ units) (RES_TSMF)	EA1c007
Insulation, Other	Residential Turnkey Solutions (5+ units) (RES_TSMF)	EA1c008
Moderate Income Qualified - Insulation, Electric	Residential Turnkey Solutions (5+ units) (RES_TSMF)	EA1c046

Measure Name	Core Initiative	BCR Measure ID
Moderate Income Qualified - Insulation, Gas	Residential Turnkey Solutions (5+ units) (RES_TSMF)	EA1c047
Moderate Income Qualified - Insulation, Oil	Residential Turnkey Solutions (5+ units) (RES_TSMF)	EA1c048
Moderate Income Qualified - Insulation, Other	Residential Turnkey Solutions (5+ units) (RES_TSMF)	EA1c049
Insulation, Gas	Residential Turnkey Solutions (5+ units) (RES_TSMF)	GA1c002
Moderate Income Qualified - Insulation, Gas	Residential Turnkey Solutions (5+ units) (RES_TSMF)	GA1c028

Algorithms for Calculating Primary Energy Impact:

Residential Turnkey Solutions (1-4 units):

The Program Administrators currently use vendor calculated gross energy savings for these measures in the Residential Turnkey Solutions (1-4 units) 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)	0.00049
Insulation (Gas, Oil, Other)	0.00058

Electric kWh savings associated with cooling and distribution systems in fossil fuel heated homes is deemed and based on evaluation results.[2] Demand savings are derived from the demand impact model which is developed as part of the Residential Baseline Study. [3]

Measure	kWh	kW
Insulation, Gas	57	0.03
Insulation, Oil	54	0.03
Insulation, Other	32	0.02

Residential Turnkey Solutions (5+ units):

$MMBtu = ((1/R_{exist} - 1/R_{new})*HDD * 24 * Area) / (1000000 * \eta_{heat})$
$kWh = MMBtu * 293.1$
$kW = kWh * kW/kWh_{heat}$

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: 0.00049 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[4]
Area = Square footage of insulated area
η_{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: 0.00095 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.[5] 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 multifamily 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).[6]

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 (Rexist) plus the R-value of the added insulation.

Measure Life:

The measure life is 25 years.[7]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Insulation	RES_TSSF RES_TSMF	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	RES_TSSF	National Grid	1.00	0.13	1.00	0.13	0.13	0.00	0.58
Insulation, Gas	RES_TSSF	National Grid	1.00	1.00	0.47	1.00	1.00	0.54	0.19
Insulation, Oil	RES_TSSF	National Grid	1.00	1.00	0.42	1.00	1.00	0.54	0.19
Insulation, Other	RES_TSSF	National Grid	1.00	1.00	0.43	1.00	1.00	0.54	0.19
Insulation, Electric	RES_TSSF	Eversource	1.00	0.13	1.00	0.13	0.13	0.00	0.58
Insulation, Gas	RES_TSSF	Eversource	1.00	1.00	0.47	1.00	1.00	0.54	0.19
Insulation, Oil	RES_TSSF	Eversource	1.00	1.00	0.42	1.00	1.00	0.54	0.19
Insulation, Other	RES_TSSF	Eversource	1.00	1.00	0.43	1.00	1.00	0.54	0.19
Insulation, Electric	RES_TSSF	Unitil	1.00	0.13	1.00	0.13	0.13	0.00	0.58
Insulation, Gas	RES_TSSF	Unitil	1.00	1.00	0.47	1.00	1.00	0.54	0.19
Insulation, Oil	RES_TSSF	Unitil	1.00	1.00	0.42	1.00	1.00	0.54	0.19
Insulation, Other	RES_TSSF	Unitil	1.00	1.00	0.43	1.00	1.00	0.54	0.19
Insulation, Electric	RES_TSSF	CLC	1.00	0.13	1.00	0.13	0.13	0.00	0.58
Insulation, Oil	RES_TSSF	CLC	1.00	1.00	0.42	1.00	1.00	0.54	0.19

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Insulation, Other	RES_TSSF	CLC	1.00	1.00	0.43	1.00	1.00	0.54	0.19
Insulation, Gas	RES_TSSF	Berkshire	1.00	1.00	0.47	1.00	1.00	0.54	0.19
Insulation, Gas	RES_TSSF	Columbia	1.00	1.00	0.47	1.00	1.00	0.54	0.19
Insulation, Gas	RES_TSSF	Liberty	1.00	1.00	0.47	1.00	1.00	0.54	0.19
Insulation, Electric	RES_TSMF	All	1.00	0.86	n/a	0.86	0.86	0.00	0.43
Insulation, Gas	RES_TSMF	All	1.00	n/a	0.86	n/a	n/a	n/a	n/a
Insulation, Oil	RES_TSMF	All	1.00	n/a	0.86	n/a	n/a	n/a	n/a
Insulation, Other	RES_TSMF	All	1.00	n/a	0.86	n/a	n/a	n/a	n/a
Moderate Income Qualified - Insulation, Electric	RES_TSMF	All	1.00	0.86	n/a	0.86	0.86	0.00	0.43
Moderate Income Qualified - Insulation, Gas	RES_TSMF	All	1.00	n/a	0.86	n/a	n/a	n/a	n/a
Moderate Income Qualified - Insulation, Oil	RES_TSMF	All	1.00	n/a	0.86	n/a	n/a	n/a	n/a
Moderate Income Qualified - Insulation, Other	RES_TSMF	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 and applied to vendor estimated savaings.[8] [9]

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.[10]

Impact Factors for Calculating Net Savings:

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

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Insulation, Electric (Single Family)	RES_TSSF	All	0.12	0.12	0.04	1.04
Insulation, Gas (Single Family)	RES_TSSF	All	0.19	0.12	0.04	0.97
Insulation, Oil (Single Family)	RES_TSSF	All	0.12	0.12	0.04	1.04
Insulation, Other (Single Family)	RES_TSSF	All	0.12	0.12	0.04	1.04
Moderate Income Qualified - Insulation, Electric	RES_TSSF	All	0.12	0.12	0.04	1.04
Moderate Income Qualified - Insulation, Gas	RES_TSSF	All	0.19	0.12	0.04	0.97
Moderate Income Qualified - Insulation, Oil	RES_TSSF	All	0.12	0.12	0.04	1.04
Moderate Income Qualified - Insulation, Other	RES_TSSF	All	0.12	0.12	0.04	1.04
Insulation, Electric	RES_TSMF	All	0.14	0.00	0.00	0.86
Insulation, Gas	RES_TSMF	All	0.14	0.00	0.00	0.86
Insulation, Oil	RES_TSMF	All	0.14	0.00	0.00	0.86
Insulation, Other	RES_TSMF	All	0.14	0.00	0.00	0.86
Moderate Income Qualified - Insulation, Electric	RES_TSMF	All	0.14	0.00	0.00	0.86
Moderate Income Qualified - Insulation, Gas	RES_TSMF	All	0.14	0.00	0.00	0.86
Moderate Income Qualified - Insulation, Oil	RES_TSMF	All	0.14	0.00	0.00	0.86
Moderate Income Qualified - Insulation, Other	RES_TSMF	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. Moderate Income uses Low Income NEIs per agreement with DOER.

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	RES_TSSF	All	$47.31	$0.00	$0.00	$0.00	$0.00	$0.00
Moderate Income Qualified Insulation	RES_TSSF	All	$263.00	$0.00	$0.00	$0.00	$0.00	$0.00
Insulation	RES_TSMF	All	$47.31	$0.00	$0.00	$0.00	$0.00	$0.00
Moderate Income Qualified Insulation	RES_TSMF	All	$391.20	$0.00	$0.00	$0.00	$0.00	$0.00

Endnotes:

1 : Guidehouse (2023). MA RBUECS Demand Impact Model 2023_Guidehouse_MA_RBUECS_Demand_Impact_Model
2 : Guidehouse (2024). Massachusetts Residential Coordinated Delivery Single Family Impact Evaluation 2024_Guidehouse_RCD_SF_Impact_Eval
3 : 2023_Guidehouse_MA_RBUECS_Demand_Impact_Model
4 : The Cadmus Group (2012). Massachusetts 2011 Residential Retrofit Multifamily Program Impact Analysis. CADMUS_2012_Multifamily_Impacts_Analysis_Report
5 : DNV (2023). Massachusetts Typical Weather – Research and Dataset Development Study. 2023_DNV_MA_TMYx-Final_Report
6 : Assumptions from National Grid program vendor.
7 : 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
8 : Guidehouse (2024). Massachusetts Residential Coordinated Delivery Single Family Impact Evaluation 2024_Guidehouse_RCD_SF_Impact_Eval
9 : Navigant Consulting (2018). Multi-Family Program Impact and Net-to-Gross Evaluation. 2018_Navigant_Multifamily_Program_Impact_Evaluation
10 : Guidehouse (2023). MA RBUECS Demand Impact Model 2023_Guidehouse_MA_RBUECS_Demand_Impact_Model
11 : 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 - 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
Windows	Residential Rebates (RES_REB)	EA1d074
Windows	Residential Rebates (RES_REB)	GA1d012

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	RES_REB	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/Oil/Propane Heat	RES_REB	All	1.00	1.00	n/a	1.00	1.00	0.54	0.19
Window - Gas Heating	RES_REB	All	1.00	1.00	n/a	1.00	1.00	0.54	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:

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_REB	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 $ per Unit	Annual $ per kWh	One-time $ per KWh	Annual $ per Therm	One-time $ per Therm
Window	RES_REB	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 (2023). MA RBUECS Demand Impact Model.

2023_Guidehouse_MA_RBUECS_Demand_Impact_Model
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

1.11 Cooking - Induction Stove

Measure Code	RES-FS-ISP
Market	Residential
Program Type	Lost Opportunity
Category	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 Gas	Residential Rebates (RES_REB)	GA1d026
Induction Stove replacing Propane	Residential Rebates (RES_REB)	EA1d072

Algorithms for Calculating Primary Energy Impact:

Unit 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	**Gas/Propane MMBTUs**
Induction Stove	RES_REB	-251	-0.06	2.10

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_REB	All	16	n/a	n/a	16

Other Resource Impacts:

There are no other resource impacts.

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_REB	All	1.00	1.00	1.00	1.00	1.00	0.30	0.62

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.[4]

Impact Factors for Calculating Net Savings:

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Induction Stove	RES_REB	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.[5] 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	RES_REB	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 (2023). MA RBUECS Demand Impact Model 2023_Guidehouse_MA_RBUECS_Demand_Impact_Model
3 : Frontier Energy (2019). Residential Cooktop Performance and Energy Comparison Study. 2019_Frontier_Energy_Residential_Cooktop_Performance_and_Energy_Comparison_Study
4 : Guidehouse (2023). MA RBUECS Demand Impact Model 2023_Guidehouse_MA_RBUECS_Demand_Impact_Model
5 : NMR (2022) : Gas-to-induction stovetop NEI study 2022_NMR_MA22X03-E-GSCNEI_Gas-to-Induction Stovetop NEIs Study_ Final Report_1

1.12 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 - Motors & VFD	Residential Turnkey Solutions (5+ units) (RES_TSMF)	EA1c026
Custom - HVAC	Residential Turnkey Solutions (5+ units) (RES_TSMF)	EA1c027
Custom - Water Heating	Residential Turnkey Solutions (5+ units) (RES_TSMF)	EA1c028
Custom - Other	Residential Turnkey Solutions (5+ units) (RES_TSMF)	EA1c029
Custom - Building Shell	Residential Turnkey Solutions (5+ units) (RES_TSMF)	EA1c030
Custom - HPWH	Residential Turnkey Solutions (5+ units) (RES_TSMF)	EA1c031
Custom - Heating Systems Replacement	Residential Turnkey Solutions (5+ units) (RES_TSMF)	EA1c032
Custom - HVAC	Residential Turnkey Solutions (5+ units) (RES_TSMF)	GA1c014
Custom - Water Heating	Residential Turnkey Solutions (5+ units) (RES_TSMF)	GA1c015
Custom - Other	Residential Turnkey Solutions (5+ units) (RES_TSMF)	GA1c024
Custom - Building Shell	Residential Turnkey Solutions (5+ units) (RES_TSMF)	GA1c025
Custom - Heating Systems Replacement	Residential Turnkey Solutions (5+ units) (RES_TSMF)	GA1c026

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 - Motors & VFD	RES_TSMF	Statewide	custom	n/a	n/a	custom
Custom - HVAC	RES_TSMF	Statewide	custom	n/a	n/a	custom
Custom - Water Heating	RES_TSMF	Statewide	custom	n/a	n/a	custom
Custom - Other	RES_TSMF	Statewide	custom	n/a	n/a	custom
Custom - Building Shell	RES_TSMF	Statewide	custom	n/a	n/a	custom
Custom - HPWH	RES_TSMF	Statewide	custom	n/a	n/a	custom
Custom - Heating Systems Replacement	RES_TSMF	Statewide	custom	n/a	n/a	custom
Custom - HVAC	RES_TSMF	Statewide	custom	n/a	n/a	custom
Custom - Water Heating	RES_TSMF	Statewide	custom	n/a	n/a	custom
Custom - Other	RES_TSMF	Statewide	custom	n/a	n/a	custom
Custom - Building Shell	RES_TSMF	Statewide	custom	n/a	n/a	custom
Custom - Heating Systems Replacement	RES_TSMF	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 - Motors & VFD	RES_TSMF	All	1.00	0.86	0.86	0.86	0.86	0.55	0.46

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Custom - HVAC	RES_TSMF	All	1.00	0.86	0.86	0.86	0.86	0.54	0.19
Custom - Water Heating	RES_TSMF	All	1.00	0.86	0.86	0.86	0.86	0.30	0.62
Custom - Other	RES_TSMF	All	1.00	0.86	0.86	0.86	0.86	0.30	0.62
Custom - Building Shell	RES_TSMF	All	1.00	0.86	0.86	0.86	0.86	0.54	0.19
Custom - HPWH	RES_TSMF	All	1.00	0.86	0.86	0.86	0.86	0.30	0.62
Custom - Heating Systems Replacement	RES_TSMF	All	1.00	0.86	0.86	0.86	0.86	0.00	0.58

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 and are applied to custom savings.[1]

Coincidence Factors:

Summer and winter coincidence factors are estimated on a custom basis or by 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_TSMF	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] [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
Custom - Motors & VFD, Elec	RES_TSMF	Statewide			$0.018			

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 - HVAC, Elec	RES_TSMF	Statewide			$0.149			
Custom - Water Heating, Elec	RES_TSMF	Statewide			$0.065			
Custom - Other, Elec	RES_TSMF	Statewide			$0.065			
Custom - Building Shell, Elec	RES_TSMF	Statewide			$0.149			
Custom - HPWH, Elec	RES_TSMF	Statewide			$0.065			
Custom - Heating Systems Replacement	RES_TSMF	Statewide	$392.92					
Custom - HVAC, Gas	RES_TSMF	Statewide					($0.037)	
Custom - Water Heating, Gas	RES_TSMF	Statewide					$0.35	
Custom - Other, Gas	RES_TSMF	Statewide					($0.045)	
Custom - Building Shell, Gas	RES_TSMF	Statewide					$0.32	

Endnotes:

1 : Navigant Consulting (2018). Multi-Family Program Impact and Net-to-Gross Evaluation. 2018_Navigant_Multifamily_Program_Impact_Evaluation
2 : Guidehouse (2023). MA RBUECS Demand Impact Model 2023_Guidehouse_MA_RBUECS_Demand_Impact_Model
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
5 : NMR (2022). Residential Heat Pump NEIs Study 2022_NMR_MA_Res_HP_NEI_Final_Report

1.13 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 ConnectedSolutions (RES_CS)	EA1f001
Daily Battery Dispatches	Residential ConnectedSolutions (RES_CS)	EA1f002
Direct Load Control (Rate Discount Customers)	Residential ConnectedSolutions (RES_CS)	EA1f003

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 Low-Income 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	Residential Connected Solutions (RES_CS)	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	Residential Connected Solutions (RES_CS)	All	1.00	1.00	1.00	1.00	1.00	1.00	0.00
Storage Daily Dispatch, discharge (savings) Summer	Residential Connected Solutions (RES_CS)	All	1.00	1.00	1.00	1.00	1.00	1.00	0.00
Storage Daily Dispatch, charge (consumption) Summer	Residential Connected Solutions (RES_CS)	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	Residential Connected Solutions (RES_CS)	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

1.14 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 HP (EE)	Residential Rebates (RES_REB)	EA1d075
Central HP (Cooling)	Residential Rebates (RES_REB)	EA1d081

Algorithms for Calculating Primary Energy Impact:

Central Heat Pump, No Integrated Controls:

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 HP (EE)	Electric	17.6	9.81	3.03	419 (cool) 1,200 (heat)	506	0.00117 (winter)	0.59

Central Heat Pump, Cooling Only

Unit savings are deemed based on a per ton savings. Savings were developed from the Massachusetts and Connecticut Heat Pump Metering Study (MA22R51-B-HPMS)[4] which metered heat pump usage and performance in homes across MA and CT.

Measure Name	ΔkWh/Ton	ΔkW/Ton
Central HP (Cooling)	69	0.07

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.

Central Heat Pump, Cooling Only:

The baseline is an existing central air conditioning system.

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.

Central Heat Pump, Cooling Only

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 HP (EE)	RES_REB	All	18	n/a	6	15
Central HP (Cooling)	RES_REB	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}
Central HP (EE)	RES_REB	All	1.00	1.00	1.00	1.00	1.00	0.54	0.06
Central HP (Cooling)	RES_REB	All	1.00	1.00	1.00	1.00	1.00	0.54	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.[6]

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 HP (EE)[7]	RES_REB	All	0.34	0.12	0.10	0.88
Central HP (Cooling)	RES_REB	All	0.34	0.12	0.10	0.88

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
Central HP (EE)	RES_REB	All	$8.11					
Central HP (Cooling)	RES_REB	All	$4.21					

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 : Guidehouse (2024) - Massachusetts and Connecticut Heat Pump Metering Study (MA22R51-B-HPMS)

5 : 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

6 : Guidehouse (2023). Baseline Demand Impact Model 2023_Guidehouse_MA_RBUECS_Demand_Impact_Model

7 : 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

1.15 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
Boiler Reset Control	Residential Turnkey Solutions (1-4 units) (RES_TSSF)	GA1b013
Room Response Boiler Reset Control	Residential Rebates (RES_REB)	EA1d048
Boiler Reset Control	Residential Rebates (RES_REB)	EA1d049
Boiler Reset Control	Residential Rebates (RES_REB)	GA1d001
Room Response Boiler Reset Control	Residential Rebates (RES_REB)	GA1d020
Boiler Reset Control - Midstream	Residential Rebates (RES_REB)	GA1d021

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	4.3

Measure Name	ΔMMBtu
Room Response Boiler Reset Control	2.2

Weighted averages for BC model

Measure Name	BCR ID	Δ Oil MMBTUs	Δ Propane MMBTUs
Boiler Reset Control	EA1d049	3.9	0.4

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	All	All	15	n/a	n/a	15
Room Response Boiler Reset Control	All	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	RES_REB	All	1.00	n/a	1.00	n/a	n/a	n/a	n/a
Room Response Boiler Reset Control	RES_REB	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[4]	BCR Measure ID	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Boiler Reset Control, Gas - Midstream	GA1d021	RES_REB	All	0.36	0.12	0.00	0.76
Boiler Reset Control - Midstream	EA1d049	RES_REB	All	0.33	0.12	0.01	0.80
Boiler Reset Control, Gas	GA1b013	RES_TSSF	All	0.36	0.12	0.00	0.76
Boiler Reset Control, Gas	GA1d001	RES_REB	All	0.36	0.12	0.00	0.76
Room Response Boiler Reset Control	EA1d048	RES_REB	All	0.33	0.12	0.01	0.80
Room Response Boiler Reset Control, Gas	GA1d020	RES_REB	All	0.36	0.12	0.00	0.76

Non-Energy Impacts:

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

Endnotes:

1 : Guidehouse (2024). Massachusetts Residential Coordinated Delivery Single Family Impact Evaluation. 2024_Guidehouse_RCD_SF_Impact_Eval
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 : ACEEE (2006). Emerging Technologies Report Advanced Boiler Controls. ACEEE_2006_Emerging_Technologies_Report_Advanced_Boiler_Controls (002)
4 : Guidehouse (2021). Residential Programs Net-to-Gross Research of RCD and Select Products Measures. 2021_Guidehouse_MA_Res_NTG_Final_Report

1.16 HVAC - CVEO Battery Storage Dispatch

Measure Code	RES-HVAC-CVEO-BAT
Market	Residential
Program Type	Active Demand Response
Category	Heating Ventilation and Air Conditioning

Measure Description:

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.

BCR Measure IDs:

Measure	Core Initiative	BCR Measure ID
CVEO Low Income - Battery Storage Daily Dispatch, discharge (savings) Summer	Residential ConnectedSolutions (RES_CS)	CVEO13
CVEO Low Income - Battery Storage Daily Dispatch, charge (consumption) Summer	Residential ConnectedSolutions (RES_CS)	CVEO14
CVEO Affordable - Battery Storage Daily Dispatch, discharge (savings) Summer	Residential ConnectedSolutions (RES_CS)	CVEO19
CVEO Affordable - Battery Storage Daily Dispatch, charge (consumption) Summer	Residential ConnectedSolutions (RES_CS)	CVEO20
CVEO Moderate - Battery Storage Daily Dispatch, discharge (savings) Summer	Residential ConnectedSolutions (RES_CS)	CVEO5
CVEO Moderate - Battery Storage Daily Dispatch, charge (consumption) Summer	Residential ConnectedSolutions (RES_CS)	CVEO6

Algorithms for Calculating Primary Energy Impact:

For Summer Storage Daily Dispatch, unit savings are calculated by the vendor based on discharge data during a DR event.[1] The CVEO measures, including the Low-Income measures, use the same methodology as the standard offerings and are unique for CLC. CLC is in the process of evaluating Battery Storage and expects to have results by summer 2025.

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.[2] [3]

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_CS	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:

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

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.[4] [5]

Coincidence Factors:

Coincidence factors are PA-determined assumptions.

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
CVEO Battery Storage	RES_CS	CLC	0.00	0.00	0.00	1.00

Non-Energy Impacts:

NEIs are based on the number of batteries per home.[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
CVEO Battery Storage	RES_CS	CLC	$162.08	$0.00	$0.00	$0.00	$0.00	$0.00

Endnotes:

1 : Guidehouse. (2020). 2019 Residential WiFi Thermostat Direct Load Control Offering Evaluation. 2019 _Guidehouse_Residential_Wi-Fi_Thermostat_DLC
2 : Guidehouse. (2020). 2019 Residential Energy Storage Demand Response Demonstration Evaluation Summer Season. 2020_Guidehouse_Residential_Energy_Storage_Demand_Response_Summer
3 : Guidehouse. (2020). 2019/20 Residential Energy Storage Demand Response Demonstration Evaluation Winter Season.
2020_Guidehouse_Residential_Energy_Storage_Demand_Response_Winter_Season
4 : Guidehouse. (2020). 2019 Residential Energy Storage Demand Response Demonstration Evaluation Summer Season. 2020_Guidehouse_Residential_Energy_Storage_Demand_Response_Summer
5 : Guidehouse. (2020). 2019/20 Residential Energy Storage Demand Response Demonstration Evaluation Winter Season.
2020_Guidehouse_Residential_Energy_Storage_Demand_Response_Winter_Season
6 : NMR Group, Inc. (2024). Battery Storage NEIs: Task 2c. Estimated Resilience NEIs.

1.17 HVAC - CVEO Solar PV

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

Measure Description:

Solar photovoltaics (PV) system sized to a participant's load to minimize excess generation. This is a CLC specific measure.

BCR Measure IDs:

Measure	Core Initiative	BCR Measure ID
CVEO Affordable - Solar PV	Residential Turnkey Solutions (1-4 units) (RES_TSSF)	CVEO18
CVEO Moderate - Solar PV	Residential Turnkey Solutions (1-4 units) (RES_TSSF)	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_TSSF	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_TSSF	CLC	1.00	1.00	1.00	1.00	1.00	0.80	0.00

In-Service Rates:

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

Realization Rates:

100% realization rates are assumed because savings are deemed.

Coincidence Factors:

Coincidence factors are PA-determined assumptions.

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_TSSF	CLC	0.00	0.00	0.00	1.00

Non-Energy Impacts:

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

1.18 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	Residential Turnkey Solutions (1-4 units) (RES_TSSF)	EA1b024
Wi-Fi Thermostat	Residential Turnkey Solutions (1-4 units) (RES_TSSF)	GA1b012
Wi-Fi Thermostat	Residential Turnkey Solutions (5+ units) (RES_TSMF)	EA1c018
Wi-Fi Thermostat	Residential Turnkey Solutions (5+ units) (RES_TSMF)	GA1c010
Wi-Fi Thermostat	Residential Rebates (RES_REB)	EA1d052
Wi-Fi Thermostat	Residential Rebates (RES_REB)	GA1d016

Algorithms for Calculating Primary Energy Impact:

Unit 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	Core Initiative	ΔkWh	ΔkW	Δ MMBtu
Wi-Fi Thermostat, Electric	RES_TSSF	181	0.10	n/a
Wi-Fi Thermostat, Oil	RES_TSSF	17	0.02	3.1
Wi-Fi Thermostat, Propane	RES_TSSF	17	0.02	2.6
Wi-Fi Thermostat, Gas	RES_TSSF	22	0.02	3.1
Wi-Fi Thermostat, AC Only	RES_TSMF	22	0.02	n/a
Wi-Fi Thermostat, Oil	RES_TSMF	22	0.02	1.1

Measure Name	Core Initiative	ΔkWh	ΔkW	Δ MMBtu
Wi-Fi Thermostat, Propane	RES_TSMF	22	0.02	2.0
Wi-Fi Thermostat, Gas	RES_TSMF	22	0.02	1.61
Wi-Fi Thermostat, AC only	RES_REB	64	0.04	n/a
Wi-Fi Thermostat, Oil	RES_REB	18	0.02	2.78
Wi-Fi Thermostat, Propane	RES_REB	18	0.02	2.78
Wi-Fi Thermostat, Gas	RES_REB	18	0.02	2.79

Weighted averages for Electric BC model

Measure Name	Core Initiative	BCR ID	ΔkWh	ΔkW	Δ Oil MMBTUs	Δ Propane MMBTUs
Wi-Fi Thermostat	RES_TSSF	EA1b024	94.8	0.05	1.55	0.26
Wi-Fi Thermostat	RES_TSMF	EA1c018	26.4	0.03	0.55	0.2
Wi-Fi Thermostat	RES_REB	EA1d052	47.4	0.03	1.4	0.28

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.[5]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Wi-Fi Thermostat	RES_TS	All	15	n/a	n/a	15
Wi-Fi Thermostat	RES_TSMF	All	15	n/a	n/a	15
Wi-Fi Thermostat	RES_REB	All	15	n/a	n/a	15
Wi-Fi Thermostat	CI_MF	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	RES_TSSF	All	0.79	1.00	1.00	1.00	1.00	0.54	0.19
Wi-Fi Thermostat	RES_TSMF	All	1.00	1.00	1.00	1.00	1.00	0.54	0.00
Wi-Fi Thermostat	RES_REB	All	1.00	1.00	1.00	1.00	1.00	0.54	0.19

In-Service Rates:

For RES_TSSF in-services rate is blended based on evaluation results.[6] [7] For RES_REB and RES_TSMF 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.[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
Wi-Fi Thermostat, Electric	RES_REB, RES_TTSF	All	0.13	0.12	0	0.99
Wi-Fi Thermostat	RES_TSMF	All	0.14	0	0	0.86
Wi-Fi Thermostat, Gas	RES_REB, RES_TTSF	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	RES_TSSF	All	$3.63					
Wi-Fi Thermostat	RES_TSMF	All	$14.35					
Wi-Fi Thermostat	RES_REB	All	$3.63					

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	RES_TSSF	All	$3.63					
Wi-Fi Thermostat	RES_REB	All	$3.63					

Endnotes:

1 : Guidehouse (2024). Massachusetts Residential Coordinated Delivery Single Family Impact Evaluation 2024_Guidehouse_RCD_SF_Impact_Eval
2 : Guidehouse (2024). Massachusetts Income-Eligible and Residential Coordinated Delivery Multifamily Impact Evaluation 2024_Guidehouse_MF_Impact_Report
3 : Navigant Consulting (2018). Wi-Fi Thermostat Impact Evaluation--Secondary Research Study Memo. 2018_Navigant_Wi-Fi_Thermostat_Impact_Evaluation_Secondary_Literature_Study
4 : Guidehouse (2023). MA RBUECS Demand Impact Model 2023_Guidehouse_MA_RBUECS_Demand_Impact_Model
5 : 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
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 (2023). MA RBUECS Demand Impact Model 2023_Guidehouse_MA_RBUECS_Demand_Impact_Model
9 : Guidehouse (2021). Residential Programs Net-to-Gross Research of RCD and Select Products Measures Workbook 2021_Guidehouse_Res_NTG_Final_Results_Memo

1.19 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	Residential Turnkey Solutions (1-4 units) (RES_TSSF)	EA1b021
Duct Insulation	Residential Turnkey Solutions (1-4 units) (RES_TSSF)	GA1b005
Duct Insulation	Residential Turnkey Solutions (5+ units) (RES_TSMF)	EA1c010
Duct Insulation	Residential Turnkey Solutions (5+ units) (RES_TSMF)	GA1c004

Algorithms for Calculating Primary Energy Impact:

Single Family:

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

Measure Name	ΔkWh	ΔkW[2]	Δ MMBtu
Duct Insulation, Electric	46	0.03	
Duct Insulation, Gas			1.0
Duct Insulation, Oil			1.0
Duct Insulation, Other			1.0

Weighted averages for BC model

Measure Name	BCR ID	ΔkWh	ΔkW	Δ Oil MMBTUs	Δ Propane MMBTUs
Duct Insulation	EA1b021	18.4	0.01	0.5	0.1

Multifamily:

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]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Duct Insulation	RES_TSSF RES_TSMF	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	RES_TSSF	All	1.00	1.00	1.00	1.00	1.00	0.54	0.19
Duct Insulation	RES_TSMF	All	1.00	0.86	0.86	0.86	0.86	0.54	0.19

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

Realization Rates:
For single family realization rates are set to 100% since savings are deemed. For multifamily 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	RES_TSSF	All	0.04	0.12	0.00	1.08
Duct Insulation	RES_TSMF	All	0.14	0.0	0.0	0.86

Non-Energy Impacts:

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

Endnotes:

1 : Guidehouse (2024). Massachusetts Residential Coordinated Delivery Single Family Impact Evaluation 2024_Guidehouse_RCD_SF_Impact_Eval
2 : Guidehouse (2023). MA RBUECS Demand Impact Model
2023_Guidehouse_MA_RBUECS_Demand_Impact_Model
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 (2023). MA RBUECS Demand Impact Model
2023_Guidehouse_MA_RBUECS_Demand_Impact_Model
7 : Guidehouse (2021). Residential Programs Net-to-Gross Research of RCD and Select Products.
2021_Guidehouse_MA_Res_NTG_Final_Report

1.20 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	Residential Turnkey Solutions (1-4 units) (RES_TSSF)	EA1b020
Duct Sealing	Residential Turnkey Solutions (1-4 units) (RES_TSSF)	GA1b006
Duct Sealing	Residential Turnkey Solutions (5+ units) (RES_TSMF)	EA1c009
Duct Sealing	Residential Turnkey Solutions (5+ units) (RES_TSMF)	GA1c003

Algorithms for Calculating Primary Energy Impact:

Single Family:

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

Measure Name	ΔkWh	ΔkW[2]	Δ MMBtu
Duct Sealing, Electric	73	0.04	
Duct Sealing, Gas			1.7
Duct Sealing, Oil			1.7
Duct Sealing, Other			1.7

Weighted averages for BC model

Measure Name	BCR ID	ΔkWh	ΔkW	Δ Oil MMBTUs	Δ Propane MMBTUs
Duct Sealing	EA1b020	29.2	0.02	0.85	0.17

Multifamily:

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[3]
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. [4]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Duct Sealing	RES_TSSF RES_TSMF	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	RES_TSSF	All	1.00	1.00	1.00	1.00	1.00	0.54	0.19
Duct Sealing	RES_TSMF	All	1.00	0.86	0.86	0.86	0.86	0.54	0.19

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 multifamily 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 values are based on evaluation results.[7]

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Duct Sealing	RES_TSSF	All	0.04	0.12	0.00	1.08
Duct Sealing	RES_TSMF	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_TSSF RES_TSMF	All	$0.23					

Endnotes:

1 : Guidehouse (2024). Massachusetts Residential Coordinated Delivery Single Family Impact Evaluation 2024_Guidehouse_RCD_SF_Impact_Eval
2 : Guidehouse (2023). MA RBUECS Demand Impact Model 2023_Guidehouse_MA_RBUECS_Demand_Impact_Model
3 : Savings assumptions from National Grid program vendor
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 (2023). MA RBUECS Demand Impact Model
2023_Guidehouse_MA_RBUECS_Demand_Impact_Model
7 : Guidehouse (2021). Residential Programs Net-to-Gross Research of RCD and Select Products Measures: Results Memo 2021_Guidehouse_Res_NTG_Final_Results_Memo

1.21 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
Minisplit HP (EE)	Residential Rebates (RES_REB)	EA1d076
Minisplit HP (Cooling)	Residential Rebates (RES_REB)	EA1d082

Algorithms for Calculating Primary Energy Impact:

Minisplit HP (EE)

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
Minisplit HP (EE)	Electric	2.33	19.7	11.2	218 (cool) 535 (heat)	251	0.00117	0.29

Minisplit HP (Cooling)

Unit savings are deemed based on a per ton savings. Savings were developed from the Massachusetts and Connecticut Heat Pump Metering Study (MA22R51-B-HPMS)[5] which metered heat pump usage and performance in homes across MA and CT.

Measure Name	ΔkWh/Ton	ΔkW/Ton
Minisplit HP (Cooling)	156	0.15

Baseline Efficiency:

Minisplit HP (EE)
The baseline is an industry standard SEER 15.0, HSPF 8.2 DMSHP system.

Minisplit HP (Cooling)
The baseline is a room air conditioner.

High Efficiency:

Minisplit HP (EE) and Minisplit HP (Cooling)
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
Minisplit HP (EE)	RES_REB	All	18	n/a	n/a	18
Minisplit HP (Cooling)	RES_REB	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}
Minisplit HP (EE)	RES_REB	All	1.00	1.00	1.00	1.00	1.00	0.54	0.06
Minisplit HP (Cooling)	RES_REB	All	1.00	1.00	1.00	1.00	1.00	0.54	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:

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

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Minisplit HP (EE)	RES_REB	All	0.34	0.12	0.10	0.88
Minisplit HP (Cooling)	RES_REB	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
Minisplit HP (EE)	RES_REB	All	$4.21					
Minisplit HP (Cooling)	RES_REB	All	$4.21					

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 (2023). Baseline Demand Impact Model
2023_Guidehouse_MA_RBUECS_Demand_Impact_Model
5 : NTG values were derived from the following study:
2021_Guidehouse_Res_NTG_Final_Results_Memo

1.22 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 Rebates (RES_REB)	EA1d047

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_REB	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_REB	All	1.00	1.00	1.00	1.00	1.00	0.00	0.58

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
Circulator Pump[4]	RES_REB	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 : Guidehouse (2023). MA RBUECS Demand Impact Model 2023_Guidehouse_MA_RBUECS_Demand_Impact_Model
4 : 2021_Guidehouse_MA_Res_NTG_Final_Report

1.23 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 Turnkey Solutions (5+ units) (RES_TSMF)	EA1c023
Custom - Heat Pumps displacing Oil	Residential Turnkey Solutions (5+ units) (RES_TSMF)	EA1c024
Custom - Heat Pumps displacing Propane	Residential Turnkey Solutions (5+ units) (RES_TSMF)	EA1c025
Moderate Income Qualified - Custom - Heat Pumps displacing Electric Heat	Residential Turnkey Solutions (5+ units) (RES_TSMF)	EA1c050
Moderate Income Qualified - Custom - Heat Pumps displacing Oil	Residential Turnkey Solutions (5+ units) (RES_TSMF)	EA1c051
Moderate Income Qualified - Custom - Heat Pumps displacing Propane	Residential Turnkey Solutions (5+ units) (RES_TSMF)	EA1c052
Custom - Heat Pumps displacing Gas	Residential Turnkey Solutions (5+ units) (RES_TSMF)	GA1c016
Moderate Income Qualified - Custom - Heat Pumps Displacing Gas	Residential Turnkey Solutions (5+ units) (RES_TSMF)	GA1c029

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 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_TSMF	All	1.00	0.86	1.00	1.00	1.00	0.00	0.43
Custom Heat Pumps, Displacing Oil	RES_TSMF	All	1.00	1.00	0.86	1.00	1.00	0.37	0.22
Custom Heat Pumps, Displacing Propane	RES_TSMF	All	1.00	1.00	0.86	1.00	1.00	0.37	0.22
Custom Heat Pumps, Displacing Gas	RES_TSMF	All	1.00	1.00	0.86	1.00	1.00	0.30	0.62
Moderate Income Qualified - Custom - Heat Pumps displacing Electric Heat	RES_TSMF	All	1.00	0.86	1.00	1.00	1.00	0.00	0.43
Moderate Income Qualified - Custom - Heat Pumps displacing Oil	RES_TSMF	All	1.00	1.00	0.86	1.00	1.00	0.37	0.22
Moderate Income Qualified - Custom - Heat Pumps displacing Propane	RES_TSMF	All	1.00	1.00	0.86	1.00	1.00	0.37	0.22
Moderate Income Qualified - Custom - Heat Pumps displacing Gas	RES_TSMF	All	1.00	1.00	0.86	1.00	1.00	0.30	0.62

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% 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.[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	RES_TSMF	All	0.14	0.00	0.00	0.86
Custom Heat Pumps, Displacing Oil	RES_TSMF	All	0.14	0.00	0.00	0.86
Custom Heat Pumps, Displacing Propane	RES_TSMF	All	0.14	0.00	0.00	0.86
Custom Heat Pumps, Displacing Gas	RES_TSMF	All	0.14	0.00	0.00	0.86
Moderate Income Qualified - Custom - Heat Pumps displacing Electric Heat	RES_TSMF	All	0.14	0.00	0.00	0.86
Moderate Income Qualified - Custom - Heat Pumps displacing Oil	RES_TSMF	All	0.14	0.00	0.00	0.86
Moderate Income Qualified - Custom - Heat Pumps displacing Propane	RES_TSMF	All	0.14	0.00	0.00	0.86
Moderate Income Qualified - Custom - Heat Pumps displacing Gas	RES_TSMF	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	RES_TSMF	All	$392.92	n/a	n/a	n/a	n/a	n/a
Moderate Income Custom Heat Pumps	RES_TSMF	All	$392.92	n/a	n/a	n/a	n/a	n/a

Endnotes:

1 : Guidehouse. (2020). Residential Baseline 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. (2023). Residential Heat Pump NEIs Study. 2022_NMR_MA21X21-E-RHPNEI_Residential Heat Pump NEIs Study Final Report_2023

1.24 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 mini split heat pump for heating.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
CVEO Moderate - MSHP displacing Electric Heat	Residential Turnkey Solutions (1-4 units) (RES_TSSF)	CVEO1
CVEO Affordable - MSHP displacing Electric Heat	Residential Turnkey Solutions (1-4 units) (RES_TSSF)	CVEO15
CVEO Moderate - MSHP fully displacing Oil Heat	Residential Turnkey Solutions (1-4 units) (RES_TSSF)	CVEO26
CVEO Moderate - MSHP fully displacing Propane Heat	Residential Turnkey Solutions (1-4 units) (RES_TSSF)	CVEO27
CVEO Affordable - MSHP fully displacing Oil Heat	Residential Turnkey Solutions (1-4 units) (RES_TSSF)	CVEO30
CVEO Affordable - MSHP fully displacing Propane Heat	Residential Turnkey Solutions (1-4 units) (RES_TSSF)	CVEO31
Minisplit HP displacing Electric Resistance	Residential Turnkey Solutions (1-4 units) (RES_TSSF)	EA1b038
Air-to-Water HP displacing Electric Resistance	Residential Turnkey Solutions (1-4 units) (RES_TSSF)	EA1b040
Minisplit HP displacing Oil - Full	Residential Turnkey Solutions (1-4 units) (RES_TSSF)	EA1b047
Minisplit HP displacing Propane - Full	Residential Turnkey Solutions (1-4 units) (RES_TSSF)	EA1b048
Air-to-Water HP displacing Oil	Residential Turnkey Solutions (1-4 units) (RES_TSSF)	EA1b049
Air-to-Water HP displacing Propane	Residential Turnkey Solutions (1-4 units) (RES_TSSF)	EA1b050

Measure Name	Core Initiative	BCR Measure ID
Moderate Income Qualified - Air-to-Water HP displacing Electric Resistance	Residential Turnkey Solutions (1-4 units) (RES_TSSF)	EA1b056
Moderate Income Qualified - Minisplit HP displacing Oil - Full	Residential Turnkey Solutions (1-4 units) (RES_TSSF)	EA1b063
Moderate Income Qualified - Minisplit HP displacing Propane - Full	Residential Turnkey Solutions (1-4 units) (RES_TSSF)	EA1b064
Moderate Income Qualified - Air-to-Water HP displacing Oil	Residential Turnkey Solutions (1-4 units) (RES_TSSF)	EA1b065
Moderate Income Qualified - Air-to-Water HP displacing Propane	Residential Turnkey Solutions (1-4 units) (RES_TSSF)	EA1b066
Moderate Income Qualified - Minisplit HP Displacing Gas - Full	Residential Turnkey Solutions (1-4 units) (RES_TSSF)	GA1b024
Moderate Income Qualified - Air-to-Water HP displacing Gas	Residential Turnkey Solutions (1-4 units) (RES_TSSF)	GA1b025
Minisplit HP Displacing Gas - Full	Residential Turnkey Solutions (1-4 units) (RES_TSSF)	GA1b030
Air-to-Water HP displacing Gas	Residential Turnkey Solutions (1-4 units) (RES_TSSF)	GA1b031
Minisplit HP displacing Electric Resistance	Residential Rebates (RES_REB)	EA1d002
Air-to-Water HP displacing Electric Resistance	Residential Rebates (RES_REB)	EA1d004
Minisplit HP displacing Oil - Full	Residential Rebates (RES_REB)	EA1d013
Minisplit HP displacing Propane - Full	Residential Rebates (RES_REB)	EA1d014
Air-to-Water HP displacing Oil	Residential Rebates (RES_REB)	EA1d015
Air-to-Water HP displacing Propane	Residential Rebates (RES_REB)	EA1d016
Moderate Income Qualified - Air-to-Water HP displacing Electric Resistance	Residential Rebates (RES_REB)	EA1d022
Moderate Income Qualified - Minisplit HP displacing Oil - Full	Residential Rebates (RES_REB)	EA1d031
Moderate Income Qualified - Minisplit HP displacing Propane - Full	Residential Rebates (RES_REB)	EA1d032
Moderate Income Qualified - Air-to-Water HP displacing Oil	Residential Rebates (RES_REB)	EA1d033

Measure Name	Core Initiative	BCR Measure ID
Moderate Income Qualified - Air-to-Water HP displacing Propane	Residential Rebates (RES_REB)	EA1d034
Minisplit HP Displacing Gas - Full	Residential Rebates (RES_REB)	GA1d007
Air-to-Water HP displacing Gas	Residential Rebates (RES_REB)	GA1d008
Moderate Income Qualified - Minisplit HP Displacing Gas - Full	Residential Rebates (RES_REB)	GA1d030
Moderate Income Qualified - Air-to-Water HP displacing Gas	Residential Rebates (RES_REB)	GA1d031

Algorithms for Calculating Primary Energy Impact:

Unit savings are deemed based on a per ton savings. Savings were developed from the Massachusetts and Connecticut Heat Pump Metering Study (MA22R51-B-HPMS)[1] which metered heat pump usage and performance in homes across MA and CT. Heating and cooling baseline weights were developed based on participant survey responses.

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	6.1	0.49	1,103
MSHP fully displacing Oil Heat	15.5	-0.97	-1,208
MSHP fully displacing Propane Heat	14.9	-0.84	-1,002
MSHP Fully Displacing Existing Boiler, Gas	14.1	-0.85	-1,014

Moderate Income Heat Pump Savings

The savings used for moderate income heat pump projects align with the income eligible project savings. Unit savings are deemed based on a per ton savings. Savings were also developed from the Massachusetts and Connecticut Heat Pump Metering Study (MA22R51-B-HPMS) but use different baseline weights than standard income projects.

The same savings are used for CVEO and moderate-income projects. 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 (Moderate Income)	n/a	1.34	2,547
MSHP fully displacing Oil Heat (Moderate Income)	17.1	-1.00	-1,208
MSHP fully displacing Propane Heat (Moderate Income)	17.5	-1.00	-1,206
MSHP Fully Displacing Existing Boiler, Gas (Moderate Income)	17.5	-1.00	-1,206

For Air to Water Heat Pump

Information on the savings analysis can be found here [2] [3] . 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[4]	3613	1.77	0
Moderate Income Qualified - Air-to-Water Heat Pump displacing Electric Heat	3613	1.77	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 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. [5]

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[6]	OYF	RUL	AML
MSHP Fully displacing any fuel	RES_REB, RES_TSSF	All	18	n/a	n/a	18
Air to Water Heat Pump displacing any fuel	RES_REB, RES_TSSF	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}
Minisplit HP displacing Electric Resistance	RES_TSSF	All	1.00	1.00	1.00	1.00	1.00	-0.02	0.55
Air-to-Water HP displacing Electric Resistance	RES_TSSF	All	1.00	1.00	1.00	1.00	1.00	0.00	0.58
Minisplit HP Displacing Oil - Full	RES_TSSF	All	1.00	1.00	1.00	1.00	1.00	0.02	0.29
Minisplit HP Displacing Propane - Full	RES_TSSF	All	1.00	1.00	1.00	1.00	1.00	0.02	0.29

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Air-to-Water HP displacing Oil	RES_TSSF	All	1.00	1.00	1.00	1.00	1.00	-0.02	0.65
Air-to-Water HP displacing Propane	RES_TSSF	All	1.00	1.00	1.00	1.00	1.00	-0.02	0.65
Moderate Income Qualified - Air-to-Water HP displacing Electric Resistance	RES_TSSF	All	1.00	1.00	1.00	1.00	1.00	0.00	0.58
Moderate Income Qualified - Minisplit HP displacing Oil - Full	RES_TSSF	All	1.00	1.00	1.00	1.00	1.00	0.02	0.29
Moderate Income Qualified - Minisplit HP displacing Propane - Full	RES_TSSF	All	1.00	1.00	1.00	1.00	1.00	0.02	0.29
Moderate Income Qualified - Air-to-Water HP displacing Oil	RES_TSSF	All	1.00	1.00	1.00	1.00	1.00	-0.02	0.65
Moderate Income Qualified - Air-to-Water HP displacing Propane	RES_TSSF	All	1.00	1.00	1.00	1.00	1.00	-0.02	0.65
Minisplit HP displacing Electric Resistance	RES_REB	All	1.00	1.00	1.00	1.00	1.00	-0.02	0.55
Air-to-Water Heat Pump displacing Electric Resistance	RES_REB	All	1.00	1.00	1.00	1.00	1.00	0.00	0.58
Minisplit HP displacing Oil - Full	RES_REB	All	1.00	1.00	1.00	1.00	1.00	0.02	0.29
Minisplit HP displacing Propane - Full	RES_REB	All	1.00	1.00	1.00	1.00	1.00	0.02	0.28
Air-to-Water HP displacing Oil	RES_REB	All	1.00	1.00	1.00	1.00	1.00	-0.02	0.65
Air-to-Water HP displacing Propane	RES_REB	All	1.00	1.00	1.00	1.00	1.00	-0.02	0.65
Moderate Income Qualified - Air-to-Water HP displacing Electric Resistance	RES_REB	All	1.00	1.00	1.00	1.00	1.00	0.00	0.58
Moderate Income Qualified - Minisplit HP displacing Oil - Full	RES_REB	All	1.00	1.00	1.00	1.00	1.00	0.02	0.29
Moderate Income Qualified - Minisplit HP displacing Propane - Full	RES_REB	All	1.00	1.00	1.00	1.00	1.00	0.02	0.28
Moderate Income Qualified - Air-to-Water HP displacing Oil	RES_REB	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 HP displacing Propane	RES_REB	All	1.00	1.00	1.00	1.00	1.00	-0.02	0.65
CVEO Moderate - MSHP displacing Electric Heat	RES_TSSF	All	1.00	1.00	1.00	1.00	1.00	-0.02	0.55
CVEO Moderate - MSHP fully displacing Oil Heat	RES_TSSF	All	1.00	1.00	1.00	1.00	1.00	0.02	0.29
CVEO Moderate - MSHP fully displacing Propane Heat	RES_TSSF	All	1.00	1.00	1.00	1.00	1.00	0.02	0.28
CVEO Affordable - MSHP displacing Electric Heat	RES_TSSF	All	1.00	1.00	1.00	1.00	1.00	-0.02	0.55
CVEO Affordable - MSHP fully displacing Oil Heat	RES_TSSF	All	1.00	1.00	1.00	1.00	1.00	0.02	0.29
CVEO Affordable - MSHP fully displacing Propane Heat	RES_TSSF	All	1.00	1.00	1.00	1.00	1.00	0.02	0.28
Moderate Income Qualified - Minisplit HP Displacing Gas - Full	RES_TSSF	All	1.00	1.00	1.00	1.00	1.00	0.02	0.28
Moderate Income Qualified - Air-to-Water HP displacing Gas	RES_TSSF	All	1.00	1.00	1.00	1.00	1.00	-0.02	0.65
Minisplit HP Displacing Gas - Full	RES_TSSF	All	1.00	1.00	1.00	1.00	1.00	0.02	0.28
Air-to-Water HP displacing Gas	RES_TSSF	All	1.00	1.00	1.00	1.00	1.00	-0.02	0.65
Minisplit HP Displacing Gas - Full	RES_REB	All	1.00	1.00	1.00	1.00	1.00	0.02	0.28
Air-to-Water HP displacing Gas	RES_REB	All	1.00	1.00	1.00	1.00	1.00	-0.02	0.65
Moderate Income Qualified - Minisplit HP Displacing Gas - Full	RES_REB	All	1.00	1.00	1.00	1.00	1.00	0.02	0.28
Moderate Income Qualified - Air-to-Water HP displacing Gas	RES_REB	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[7] **:**

Coincidence factors are custom calculated.

Impact Factors for Calculating Net Savings:

Net to gross factors are set to 100% since this is a market transformation initiative and per The Resolution of the Energy Efficiency Advisory Council Regarding 2025-2027 Three-Year Plan Evaluation, Measurement and Verification Principles and Policy memo market transformation initiative may not be subject to net-to-gross factors.[8]

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Minisplit HP displacing Electric Resistance	RES_TSSF	All	0.00	0.00	0.00	1.00
Air-to-Water HP displacing Electric Resistance	RES_TSSF	All	0.00	0.00	0.00	1.00
Minisplit HP Displacing Oil - Full	RES_TSSF	All	0.00	0.00	0.00	1.00
Minisplit HP Displacing Propane - Full	RES_TSSF	All	0.00	0.00	0.00	1.00
Air-to-Water HP displacing Oil	RES_TSSF	All	0.00	0.00	0.00	1.00
Air-to-Water HP displacing Propane	RES_TSSF	All	0.00	0.00	0.00	1.00
Moderate Income Qualified - Air-to-Water HP displacing Electric Resistance	RES_TSSF	All	0.00	0.00	0.00	1.00
Moderate Income Qualified - Minisplit HP displacing Oil - Full	RES_TSSF	All	0.00	0.00	0.00	1.00
Moderate Income Qualified - Minisplit HP displacing Propane - Full	RES_TSSF	All	0.00	0.00	0.00	1.00
Moderate Income Qualified - Air-to-Water HP displacing Oil	RES_TSSF	All	0.00	0.00	0.00	1.00
Moderate Income Qualified - Air-to-Water HP displacing Propane	RES_TSSF	All	0.00	0.00	0.00	1.00
Minisplit HP displacing Electric Resistance	RES_REB	All	0.00	0.00	0.00	1.00
Air-to-Water Heat Pump displacing Electric Resistance	RES_REB	All	0.00	0.00	0.00	1.00
Minisplit HP displacing Oil - Full	RES_REB	All	0.00	0.00	0.00	1.00
Minisplit HP displacing Propane - Full	RES_REB	All	0.00	0.00	0.00	1.00
Air-to-Water HP displacing Oil	RES_REB	All	0.00	0.00	0.00	1.00
Air-to-Water HP displacing Propane	RES_REB	All	0.00	0.00	0.00	1.00
Moderate Income Qualified - Air-to-Water HP displacing Electric Resistance	RES_REB	All	0.00	0.00	0.00	1.00
Moderate Income Qualified - Minisplit HP displacing Oil - Full	RES_REB	All	0.00	0.00	0.00	1.00

Measure Name	**Core Initiative**	**PA**	**FR**	**SO_P**	**SO_{NP}**	**NTG**
Moderate Income Qualified - Minisplit HP displacing Propane - Full	RES_REB	All	0.00	0.00	0.00	1.00
Moderate Income Qualified - Air-to-Water HP displacing Oil	RES_REB	All	0.00	0.00	0.00	1.00
Moderate Income Qualified - Air-to-Water HP displacing Propane	RES_REB	All	0.00	0.00	0.00	1.00
CVEO Moderate - MSHP displacing Electric Heat	RES_TSSF	All	0.00	0.00	0.00	1.00
CVEO Moderate - MSHP fully displacing Oil Heat	RES_TSSF	All	0.00	0.00	0.00	1.00
CVEO Moderate - MSHP fully displacing Propane Heat	RES_TSSF	All	0.00	0.00	0.00	1.00
CVEO Affordable - MSHP displacing Electric Heat	RES_TSSF	All	0.00	0.00	0.00	1.00
CVEO Affordable - MSHP fully displacing Oil Heat	RES_TSSF	All	0.00	0.00	0.00	1.00
CVEO Affordable - MSHP fully displacing Propane Heat	RES_TSSF	All	0.00	0.00	0.00	1.00
Moderate Income Qualified - Minisplit HP Displacing Gas - Full	RES_TSSF	All	0.00	0.00	0.00	1.00
Moderate Income Qualified - Air-to-Water HP displacing Gas	RES_TSSF	All	0.00	0.00	0.00	1.00
Minisplit HP Displacing Gas - Full	RES_TSSF	All	0.00	0.00	0.00	1.00
Air-to-Water HP displacing Gas	RES_TSSF	All	0.00	0.00	0.00	1.00
Minisplit HP Displacing Gas - Full	RES_REB	All	0.00	0.00	0.00	1.00
Air-to-Water HP displacing Gas	RES_REB	All	0.00	0.00	0.00	1.00
Moderate Income Qualified - Minisplit HP Displacing Gas - Full	RES_REB	All	0.00	0.00	0.00	1.00
Moderate Income Qualified - Air-to-Water HP displacing Gas	RES_REB	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 similar 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
Minisplit HP displacing Electric Resistance	RES_TSSF	All	$196.46					
Air-to-Water HP displacing Electric Resistance	RES_TSSF	All						
Minisplit HP Displacing Oil - Full	RES_TSSF	All	$94.14					
Minisplit HP Displacing Propane - Full	RES_TSSF	All	$94.14					
Air-to-Water HP displacing Oil	RES_TSSF	All	$46.85					
Air-to-Water HP displacing Propane	RES_TSSF	All	$46.85					
Moderate Income Qualified - Air-to-Water HP displacing Electric Resistance	RES_TSSF	All						
Moderate Income Qualified - Minisplit HP displacing Oil - Full	RES_TSSF	All	$94.14					
Moderate Income Qualified - Minisplit HP displacing Propane - Full	RES_TSSF	All	$94.14					
Moderate Income Qualified - Air-to-Water HP displacing Oil	RES_TSSF	All	$46.85					
Moderate Income Qualified - Air-to-Water HP displacing Propane	RES_TSSF	All	$46.85					
Minisplit HP displacing Electric Resistance	RES_REB	All	$196.46					
Air-to-Water Heat Pump displacing Electric Resistance	RES_REB	All						
Minisplit HP displacing Oil - Full	RES_REB	All	$94.14					
Minisplit HP displacing Propane - Full	RES_REB	All	$94.14					
Air-to-Water HP displacing Oil	RES_REB	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 HP displacing Propane	RES_REB	All	$46.85					
Moderate Income Qualified - Air-to-Water HP displacing Electric Resistance	RES_REB	All						
Moderate Income Qualified - Minisplit HP displacing Oil - Full	RES_REB	All	$94.14					
Moderate Income Qualified - Minisplit HP displacing Propane - Full	RES_REB	All	$94.14					
Moderate Income Qualified - Air-to-Water HP displacing Oil	RES_REB	All	$46.85					
Moderate Income Qualified - Air-to-Water HP displacing Propane	RES_REB	All	$46.85					
CVEO Moderate - MSHP displacing Electric Heat	RES_TSSF	All						
CVEO Moderate - MSHP fully displacing Oil Heat	RES_TSSF	All	$94.14					
CVEO Moderate - MSHP fully displacing Propane Heat	RES_TSSF	All	$94.14					
CVEO Affordable - MSHP displacing Electric Heat	RES_TSSF	All	$46.85					
CVEO Affordable - MSHP fully displacing Oil Heat	RES_TSSF	All	$46.85					
CVEO Affordable - MSHP fully displacing Propane Heat	RES_TSSF	All	$196.46					
Moderate Income Qualified - Minisplit HP Displacing Gas - Full	RES_TSSF	All	$94.14					
Moderate Income Qualified - Air-to-Water HP displacing Gas	RES_TSSF	All	$46.85					
Minisplit HP Displacing Gas - Full	RES_TSSF	All	$94.14					
Air-to-Water HP displacing Gas	RES_TSSF	All	$46.85					
Minisplit HP Displacing Gas - Full	RES_REB	All	$94.14					

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 HP displacing Gas	RES_REB	All	$46.85					
Moderate Income Qualified - Minisplit HP Displacing Gas - Full	RES_REB	All	$94.14					
Moderate Income Qualified - Air-to-Water HP displacing Gas	RES_REB	All	$46.85					

Endnotes:

1 : Guidehouse (2024). Heat Pump Metering Study 2024_Guidehouse_Resi_Heat Pump Metering Study
2 : 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
3 : 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
4 : 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
5 : More information on both the baseline definitions and weights can be found in the following study: 2021_Guidehouse_Fuel Displacement Report_HP
6 : 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
7 : Guidehouse (2023). Residential Demand Impact Model
2023_Guidehouse_MA_RBUECS_Demand_Impact_Model
8 : The Resolution of the Energy Efficiency Advisory Council Regarding 2025-2027 Three-Year Plan Evaluation, Measurement and Verification Principles and Policy memo - https://ma-eeac.org/wp-content/uploads/2025-2027-Three-Year-Plan-EMV-Policy-Memo-FINAL-1.pdf
9 : NMR (2022) - 2022_NMR_MA21X21-E-RHPNEI_Residential Heat Pump NEIs Study Final Report_2023

1.25 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
CVEO Moderate - Central Heat Pump fully displacing Oil Heat	Residential Turnkey Solutions (1-4 units) (RES_TSSF)	CVEO24
CVEO Moderate - Central Heat Pump fully displacing Propane Heat	Residential Turnkey Solutions (1-4 units) (RES_TSSF)	CVEO25
CVEO Affordable - Central Heat Pump fully displacing Oil Heat	Residential Turnkey Solutions (1-4 units) (RES_TSSF)	CVEO28
CVEO Affordable - Central Heat Pump fully displacing Propane Heat	Residential Turnkey Solutions (1-4 units) (RES_TSSF)	CVEO29
Central HP displacing Electric Resistance	Residential Turnkey Solutions (1-4 units) (RES_TSSF)	EA1b037
GSHP displacing Electric Resistance	Residential Turnkey Solutions (1-4 units) (RES_TSSF)	EA1b039
Central HP displacing Oil - Full	Residential Turnkey Solutions (1-4 units) (RES_TSSF)	EA1b043
Central HP displacing Propane - Full	Residential Turnkey Solutions (1-4 units) (RES_TSSF)	EA1b044
GSHP displacing Oil	Residential Turnkey Solutions (1-4 units) (RES_TSSF)	EA1b051
GSHP displacing Propane	Residential Turnkey Solutions (1-4 units) (RES_TSSF)	EA1b052
Moderate Income Qualified - Central HP displacing Electric Resistance	Residential Turnkey Solutions (1-4 units) (RES_TSSF)	EA1b053
Moderate Income Qualified - GSHP displacing Electric Resistance	Residential Turnkey Solutions (1-4 units) (RES_TSSF)	EA1b055
Moderate Income Qualified - Central HP displacing Oil - Full	Residential Turnkey Solutions (1-4 units) (RES_TSSF)	EA1b059

Measure Name	Core Initiative	BCR Measure ID
Moderate Income Qualified - Central HP displacing Propane - Full	Residential Turnkey Solutions (1-4 units) (RES_TSSF)	EA1b060
Moderate Income Qualified - GSHP displacing Oil	Residential Turnkey Solutions (1-4 units) (RES_TSSF)	EA1b067
Moderate Income Qualified - GSHP displacing Propane	Residential Turnkey Solutions (1-4 units) (RES_TSSF)	EA1b068
Moderate Income Qualified - Central HP Displacing Gas - Full	Residential Turnkey Solutions (1-4 units) (RES_TSSF)	GA1b022
Moderate Income Qualified - GSHP Displacing Gas	Residential Turnkey Solutions (1-4 units) (RES_TSSF)	GA1b026
Central HP Displacing Gas - Full	Residential Turnkey Solutions (1-4 units) (RES_TSSF)	GA1b028
GSHP displacing Gas	Residential Turnkey Solutions (1-4 units) (RES_TSSF)	GA1b032
Central HP displacing Electric Resistance	Residential Rebates (RES_REB)	EA1d001
GSHP displacing Electric Resistance	Residential Rebates (RES_REB)	EA1d003
Central HP displacing Oil - Full	Residential Rebates (RES_REB)	EA1d009
Central HP displacing Propane - Full	Residential Rebates (RES_REB)	EA1d010
GSHP displacing Oil	Residential Rebates (RES_REB)	EA1d017
GSHP displacing Propane	Residential Rebates (RES_REB)	EA1d018
Moderate Income Qualified - Central HP displacing Electric Resistance	Residential Rebates (RES_REB)	EA1d019
Moderate Income Qualified - GSHP displacing Electric Resistance	Residential Rebates (RES_REB)	EA1d021
Moderate Income Qualified - Central HP displacing Oil - Full	Residential Rebates (RES_REB)	EA1d027
Moderate Income Qualified - Central HP displacing Propane - Full	Residential Rebates (RES_REB)	EA1d028
Moderate Income Qualified - GSHP displacing Oil	Residential Rebates (RES_REB)	EA1d035
Moderate Income Qualified - GSHP displacing Propane	Residential Rebates (RES_REB)	EA1d036
Central HP Displacing Gas - Full	Residential Rebates (RES_REB)	GA1d005
GSHP displacing Gas	Residential Rebates (RES_REB)	GA1d009

Measure Name	Core Initiative	BCR Measure ID
Moderate Income Qualified - Central HP Displacing Gas - Full	Residential Rebates (RES_REB)	GA1d028
Moderate Income Qualified - GSHP Displacing Gas	Residential Rebates (RES_REB)	GA1d032

Algorithms for Calculating Primary Energy Impact:

Unit savings are deemed based on a per ton savings. Savings were developed from the Massachusetts and Connecticut Heat Pump Metering Study (MA22R51-B-HPMS)[1] which metered heat pump usage and performance in homes across MA and CT. Heating and cooling baseline weights were developed based on participant survey responses.

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 Electric Resistance	11.5	-0.69	-28
Central Heat Pump fully displacing Oil Heat	16.8	-1.85	-1,338
Central Heat Pump fully displacing Propane Heat	15.4	-1.84	-1,328
Central Ducted Heat Pump Fully Displacing Gas Heat	15.8	-1.85	-1,336
Ground Source Heat Pump Displacing Electric Resistance	10.1	0.10	152
Ground Source Heat Pump Displacing Oil Heat	14.7	-0.83	-991
Ground Source Heat Pump Displacing Propane Heat	13.9	-0.83	-992
Ground Source Heat Pump Displacing Gas Heat	13.7	-0.83	-987

Moderate Income Heat Pump Savings

The savings used for moderate income central heat pumps align with the Low-Income central heat pump savings. Unit savings are deemed based on a per ton savings. Savings were also developed from the Massachusetts and Connecticut Heat Pump Metering Study (MA22R51-B-HPMS), but use different baseline weights than standard income projects.

The same savings are used for CVEO and moderate-income central heat pump projects. CVEO is a CLC specific measure offering.

Measure Name	Saved MMBtu Oil/Propane/Gas (Per Ton)	ΔkW/Ton	ΔkWh/Ton
Central Heat Pump fully displacing Electric Resistance (Moderate Income)	n/a	1.52	2,537
Central Heat Pump fully displacing Oil Heat (Moderate Income)	16.6	-1.83	-1,238
Central Heat Pump fully displacing Propane Heat (Moderate Income)	15.5	-1.84	-1,249
Central Ducted Heat Pump Fully Displacing Gas Heat (Moderate Income)	15.5	-1.84	-1,249

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. [2]

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[3]	OYF	RUL	AML
Central Ducted Heat Pump Fully Displacing Any Heat	RES_TSSF; RES_REB	All	17	n/a	n/a	17
Ground Source Heat Pump Fully Replacing Any Heat	RES_TSSF; RES_REB	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 HP displacing Electric Resistance	RES_TSSF	All	1.00	1.00	1.00	1.00	1.00	-0.04	0.03
GSHP displacing Electric Resistance	RES_TSSF	All	1.00	1.00	1.00	1.00	1.00	0.33	0.30
Central HP displacing Oil - Full	RES_TSSF	All	1.00	1.00	1.00	1.00	1.00	-0.01	0.19
Central HP displacing Propane - Full	RES_TSSF	All	1.00	1.00	1.00	1.00	1.00	-0.01	0.19
GSHP displacing Oil	RES_TSSF	All	1.00	1.00	1.00	1.00	1.00	-0.04	0.30
GSHP displacing Propane	RES_TSSF	All	1.00	1.00	1.00	1.00	1.00	-0.04	0.30
Moderate Income Qualified - Central HP displacing Electric Resistance	RES_TSSF	All	1.00	1.00	1.00	1.00	1.00	-0.04	0.03
Moderate Income Qualified - GSHP displacing Electric Resistance	RES_TSSF	All	1.00	1.00	1.00	1.00	1.00	0.33	0.30
Moderate Income Qualified - Central HP displacing Oil - Full	RES_TSSF	All	1.00	1.00	1.00	1.00	1.00	-0.01	0.19
Moderate Income Qualified - Central HP displacing Propane - Full	RES_TSSF	All	1.00	1.00	1.00	1.00	1.00	-0.01	0.19

Measure Name	**Core Initiative**	**PA**	**ISR**	**RR_E**	**RR_{NE}**	**RR_{SP}**	**RR_{WP}**	**CF_{SP}**	**CF_{WP}**
Moderate Income Qualified - GSHP displacing Oil	RES_TSSF	All	1.00	1.00	1.00	1.00	1.00	-0.04	0.30
Moderate Income Qualified - GSHP displacing Propane	RES_TSSF	All	1.00	1.00	1.00	1.00	1.00	-0.04	0.30
Central HP displacing Electric Resistance	RES_REB	All	1.00	1.00	1.00	1.00	1.00	-0.04	0.03
GSHP displacing Electric Resistance	RES_REB	All	1.00	1.00	1.00	1.00	1.00	0.33	0.30
Central HP displacing Oil - Full	RES_REB	All	1.00	1.00	1.00	1.00	1.00	-0.01	0.19
Central HP displacing Propane - Full	RES_REB	All	1.00	1.00	1.00	1.00	1.00	-0.01	0.19
GSHP displacing Oil	RES_REB	All	1.00	1.00	1.00	1.00	1.00	-0.04	0.30
GSHP displacing Propane	RES_REB	All	1.00	1.00	1.00	1.00	1.00	-0.04	0.30
Moderate Income Qualified - Central HP displacing Electric Resistance	RES_REB	All	1.00	1.00	1.00	1.00	1.00	-0.04	0.03
Moderate Income Qualified - GSHP displacing Electric Resistance	RES_REB	All	1.00	1.00	1.00	1.00	1.00	0.33	0.30
Moderate Income Qualified - Central HP displacing Oil - Full	RES_REB	All	1.00	1.00	1.00	1.00	1.00	-0.01	0.19
Moderate Income Qualified - Central HP displacing Propane - Full	RES_REB	All	1.00	1.00	1.00	1.00	1.00	-0.01	0.19
Moderate Income Qualified - GSHP displacing Oil	RES_REB	All	1.00	1.00	1.00	1.00	1.00	-0.04	0.30
Moderate Income Qualified - GSHP displacing Propane	RES_REB	All	1.00	1.00	1.00	1.00	1.00	-0.04	0.30
CVEO Moderate - Central Heat Pump fully displacing Oil Heat	RES_TSSF	All	1.00	1.00	1.00	1.00	1.00	-0.01	0.19
CVEO Moderate - Central Heat Pump fully displacing Propane Heat	RES_TSSF	All	1.00	1.00	1.00	1.00	1.00	-0.01	0.19

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
CVEO Affordable - Central Heat Pump fully displacing Oil Heat	RES_TSSF	All	1.00	1.00	1.00	1.00	1.00	-0.01	0.19
CVEO Affordable - Central Heat Pump fully displacing Propane Heat	RES_TSSF	All	1.00	1.00	1.00	1.00	1.00	-0.01	0.19
Moderate Income Qualified - Central HP Displacing Gas - Full	RES_TSSF	All	1.00	1.00	1.00	1.00	1.00	-0.01	0.19
Moderate Income Qualified - GSHP Displacing Gas	RES_TSSF	All	1.00	1.00	1.00	1.00	1.00	-0.04	0.30
Central HP Displacing Gas - Full	RES_TSSF	All	1.00	1.00	1.00	1.00	1.00	-0.01	0.19
GSHP displacing Gas	RES_TSSF	All	1.00	1.00	1.00	1.00	1.00	-0.04	0.30
Central HP Displacing Gas - Full	RES_REB	All	1.00	1.00	1.00	1.00	1.00	-0.01	0.19
GSHP displacing Gas	RES_REB	All	1.00	1.00	1.00	1.00	1.00	-0.04	0.30
Moderate Income Qualified - Central HP Displacing Gas - Full	RES_REB	All	1.00	1.00	1.00	1.00	1.00	-0.01	0.19
Moderate Income Qualified - GSHP Displacing Gas	RES_REB	All	1.00	1.00	1.00	1.00	1.00	-0.04	0.30

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[4] **:**
Coincidence factors are calculated to reflect blend of heating and cooling.

Impact Factors for Calculating Net Savings:

Net to gross factors are set to 100% since this is a market transformation initiative and per The Resolution of the Energy Efficiency Advisory Council Regarding 2025-2027 Three-Year Plan Evaluation, Measurement and Verification Principles and Policy memo market transformation initiative may not be subject to net-to-gross factors.[5]

Measure Name	**Core Initiative**	**PA**	**FR**	**SO_P**	**SO_{NP}**	**NTG**
Central HP displacing Electric Resistance	RES_TSSF	All	0.00	0.00	0.00	1.00
GSHP displacing Electric Resistance	RES_TSSF	All	0.00	0.00	0.00	1.00
Central HP displacing Oil - Full	RES_TSSF	All	0.00	0.00	0.00	1.00
Central HP displacing Propane - Full	RES_TSSF	All	0.00	0.00	0.00	1.00
GSHP displacing Oil	RES_TSSF	All	0.00	0.00	0.00	1.00
GSHP displacing Propane	RES_TSSF	All	0.00	0.00	0.00	1.00
Moderate Income Qualified - Central HP displacing Electric Resistance	RES_TSSF	All	0.00	0.00	0.00	1.00
Moderate Income Qualified - GSHP displacing Electric Resistance	RES_TSSF	All	0.00	0.00	0.00	1.00
Moderate Income Qualified - Central HP displacing Oil - Full	RES_TSSF	All	0.00	0.00	0.00	1.00
Moderate Income Qualified - Central HP displacing Propane - Full	RES_TSSF	All	0.00	0.00	0.00	1.00
Moderate Income Qualified - GSHP displacing Oil	RES_TSSF	All	0.00	0.00	0.00	1.00
Moderate Income Qualified - GSHP displacing Propane	RES_TSSF	All	0.00	0.00	0.00	1.00
Central HP displacing Electric Resistance	RES_REB	All	0.00	0.00	0.00	1.00
GSHP displacing Electric Resistance	RES_REB	All	0.00	0.00	0.00	1.00
Central HP displacing Oil - Full	RES_REB	All	0.00	0.00	0.00	1.00
Central HP displacing Propane - Full	RES_REB	All	0.00	0.00	0.00	1.00
GSHP displacing Oil	RES_REB	All	0.00	0.00	0.00	1.00
GSHP displacing Propane	RES_REB	All	0.00	0.00	0.00	1.00
Moderate Income Qualified - Central HP displacing Electric Resistance	RES_REB	All	0.00	0.00	0.00	1.00
Moderate Income Qualified - GSHP displacing Electric Resistance	RES_REB	All	0.00	0.00	0.00	1.00
Moderate Income Qualified - Central HP displacing Oil - Full	RES_REB	All	0.00	0.00	0.00	1.00
Moderate Income Qualified - Central HP displacing Propane - Full	RES_REB	All	0.00	0.00	0.00	1.00
Moderate Income Qualified - GSHP displacing Oil	RES_REB	All	0.00	0.00	0.00	1.00

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Moderate Income Qualified - GSHP displacing Propane	RES_REB	All	0.00	0.00	0.00	1.00
CVEO Moderate - Central Heat Pump fully displacing Oil Heat	RES_TSSF	All	0.00	0.00	0.00	1.00
CVEO Moderate - Central Heat Pump fully displacing Propane Heat	RES_TSSF	All	0.00	0.00	0.00	1.00
CVEO Affordable - Central Heat Pump fully displacing Oil Heat	RES_TSSF	All	0.00	0.00	0.00	1.00
CVEO Affordable - Central Heat Pump fully displacing Propane Heat	RES_TSSF	All	0.00	0.00	0.00	1.00
Moderate Income Qualified - Central HP Displacing Gas - Full	RES_TSSF	All	0.00	0.00	0.00	1.00
Moderate Income Qualified - GSHP Displacing Gas	RES_TSSF	All	0.00	0.00	0.00	1.00
Central HP Displacing Gas - Full	RES_TSSF	All	0.00	0.00	0.00	1.00
GSHP displacing Gas	RES_TSSF	All	0.00	0.00	0.00	1.00
Central HP Displacing Gas - Full	RES_REB	All	0.00	0.00	0.00	1.00
GSHP displacing Gas	RES_REB	All	0.00	0.00	0.00	1.00
Moderate Income Qualified - Central HP Displacing Gas - Full	RES_REB	All	0.00	0.00	0.00	1.00
Moderate Income Qualified - GSHP Displacing Gas	RES_REB	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 similar 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 HP displacing Electric Resistance	RES_TSSF	All	196.46					
GSHP displacing Electric Resistance	RES_TSSF	All	0					
Central HP displacing Oil - Full	RES_TSSF	All	64.24					

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
Central HP displacing Propane - Full	RES_TSSF	All	64.24					
GSHP displacing Oil	RES_TSSF	All	75.48					
GSHP displacing Propane	RES_TSSF	All	75.48					
Moderate Income Qualified - Central HP displacing Electric Resistance	RES_TSSF	All	196.46					
Moderate Income Qualified - GSHP displacing Electric Resistance	RES_TSSF	All	0					
Moderate Income Qualified - Central HP displacing Oil - Full	RES_TSSF	All	64.24					
Moderate Income Qualified - Central HP displacing Propane - Full	RES_TSSF	All	64.24					
Moderate Income Qualified - GSHP displacing Oil	RES_TSSF	All	75.48					
Moderate Income Qualified - GSHP displacing Propane	RES_TSSF	All	75.48					
Central HP displacing Electric Resistance	RES_REB	All	196.46					
GSHP displacing Electric Resistance	RES_REB	All	0					
Central HP displacing Oil - Full	RES_REB	All	64.24					
Central HP displacing Propane - Full	RES_REB	All	64.24					
GSHP displacing Oil	RES_REB	All	75.48					
GSHP displacing Propane	RES_REB	All	75.48					
Moderate Income Qualified - Central HP displacing Electric Resistance	RES_REB	All	196.46					

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 - GSHP displacing Electric Resistance	RES_REB	All	0					
Moderate Income Qualified - Central HP displacing Oil - Full	RES_REB	All	64.24					
Moderate Income Qualified - Central HP displacing Propane - Full	RES_REB	All	64.24					
Moderate Income Qualified - GSHP displacing Oil	RES_REB	All	75.48					
Moderate Income Qualified - GSHP displacing Propane	RES_REB	All	75.48					
CVEO Moderate - Central Heat Pump fully displacing Oil Heat	RES_TSSF	All	0					
CVEO Moderate - Central Heat Pump fully displacing Propane Heat	RES_TSSF	All	0					
CVEO Affordable - Central Heat Pump fully displacing Oil Heat	RES_TSSF	All	0					
CVEO Affordable - Central Heat Pump fully displacing Propane Heat	RES_TSSF	All	196.46					
Moderate Income Qualified - Central HP Displacing Gas - Full	RES_TSSF	All	64.24					
Moderate Income Qualified - GSHP Displacing Gas	RES_TSSF	All	75.48					
Central HP Displacing Gas - Full	RES_TSSF	All	64.24					
GSHP displacing Gas	RES_TSSF	All	75.48					
Central HP Displacing Gas - Full	RES_REB	All	64.24					

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
GSHP displacing Gas	RES_REB	All	75.48					
Moderate Income Qualified - Central HP Displacing Gas - Full	RES_REB	All	64.24					
Moderate Income Qualified - GSHP Displacing Gas	RES_REB	All	75.48					

Endnotes:

1 : Guidehouse (2024). Heat Pump Metering Study 2024_Guidehouse_Resi_Heat Pump Metering Study
2 : More information on the baseline calculations can be found in the following study: 2021_Guidehouse_Fuel Displacement Report_HP
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 (2023). Baseline Demand Impact Model
2023_Guidehouse_MA_RBUECS_Demand_Impact_Model
5 : The Resolution of the Energy Efficiency Advisory Council Regarding 2025-2027 Three-Year Plan Evaluation, Measurement and Verification Principles and Policy memo - https://ma-eeac.org/wp-content/uploads/2025-2027-Three-Year-Plan-EMV-Policy-Memo-FINAL-1.pdf
6 : 2022 NMR study - 2022_NMR_MA21X21-E-RHPNEI_Residential Heat Pump NEIs Study Final Report_2023

1.26 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 mini split heat pump for heating.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Minisplit HP displacing Oil - Partial	Residential Turnkey Solutions (1-4 units) (RES_TSSF)	EA1b045
Minisplit HP displacing Propane - Partial	Residential Turnkey Solutions (1-4 units) (RES_TSSF)	EA1b046
Moderate Income Qualified - Minisplit HP displacing Electric Resistance	Residential Turnkey Solutions (1-4 units) (RES_TSSF)	EA1b054
Moderate Income Qualified - Minisplit HP displacing Oil - Partial	Residential Turnkey Solutions (1-4 units) (RES_TSSF)	EA1b061
Moderate Income Qualified - Minisplit HP displacing Propane - Partial	Residential Turnkey Solutions (1-4 units) (RES_TSSF)	EA1b062
Moderate Income Qualified - Minisplit HP Displacing Gas - Partial	Residential Turnkey Solutions (1-4 units) (RES_TSSF)	GA1b023
Minisplit HP Displacing Gas - Partial	Residential Turnkey Solutions (1-4 units) (RES_TSSF)	GA1b029
Integrated Controls for HP displacing Oil	Residential Rebates (RES_REB)	EA1d005
Integrated Controls for HP displacing Propane	Residential Rebates (RES_REB)	EA1d006
Minisplit HP displacing Oil - Partial	Residential Rebates (RES_REB)	EA1d011
Minisplit HP displacing Propane - Partial	Residential Rebates (RES_REB)	EA1d012
Moderate Income Qualified - Minisplit HP displacing Electric Resistance	Residential Rebates (RES_REB)	EA1d020
Moderate Income Qualified - Integrated Controls for HP displacing Oil	Residential Rebates (RES_REB)	EA1d023

Measure Name	Core Initiative	BCR Measure ID
Moderate Income Qualified - Integrated Controls for HP displacing Propane	Residential Rebates (RES_REB)	EA1d024
Moderate Income Qualified - Minisplit HP displacing Oil - Partial	Residential Rebates (RES_REB)	EA1d029
Moderate Income Qualified - Minisplit HP displacing Propane - Partial	Residential Rebates (RES_REB)	EA1d030
Integrated Controls for HP displacing Gas	Residential Rebates (RES_REB)	GA1d003
Minisplit HP Displacing Gas - Partial	Residential Rebates (RES_REB)	GA1d006
Moderate Income Qualified - Minisplit HP Displacing Gas - Partial	Residential Rebates (RES_REB)	GA1d029

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. Unit savings are deemed based on a per ton savings. Savings were developed from the Massachusetts and Connecticut Heat Pump Metering Study (MA22R51-B-HPMS)[1] which metered heat pump usage and performance in homes across MA and CT. Heating and cooling baseline weights were developed based on participant survey responses.

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	15.3	-1.03	-1,129
MSHP partially displacing Propane Heat	14.6	-0.87	-927
MSHP partially displacing Electric Resistance	6.1	0.49	1,103
MSHP partially displacing Gas Heat	13.9	-0.89	-938
MSHP Integrated Controls Retrofit Oil*	24.6	-0.71	-1,678
MSHP Integrated Controls Retrofit, Propane*	25.2	-0.71	-1,678
MSHP Integrated Controls Retrofit, Gas*	24.6	-0.71	-1,678

* 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.

Moderate Income Heat Pump Savings

The savings used for moderate income heat pump projects (displacing oil, propane, or gas) align with the Low-Income project savings. Unit savings are deemed based on a per ton savings. Savings were also developed from the Massachusetts and Connecticut Heat Pump Metering Study (MA22R51-B-HPMS) but use different baseline weights than standard income projects.

Measure Name	Saved MMBtu Oil/Propane/Gas (Per Ton)	ΔkW Per Ton	ΔkWh Per Ton
MSHP partially displacing Oil Heat (Moderate Income)	15.9	-1.06	-961
MSHP partially displacing Propane Heat (Moderate Income)	16.3	-1.06	-960
MSHP partially displacing Gas Heat (Moderate Income)	16.3	-1.06	-960

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. [2]

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[3]	OYF	RUL	AML
MSHP partially displacing Any Fuel Heat	RES_REB; RES_TSSF	All	18	n/a	n/a	18
DMSHP Integrated Controls Retrofit	RES_REB; RES_TSSF	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}
Minisplit HP displacing Oil - Partial	RES_TSSF	All	1.00	1.00	1.00	1.00	1.00	0.01	0.26
Minisplit HP displacing Propane - Partial	RES_TSSF	All	1.00	1.00	1.00	1.00	1.00	0.01	0.25
Moderate Income Qualified - Minisplit HP displacing Electric Resistance	RES_TSSF	All	1.00	1.00	1.00	1.00	1.00	-0.02	0.55
Moderate Income Qualified - Minisplit HP displacing Oil - Partial	RES_TSSF	All	1.00	1.00	1.00	1.00	1.00	0.01	0.26
Moderate Income Qualified - Minisplit HP displacing Propane - Partial	RES_TSSF	All	1.00	1.00	1.00	1.00	1.00	0.01	0.25
Integrated Controls for HP displacing Oil	RES_REB	All	1.00	1.00	1.00	1.00	1.00	0.00	0.63
Integrated Controls for HP displacing Propane	RES_REB	All	1.00	1.00	1.00	1.00	1.00	0.00	0.63
Minisplit HP displacing Oil - Partial	RES_REB	All	1.00	1.00	1.00	1.00	1.00	0.01	0.26
Minisplit HP displacing Propane - Partial	RES_REB	All	1.00	1.00	1.00	1.00	1.00	0.01	0.25
Moderate Income Qualified - Minisplit HP displacing Electric Resistance	RES_REB	All	1.00	1.00	1.00	1.00	1.00	-0.02	0.55
Moderate Income Qualified - Integrated Controls for HP displacing Oil	RES_REB	All	1.00	1.00	1.00	1.00	1.00	0.00	0.63

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Moderate Income Qualified - Integrated Controls for HP displacing Propane	RES_REB	All	1.00	1.00	1.00	1.00	1.00	0.00	0.63
Moderate Income Qualified - Minisplit HP displacing Oil - Partial	RES_REB	All	1.00	1.00	1.00	1.00	1.00	0.01	0.26
Moderate Income Qualified - Minisplit HP displacing Propane - Partial	RES_REB	All	1.00	1.00	1.00	1.00	1.00	0.01	0.25
Moderate Income Qualified - Minisplit HP Displacing Gas - Partial	RES_TSSF	All	1.00	1.00	1.00	1.00	1.00	0.01	0.25
Minisplit HP Displacing Gas - Partial	RES_TSSF	All	1.00	1.00	1.00	1.00	1.00	0.01	0.25
Integrated Controls for HP displacing Gas	RES_REB	All	1.00	1.00	1.00	1.00	1.00	0.00	0.63
Minisplit HP Displacing Gas - Partial	RES_REB	All	1.00	1.00	1.00	1.00	1.00	0.01	0.25
Moderate Income Qualified - Minisplit HP Displacing Gas - Partial	RES_REB	All	1.00	1.00	1.00	1.00	1.00	0.01	0.26

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[4] :

Coincidence factors are custom calculated.

Impact Factors for Calculating Net Savings:

Net to gross factors are set to 100% since this is a market transformation initiative and per The Resolution of the Energy Efficiency Advisory Council Regarding 2025-2027 Three-Year Plan Evaluation, Measurement and Verification Principles and Policy memo market transformation initiative may not be subject to net-to-gross factors.[4]

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Minisplit HP displacing Oil - Partial	RES_TSSF	All	0.00	0.00	0.00	1.00

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Minisplit HP displacing Propane - Partial	RES_TSSF	All	0.00	0.00	0.00	1.00
Moderate Income Qualified - Minisplit HP displacing Electric Resistance	RES_TSSF	All	0.00	0.00	0.00	1.00
Moderate Income Qualified - Minisplit HP displacing Oil - Partial	RES_TSSF	All	0.00	0.00	0.00	1.00
Moderate Income Qualified - Minisplit HP displacing Propane - Partial	RES_TSSF	All	0.00	0.00	0.00	1.00
Integrated Controls for HP displacing Oil	RES_REB	All	0.00	0.00	0.00	1.00
Integrated Controls for HP displacing Propane	RES_REB	All	0.00	0.00	0.00	1.00
Minisplit HP displacing Oil - Partial	RES_REB	All	0.00	0.00	0.00	1.00
Minisplit HP displacing Propane - Partial	RES_REB	All	0.00	0.00	0.00	1.00
Moderate Income Qualified - Minisplit HP displacing Electric Resistance	RES_REB	All	0.00	0.00	0.00	1.00
Moderate Income Qualified - Integrated Controls for HP displacing Oil	RES_REB	All	0.00	0.00	0.00	1.00
Moderate Income Qualified - Integrated Controls for HP displacing Propane	RES_REB	All	0.00	0.00	0.00	1.00
Moderate Income Qualified - Minisplit HP displacing Oil - Partial	RES_REB	All	0.00	0.00	0.00	1.00
Moderate Income Qualified - Minisplit HP displacing Propane - Partial	RES_REB	All	0.00	0.00	0.00	1.00
Moderate Income Qualified - Minisplit HP Displacing Gas - Partial	RES_TSSF	All	0.00	0.00	0.00	1.00
Minisplit HP Displacing Gas - Partial	RES_TSSF	All	0.00	0.00	0.00	1.00
Integrated Controls for HP displacing Gas	RES_REB	All	0.00	0.00	0.00	1.00
Minisplit HP Displacing Gas - Partial	RES_REB	All	0.00	0.00	0.00	1.00
Moderate Income Qualified - Minisplit HP Displacing Gas - Partial	RES_REB	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
Minisplit HP displacing Oil - Partial	RES_TSSF	All	$104.35					
Minisplit HP displacing Propane - Partial	RES_TSSF	All	$104.35					
Moderate Income Qualified - Minisplit HP displacing Electric Resistance	RES_TSSF	All	$196.46					
Moderate Income Qualified - Minisplit HP displacing Oil - Partial	RES_TSSF	All	$104.35					
Moderate Income Qualified - Minisplit HP displacing Propane - Partial	RES_TSSF	All	$104.35					
Integrated Controls for HP displacing Oil	RES_REB	All	$292.19					
Integrated Controls for HP displacing Propane	RES_REB	All	$292.19					
Minisplit HP displacing Oil - Partial	RES_REB	All	$104.35					
Minisplit HP displacing Propane - Partial	RES_REB	All	$104.35					
Moderate Income Qualified - Minisplit HP displacing Electric Resistance	RES_REB	All	$196.46					
Moderate Income Qualified - Integrated Controls for HP displacing Oil	RES_REB	All	$292.19					
Moderate Income Qualified - Integrated Controls for HP displacing Propane	RES_REB	All	$292.19					
Moderate Income Qualified -	RES_REB	All						

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
Minisplit HP displacing Oil - Partial			$104.35					
Moderate Income Qualified - Minisplit HP displacing Propane - Partial	RES_REB	All	$104.35					
Moderate Income Qualified - Minisplit HP Displacing Gas - Partial	RES_TSSF	All	$104.35					
Minisplit HP Displacing Gas - Partial	RES_TSSF	All	$104.35					
Integrated Controls for HP displacing Gas	RES_REB	All	$292.19					
Minisplit HP Displacing Gas - Partial	RES_REB	All	$104.35					
Moderate Income Qualified - Minisplit HP Displacing Gas - Partial	RES_REB	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 similar to savings values.

Endnotes:

1 : Guidehouse (2024). Heat Pump Metering Study 2024_Guidehouse_Resi_Heat Pump Metering Study
2 : More information on the baseline methodology can be found in the following report: 2021_Guidehouse_Fuel Displacement Report_HP
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 (2024). Baseline Demand Impact Model
2023_Guidehouse_MA_RBUECS_Demand_Impact_Model
4 : The Resolution of the Energy Efficiency Advisory Council Regarding 2025-2027 Three-Year Plan Evaluation, Measurement and Verification Principles and Policy memo - https://ma-eeac.org/wp-content/uploads/2025-2027-Three-Year-Plan-EMV-Policy-Memo-FINAL-1.pdf
6 : 2022 NMR study - 2022_NMR_MA21X21-E-RHPNEI_Residential Heat Pump NEIs Study Final Report_2023

1.27 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 HP displacing Oil - Partial	Residential Turnkey Solutions (1-4 units) (RES_TSSF)	EA1b041
Central HP displacing Propane - Partial	Residential Turnkey Solutions (1-4 units) (RES_TSSF)	EA1b042
Moderate Income Qualified - Central HP displacing Oil - Partial	Residential Turnkey Solutions (1-4 units) (RES_TSSF)	EA1b057
Moderate Income Qualified - Central HP displacing Propane - Partial	Residential Turnkey Solutions (1-4 units) (RES_TSSF)	EA1b058
Moderate Income Qualified - Central HP Displacing Gas - Partial	Residential Turnkey Solutions (1-4 units) (RES_TSSF)	GA1b021
Central HP Displacing Gas - Partial	Residential Turnkey Solutions (1-4 units) (RES_TSSF)	GA1b027
Central HP displacing Oil - Partial	Residential Rebates (RES_REB)	EA1d007
Central HP displacing Propane - Partial	Residential Rebates (RES_REB)	EA1d008
Moderate Income Qualified - Central HP displacing Oil - Partial	Residential Rebates (RES_REB)	EA1d025
Moderate Income Qualified - Central HP displacing Propane - Partial	Residential Rebates (RES_REB)	EA1d026
Central HP Displacing Gas - Partial	Residential Rebates (RES_REB)	GA1d004
Moderate Income Qualified - Central HP Displacing Gas - Partial	Residential Rebates (RES_REB)	GA1d027

Algorithms for Calculating Primary Energy Impact:

Unit savings are deemed based on a per ton savings. Savings were developed from the Massachusetts and Connecticut Heat Pump Metering Study (MA22R51-B-HPMS)[1] which metered heat pump usage and performance in homes across MA and CT. Heating and cooling baseline weights were developed based on participant survey responses.

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	10.6	-0.90	-920
Central Heat Pump partially displacing Propane Heat	9.7	-0.89	-915
Central Heat Pump partially displacing Gas Heat	10.0	-0.90	-920

Moderate Income Heat Pump Savings

The savings used for moderate income heat pumps align with the Low-Income heat pump savings. Unit savings are deemed based on a per ton savings. Savings were also developed from the Massachusetts and Connecticut Heat Pump Metering Study (MA22R51-B-HPMS) but use different baseline weights than standard income projects.

Measure Name	Saved MMBtu Oil/Propane/Gas (Per Ton)	ΔkW (Per Ton)	ΔkWh (Per Ton)
Central Heat Pump partially displacing Oil Heat (Moderate Income)	10.5	-0.89	-832
Central Heat Pump partially displacing Propane Heat (Moderate Income)	9.8	-0.89	-839
Central Heat Pump partially displacing Gas Heat (Moderate Income)	9.8	-0.89	-839

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. [2]

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.[3]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Central Ducted Heat Pump Partially Displacing Any Fuel Heating	RES_TSSF RES_REB	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 HP displacing Oil - Partial	RES_TSSF	All	1.00	1.00	1.00	1.00	1.00	-0.01	0.25
Central HP displacing Propane - Partial	RES_TSSF	All	1.00	1.00	1.00	1.00	1.00	-0.01	0.25
Moderate Income Qualified - Central HP displacing Oil - Partial	RES_TSSF	All	1.00	1.00	1.00	1.00	1.00	-0.01	0.25
Moderate Income Qualified - Central HP displacing Propane - Partial	RES_TSSF	All	1.00	1.00	1.00	1.00	1.00	-0.01	0.25
Central HP displacing Oil - Partial	RES_REB	All	1.00	1.00	1.00	1.00	1.00	-0.01	0.25
Central HP displacing Propane - Partial	RES_REB	All	1.00	1.00	1.00	1.00	1.00	-0.01	0.25

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Moderate Income Qualified - Central HP displacing Oil - Partial	RES_REB	All	1.00	1.00	1.00	1.00	1.00	-0.01	0.25
Moderate Income Qualified - Central HP displacing Propane - Partial	RES_REB	All	1.00	1.00	1.00	1.00	1.00	-0.01	0.25
Moderate Income Qualified - Central HP Displacing Gas - Partial	RES_TSSF	All	1.00	1.00	1.00	1.00	1.00	-0.01	0.25
Central HP Displacing Gas - Partial	RES_TSSF	All	1.00	1.00	1.00	1.00	1.00	-0.01	0.25
Central HP Displacing Gas - Partial	RES_REB	All	1.00	1.00	1.00	1.00	1.00	-0.01	0.25
Moderate Income Qualified - Central HP Displacing Gas - Partial	RES_REB	All	1.00	1.00	1.00	1.00	1.00	-0.01	0.25

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[4]:

Coincidence factors are PA-calculated to reflect the blend of heating and cooling provided by heat pumps.

Impact Factors for Calculating Net Savings:

Net to gross factors are set to 100% since this is a market transformation initiative and per The Resolution of the Energy Efficiency Advisory Council Regarding 2025-2027 Three-Year Plan Evaluation, Measurement and Verification Principles and Policy memo market transformation initiative may not be subject to net-to-gross factors.[5]

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Central HP displacing Oil - Partial	RES_TSSF	All	0.00	0.00	0.00	1.00
Central HP displacing Propane - Partial	RES_TSSF	All	0.00	0.00	0.00	1.00
Moderate Income Qualified - Central HP displacing Oil - Partial	RES_TSSF	All	0.00	0.00	0.00	1.00
Moderate Income Qualified - Central HP	RES_TSSF	All	0.00	0.00	0.00	1.00

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
displacing Propane - Partial						
Central HP displacing Oil - Partial	RES_REB	All	0.00	0.00	0.00	1.00
Central HP displacing Propane - Partial	RES_REB	All	0.00	0.00	0.00	1.00
Moderate Income Qualified - Central HP displacing Oil - Partial	RES_REB	All	0.00	0.00	0.00	1.00
Moderate Income Qualified - Central HP displacing Propane - Partial	Residential Rebates (RES_REB)	All	0.00	0.00	0.00	1.00
Moderate Income Qualified - Central HP Displacing Gas - Partial	RES_TSSF	All	0.00	0.00	0.00	1.00
Central HP Displacing Gas - Partial	RES_TSSF	All	0.00	0.00	0.00	1.00
Central HP Displacing Gas - Partial	RES_REB	All	0.00	0.00	0.00	1.00
Moderate Income Qualified - Central HP Displacing Gas - Partial	RES_REB	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 similar 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 HP displacing Oil - Partial	RES_TSSF	All	56.18					
Central HP displacing Propane - Partial	RES_TSSF	All	56.18					
Moderate Income Qualified - Central HP displacing Oil - Partial	RES_TSSF	All	56.18					
Moderate Income Qualified - Central HP displacing Propane - Partial	RES_TSSF	All	56.18					
Central HP displacing Oil - Partial	RES_REB	All	56.18					
Central HP displacing Propane -	RES_REB	All	56.18					

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
Partial								
Moderate Income Qualified - Central HP displacing Oil - Partial	RES_REB	All	56.18					
Moderate Income Qualified - Central HP displacing Propane - Partial	RES_TSSF	All	56.18					
Moderate Income Qualified - Central HP Displacing Gas - Partial	RES_TSSF	All	56.18					
Central HP Displacing Gas - Partial	RES_TSSF	All	56.18					
Central HP Displacing Gas - Partial	RES_REB	All	56.18					
Moderate Income Qualified - Central HP Displacing Gas - Partial	RES_REB	All	56.18					

Endnotes:

1 : Guidehouse (2024). Heat Pump Metering Study 2024_Guidehouse_Resi_Heat Pump Metering Study
2 : More information on the baselines and the weighted methodology can be found in the report: 2021_Guidehouse_Fuel Displacement Report_HP
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; Page 1-3, Table 1. GDS_2007_Measure_Life_Report_Residential_and_CI_Lighting_and_HVAC_Measures
4 : Guidehouse (2023). Baseline Demand Impact Model
2023_Guidehouse_MA_RBUECS_Demand_Impact_Model
5 : The Resolution of the Energy Efficiency Advisory Council Regarding 2025-2027 Three-Year Plan Evaluation, Measurement and Verification Principles and Policy memo - https://ma-eeac.org/wp-content/uploads/2025-2027-Three-Year-Plan-EMV-Policy-Memo-FINAL-1.pdf
6 : NMR (2022) - 2022_NMR_MA21X21-E-RHPNEI_Residential Heat Pump NEIs Study Final Report_2023

1.28 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	Residential Turnkey Solutions (1-4 units) (RES_TSSF)	GA1b014
Heat Recovery Ventilator	Residential Turnkey Solutions (5+ units) (RES_TSMF)	GA1c011
Heat Recovery Ventilator	Residential Rebates (RES_REB)	EA1d050
Heat Recovery Ventilator - Midstream	Residential Rebates (RES_REB)	GA1d002
Heat Recovery Ventilator	Residential Rebates (RES_REB)	GA1d022

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. kW savings are derived from the Guidehouse Demand Impact Model.[2]

Measure Name	Core Initiative	ΔMMBtu/Unit	ΔkWh/Unit	ΔkW/Unit
Heat Recovery Ventilator, Gas	All	8.6	-171	-0.10
Heat Recovery Ventilator	RES_REB	8.6	-171	-0.10

The electric HRV measures for oil, gas, and other fuel savings have been combined into a single composite measure. MMBTU and kWh savings are weighted for this composite measure based on historical installations. The weights and resulting MMBTU and kWh impacts are summarized below.

Measure Name	Core Initiative	Weighting	ΔMMBtu/Unit	ΔkWh/Unit
Heat Recovery Ventilator, Oil	RES_REB	77%	6.62	-131.54
Heat Recovery Ventilator, Gas	RES_REB	8%	0.66	-13.15
Heat Recovery Ventilator, Other	RES_REB	15%	1.32	-26.31

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.[3]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Heat Recovery Ventilator	All	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	All	All	1.00	1.00	1.00	1.00	1.00	0.54	0.19

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:

All PAs use statewide net-to-gross values based on study results.[5]

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Heat Recovery Ventilator	RES_REB	All	0.33	0.12	0.01	0.80
Heat Recovery Ventilator, Gas - Midstream	RES_REB	All	0.36	0.12	0.00	0.76
Heat Recovery Ventilator, Gas	RES_REB	All	0.36	0.12	0.00	0.76
Heat Recovery Ventilator, Gas	RES_TSSF	All	0.36	0.12	0.00	0.76
Heat Recovery Ventilator, Gas	RES_TSSF	All	0.14	0.00	0.00	0.86

Non-Energy Impacts:

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

Endnotes:

1 : TRM Study Update 2021_Guidehouse_TRM_Final_Report
2 : Guidehouse (2023). MA RBUECS Demand Impact Model.
2023_Guidehouse_MA_RBUECS_Demand_Impact_Model
3 : GDS Associates, Inc. (2009). Natural Gas Energy Efficiency Potential in Massachusetts.
GDS_2009_Natural_Gas_Energy_Efficiency_Potential_in_MA
4 : Guidehouse (2023). MA RBUECS Demand Impact Model
2023_Guidehouse_MA_RBUECS_Demand_Impact_Model
5 : Guidehouse (2021). Residential Programs Net-to-Gross Research of RCD and Select Products.
2021_Guidehouse_MA_Res_NTG_Final_Report

1.29 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)	Residential Turnkey Solutions (1-4 units) (RES_TSSF)	EA1b022
Pipe Wrap (Heating)	Residential Turnkey Solutions (1-4 units) (RES_TSSF)	GA1b008
Pipe Wrap (Heating)	Residential Turnkey Solutions (5+ units) (RES_TSMF)	EA1c012
Pipe Wrap (Heating)	Residential Turnkey Solutions (5+ units) (RES_TSMF)	GA1c006

Algorithms for Calculating Primary Energy Impact:

Unit savings are deemed based on study results where unit is a household for single family[1] with pipe wrap installed on heating pipes and per linear foot for multifamily[2].

Measure Name	Core Initiative	Δ MMBtu
Pipe Wrap (Heating), Gas	RES_TSSF	1.3
Pipe Wrap (Heating), Oil	RES_TSSF	1.3
Pipe Wrap (Heating), Other	RES_TSSF	1.3
Pipe Wrap (Heating), Gas	RES_TSMF	0.03
Pipe Wrap (Heating), Oil	RES_TSMF	0.02
Pipe Wrap (Heating), Other	RES_TSMF	0.03

Weighted averages for BC model

Measure Name	Core Initiative	BCR ID	ΔkWh	ΔkW	Δ Oil MMBTUs	Δ Propane MMBTUs
Pipe Wrap (Heating)	RES_TSSF	EA1b022			0.16	0.10
Pipe Wrap (Heating)	RES_TSMF	EA1c012	7.3	0.01	0.01	0.00

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.[3]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Pipe Wrap (Heating)	RES_TSSF RES_TSMF	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_TSSF RES_TSMF	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.[4]

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Pipe Wrap (Heating)	RES_TSSF	All	0.04	0.12	0.00	1.08
Pipe Wrap (Heating)	RES_TSMF	All	0.14	0.0	0.0	0.86

Non-Energy Impacts:

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

Endnotes:

1 : Guidehouse (2024). Massachusetts Residential Coordinated Delivery Single Family Impact Evaluation 2024_Guidehouse_RCD_SF_Impact_Eval
2 : Guidehouse (2024). Massachusetts Income-Eligible and Residential Coordinated Delivery Multifamily Impact Evaluation 2024_Guidehouse_MF_Impact_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 : Guidehouse (2021). Residential Programs Net-to-Gross Research of RCD and Select Products Measures: Results Memo 2021_Guidehouse_Res_NTG_Final_Results_Memo

1.30 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	Residential Turnkey Solutions (1-4 units) (RES_TSSF)	EA1b023
Programmable Thermostat	Residential Turnkey Solutions (1-4 units) (RES_TSSF)	GA1b011
Programmable Thermostat	Residential Turnkey Solutions (5+ units) (RES_TSMF)	EA1c017
Programmable Thermostat	Residential Turnkey Solutions (5+ units) (RES_TSMF)	GA1c009
Programmable Thermostat	Residential Rebates (RES_REB)	EA1d051
Programmable Thermostat	Residential Rebates (RES_REB)	GA1d015

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	Core Initiative	ΔkWh	ΔkW	Fuel Oil ΔMMBtu	Propane ΔMMBtu	Gas ΔMMBtu
Programmable Thermostat, Electric	RES_TSSF	181	0.10			
Programmable Thermostat, Gas	RES_TSSF	23	0.01			2.3
Programmable Thermostat, Oil	RES_TSSF	21	0.01	2.1		

Measure Name	Core Initiative	ΔkWh	ΔkW	Fuel Oil ΔMMBtu	Propane ΔMMBtu	Gas ΔMMBtu
Programmable Thermostat, Other	RES_TSSF	19	0.01	2.1		
Programmable Thermostat, Electric Resistance, No AC	RES_TSMF	475	0.23	n/a	n/a	n/a
Programmable Thermostat, Electric Resistance, With AC	RES_TSMF	499	0.24	n/a	n/a	n/a
Programmable Thermostat, AC Only	RES_TSMF	24	0.02	n/a	n/a	n/a
Programmable Thermostat, Heat Pump	RES_TSMF	250	0.12	n/a	n/a	n/a
Programmable Thermostat, Oil	RES_TSMF	24	0.02	0.9	n/a	n/a
Programmable Thermostat, Gas	RES_TSMF	24	0.02	n/a	n/a	1.3
Programmable Thermostat, Electric	RES_REB	278	0.19			
Programmable Thermostat, Gas	RES_REB	27	0.04	2.1		
Programmable Thermostat, Oil	RES_REB	27	0.04		2.1	
Programmable Thermostat, Other	RES_REB	27	0.04			2.1

Weighted averages for BC model

Measure Name	Core Initiative	BCR ID	ΔkWh	ΔkW	Δ Oil MMBTUs	Δ Propane MMBTUs
Programmable Thermostat	RES_TSSF	EA1b023	97.6	0.06	1.05	0.21
Programmable Thermostat	RES_TSMF	EA1c017	509	0.25	0.5	n/a
Programmable Thermostat	RES_REB	EA1d051	144	0.08	1.05	0.21

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 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	RES_TSSF RES_REB	All	19	n/a	n/a	n/a
Programmable Thermostat	RES_TSMF	All	13	n/a	n/a	n/a

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	RES_TSSF	All	0.79	1.00	1.00	1.00	1.00	0.54	0.19
Programmable Thermostat	RES_TSMF	All	1.00	1.00	1.00	1.00	1.00	0	0.58
Programmable Thermostat	RES_REB	All	1.00	1.00	1.00	1.00	1.00	0.54	0.19
Programmable Thermostat	RES_TSSF	All	0.79	1.00	1.00	1.00	1.00	0.54	0.19
Programmable Thermostat	RES_TSMF	All	0.79	1.00	1.00	1.00	1.00	0.54	0
Programmable Thermostat	RES_REB	All	1.00	1.00	1.00	1.00	1.00	0.54	0.19

In-Service Rates:

RCD Single Family in-service rates are blended and based on evaluation results.[7] [8] Retail and Multifamily 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	RES_TSSF	All	0.13	0.12	0.00	0.99
Programmable Thermostat	RES_TSMF	All	0.14	0.00	0.00	0.86
Programmable Thermostat	RES_REB	All	0.58	0.00	0.00	0.42
Programmable Thermostat	RES_TSSF	All	0.25	0.12	0.00	0.87
Programmable Thermostat	RES_REB	All	0.25	0.12	0.00	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
Programmable Thermostat	RES_TSSF	All	$3.63					
Programmable Thermostat	RES_TSMF	All	$14.35					
Programmable Thermostat	RES_REB	All	$3.63					
Programmable Thermostat	RES_TSSF	All	$3.63					
Programmable Thermostat	RES_REB	All	$3.63					

Endnotes:

1 : Guidehouse (2024). Massachusetts Residential Coordinated Delivery Single Family Impact Evaluation 2024_Guidehouse_RCD_SF_Impact_Eval
2 : Guidehouse (2024). Massachusetts Income-Eligible and Residential Coordinated Delivery Multifamily Impact Evaluation 2024_Guidehouse_MF_Impact_Report
3 : Guidehouse (2021). Residential Wi-Fi and Programmable Thermostat Impacts. 2021_Guidehouse_Thermostat_Impact_Study
4 : Guidehouse (2023). MA RBUECS Demand Impact Model 2023_Guidehouse_MA_RBUECS_Demand_Impact_Model
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 (2023). MA RBUECS Demand Impact Model 2023_Guidehouse_MA_RBUECS_Demand_Impact_Model
10 : Guidehouse (2021). Residential Programs Net-to-Gross Research of RCD and Select Products Measures Workbook 2021_Guidehouse_Res_NTG_Final_Results_Memo

1.31 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 Rebates (RES_REB)	EA1d055

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 full load equivalent hours/1000

Where:

Cooling Capacity = 8,000 Btu/hr
Federal Standard CEER (until May 2026) = 10.9[1]
Energy Star CEER (version 5.0) = 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	0.06

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_REB	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_REB	All	1.00	1.00	n/a	1.00	1.00	0.54	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]

Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Room Air Conditioner	RES_REB	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 (2023). MA RBUECS Demand Impact Model 2023_Guidehouse_MA_RBUECS_Demand_Impact_Model
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 (2023). MA RBUECS Demand Impact Model 2023_Guidehouse_MA_RBUECS_Demand_Impact_Model
10 : NMR Group, Inc. (2021). Residential Products NTG Report. 2021_NMR_Res_Products_NTG_Report

1.32 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	Residential Turnkey Solutions (1-4 units) (RES_TSSF)	EA1b018
Faucet Aerator	Residential Turnkey Solutions (1-4 units) (RES_TSSF)	GA1b009
Faucet Aerator	Residential Turnkey Solutions (5+ units) (RES_TSMF)	EA1c013
Faucet Aerator	Residential Turnkey Solutions (5+ units) (RES_TSMF)	GA1c007

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	Core Initiative	ΔkWh	ΔkW	Δ MMBtu
Faucet Aerator, Electric	RES_TSSF	63.0	0.02	
Faucet Aerator, Gas	RES_TSSF			0.4
Faucet Aerator, Oil	RES_TSSF			0.4
Faucet Aerator, Other	RES_TSSF			0.4
Faucet Aerator, Electric	RES_TSMF	50	0.01	
Faucet Aerator, Gas	RES_TSMF			0.3
Faucet Aerator, Oil	RES_TSMF			0.3
Faucet Aerator, Other	RES_TSMF			0.3

Weighted averages for Electric BC model

Measure Name	BCR ID	ΔkWh	ΔkW	Δ Oil MMBTUs	Δ Propane MMBTUs
Faucet Aerator	EA1b018	32.5	0.01	0.02	0.02
Faucet Aerator	EA1c013	40.5	0.01	0.04	0.02

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_TSSF RES_TSMF	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	RES_TSSF	All	0.74	1.00	1.00	1.00	1.00	0.30	0.62
Faucet Aerator	RES_TSMF	All	1.00	1.00	1.00	1.00	1.00	0.30	0.62

In-Service Rates:

For Single Family in-service rates are blended and based on evaluation results.[5] [6] All multifamily 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.[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	RES_TSSF	All	0.04	0.12	0.00	1.08
Faucet Aerator	RES_TSMF	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	RES_TSSF	All						
Faucet Aerator	RES_TSMF	All	$0.58					

Endnotes:

1 : Guidehouse (2024). Massachusetts Residential Coordinated Delivery Single Family Impact Evaluation 2024_Guidehouse_RCD_SF_Impact_Eval
2 : Guidehouse (2024). Massachusetts Income-Eligible and Residential Coordinated Delivery Multifamily Impact Evaluation 2024_Guidehouse_MF_Impact_Report
3 : Guidehouse (2023). MA RBUECS Demand Impact Model 2023_Guidehouse_MA_RBUECS_Demand_Impact_Model
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 (2023). MA RBUECS Demand Impact Model 2023_Guidehouse_MA_RBUECS_Demand_Impact_Model
8 : Guidehouse (2021). Residential Programs Net-to-Gross Research of RCD and Select Products Measures: Results Memo 2021_Guidehouse_Res_NTG_Final_Results_Memo

1.33 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) in place of an electric resistance, oil, propane, or gas water heater.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
HP Water Heater - Small	Residential Turnkey Solutions (1-4 units) (RES_TSSF)	EA1b072
HP Water Heater - Large	Residential Turnkey Solutions (1-4 units) (RES_TSSF)	EA1b073
HP Water Heater displacing Oil - Small	Residential Turnkey Solutions (1-4 units) (RES_TSSF)	EA1b074
HP Water Heater displacing Oil - Large	Residential Turnkey Solutions (1-4 units) (RES_TSSF)	EA1b075
HP Water Heater displacing Propane - Small	Residential Turnkey Solutions (1-4 units) (RES_TSSF)	EA1b076
HP Water Heater displacing Propane - Large	Residential Turnkey Solutions (1-4 units) (RES_TSSF)	EA1b077
Moderate Income Qualified - HP Water Heater - Small	Residential Turnkey Solutions (1-4 units) (RES_TSSF)	EA1b078
Moderate Income Qualified - HP Water Heater - Large	Residential Turnkey Solutions (1-4 units) (RES_TSSF)	EA1b079
Moderate Income Qualified - HP Water Heater displacing Oil - Small	Residential Turnkey Solutions (1-4 units) (RES_TSSF)	EA1b080
Moderate Income Qualified - HP Water Heater displacing Oil - Large	Residential Turnkey Solutions (1-4 units) (RES_TSSF)	EA1b081
Moderate Income Qualified - HP Water Heater displacing Propane - Small	Residential Turnkey Solutions (1-4 units) (RES_TSSF)	EA1b082
Moderate Income Qualified - HP Water Heater displacing Propane - Large	Residential Turnkey Solutions (1-4 units) (RES_TSSF)	EA1b083
HP Water Heater - Small	Residential Rebates (RES_REB)	EA1d037

Measure Name	Core Initiative	BCR Measure ID
HP Water Heater - Large	Residential Rebates (RES_REB)	EA1d038
HP Water Heater displacing Oil - Small	Residential Rebates (RES_REB)	EA1d039
HP Water Heater displacing Oil - Large	Residential Rebates (RES_REB)	EA1d040
HP Water Heater displacing Propane - Small	Residential Rebates (RES_REB)	EA1d041
HP Water Heater displacing Propane - Large	Residential Rebates (RES_REB)	EA1d042
HP Water Heater displacing Gas - Small	Residential Rebates (RES_REB)	GA1d010
HP Water Heater displacing Gas - Large	Residential Rebates (RES_REB)	GA1d011
HP Water Heater - Small	Residential Turnkey Solutions (1-4 units) (RES_TSSF)	GA1b037
HP Water Heater - Large	Residential Turnkey Solutions (1-4 units) (RES_TSSF)	GA1b038
Moderate Income Qualified - HP Water Heater - Small	Residential Turnkey Solutions (1-4 units) (RES_TSSF)	GA1b039
Moderate Income Qualified - HP Water Heater - Large	Residential Turnkey Solutions (1-4 units) (RES_TSSF)	GA1b040

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 (small)	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 (large), UEF 2.70	360	0	0	0	360	0.00025	0.09	0
Heat Pump Water Heater, <55-gallon (small) displacing Oil	-1130	20.0	0	-0.67	-1130	0.00025	-0.28	19.3

Measure Name	Water Heating Savings		Heating Savings (Penalty)		Total Savings			
	ΔkWh	ΔMMBTU	ΔkWh	ΔMMBTU	ΔkWh	Max Load Factor	ΔkW	ΔMMBTU
Heat Pump Water Heater, >55-gallon (large) displacing Oil	-1233	15.9	0	-0.67	-1233	0.00025	-0.31	15.23
Heat Pump Water Heater, <55-gallon (small) displacing Propane	-831	17.1	0	-0.67	-831	0.00025	-0.21	16.4
Heat Pump Water Heater, >55-gallon (large) 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, small)	-831	17.1	0	-0.67	-831	0.00025	-0.21	16.4
Heat Pump Water Heater displacing Existing Water Heater, Gas (>55 Gal, large)	-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 gallons. 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	RES_REB	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 Pump, <55 gallon (small)	RES_REB	All	1.00	1.00	1.00	1.00	1.00	0.30	0.62
Water Heater, Heat Pump, >55 gallon (large)	RES_REB	All	1.00	1.00	1.00	1.00	1.00	0.30	0.62
Heat Pump Water Heater displacing Existing Water Heater, Oil (both < 55 gallon and > 55 gallon, small and large)	RES_REB	All	1.00	1.00	1.00	1.00	1.00	0.30	0.62
Heat Pump Water Heater displacing Existing Water Heater, Propane (both < 55 gallon and > 55 gallon, small and large)	RES_REB	All	1.00	1.00	1.00	1.00	1.00	0.30	0.62
Heat Pump Water Heater displacing Existing Water Heater, Gas (both < 55 gallon and > 55 gallon, small and large)	RES_REB	All	1.00	1.00	1.00	1.00	1.00	0.30	0.62

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[4] **:**
Coincidence factors are based on evaluation results.

Impact Factors for Calculating Net Savings:

Impact factors for net savings:[5]

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Water Heater, Heat Pump, <55 gallon (small)	RES_REB	All	0.30	0.12	0.00	0.82
Water Heater, Heat Pump, >55 gallon (large)	RES_REB	All	0.30	0.12	0.00	0.82
Heat Pump Water Heater displacing Existing Water Heater, Oil (both < 55 gallon and > 55 gallon, small and large)	RES_REB	All	0.30	0.12	0.00	0.82
Heat Pump Water Heater displacing Existing Water Heater, Propane (both < 55 gallon and > 55 gallon, small and large)	RES_REB	All	0.30	0.12	0.00	0.82
Heat Pump Water Heater displacing Existing Water Heater, Gas (both < 55 gallon and > 55 gallon, small and large)	RES_REB	All	0.31	0.22	0.00	0.91

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 (small)	RES_REB	All	$0.70					
Water Heater, Heat Pump, >55 gallon (large)	RES_REB	All	$0.70					
Heat Pump Water Heater displacing Existing Water Heater, Oil (both < 55 gallon and > 55 gallon, small and large)	RES_REB	All	$0.70					

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 displacing Existing Water Heater, Propane (both < 55 gallon and > 55 gallon, small and large)	RES_REB	All	$0.70					
Heat Pump Water Heater displacing Existing Water Heater, Gas (both < 55 gallon and > 55 gallon, small and large)	RES_REB	All	$0.70					

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 (2023). Baseline Demand Impact Model
2023_Guidehouse_MA_RBUECS_Demand_Impact_Model
5 : Guidehouse (2021) - NTG Study 2021_Guidehouse_Res_NTG_Final_Results_Memo

1.34 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	Residential Turnkey Solutions (1-4 units) (RES_TSSF)	EA1b019
Low-Flow Showerhead	Residential Turnkey Solutions (1-4 units) (RES_TSSF)	GA1b010
Low-Flow Showerhead	Residential Turnkey Solutions (5+ units) (RES_TSMF)	EA1c014
Low-Flow Showerhead	Residential Turnkey Solutions (5+ units) (RES_TSMF)	GA1c008
Low-Flow Showerhead	Residential Rebates (RES_REB)	EA1d085
Low-Flow Showerhead	Residential Rebates (RES_REB)	GA1d017

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	Core Initiative	ΔkWh	ΔkW	Δ MMBtu
Low-Flow Showerhead, Electric	RES_TSSF	204	0.05	
Low-Flow Showerhead, Gas	RES_TSSF			1.1
Low-Flow Showerhead, Oil	RES_TSSF			1.2
Low-Flow Showerhead, Other	RES_TSSF			1.1
Low-Flow Showerhead, Electric	RES_TSMF	182	0.05	
Low-Flow Showerhead, Gas	RES_TSMF			1.0
Low-Flow Showerhead, Oil	RES_TSMF			1.1
Low-Flow Showerhead, Other	RES_TSMF			1.0

Measure Name	Core Initiative	ΔkWh	ΔkW	Δ MMBtu
Low-Flow Showerhead	RES_REB			1.2

Weighted averages for BC model

Measure Name	BCR ID	ΔkWh	ΔkW	Δ Oil MMBTUs	Δ Propane MMBTUs
Low-Flow Showerhead	EA1b019	165	0.04	0.14	0.09
Low-Flow Showerhead	EA1d085	165	0.04	0.14	0.09
Low-Flow Showerhead	EA1c014	147	0.04	0.13	0.08

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_TSSF RES_TSMF RES_REBATE	All	15	n/a	n/a	15

Other Resource Impacts:

Water savings for Rebate and Single Family are 2,401 gallons per unit and for Multifamily 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	RES_TSSF	All	0.66	1.00	1.00	n/a	n/a	0.30	0.62
Low-Flow Showerhead	RES_TSMF	All	1.00	1.00	1.00	n/a	n/a	0.30	0.62
Low-Flow Showerhead	RES_REB	All	0.78	1.00	1.00	n/a	n/a	n/a	n/a

In-Service Rates:
For Single Family in-service rates are blended and based on evaluation results.[6] [7] All multifamily 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] [10]

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Low-Flow Showerhead	RES_TSSF	All	0.04	0.12	0.00	1.08
Low-Flow Showerhead	RES_TSMF	All	0.14	0.0	0.0	0.86
Low-Flow Showerhead	RES_REB	All	0.0	0.0	0.00	0.96

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	RES_TSSF	All		$0.03				
Low-Flow Showerhead	RES_TSMF	All	$0.58					
Low-Flow Showerhead	RES_REB	All		$0.03				

Endnotes:

1 : The Cadmus Group (2012). Massachusetts Multifamily Program Impact Analysis July 2012 – Revised May 2013. 2024_Guidehouse_MF_Impact_Report
2 : Guidehouse (2024). Massachusetts Residential Coordinated Delivery Single Family Impact Evaluation 2024_Guidehouse_MF_Impact_Report
3 : Guidehouse (2023). MA RBUECS Demand Impact Model 2023_Guidehouse_MA_RBUECS_Demand_Impact_Model
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 (2023). MA RBUECS Demand Impact Model
2023_Guidehouse_MA_RBUECS_Demand_Impact_Model
9 : Guidehouse (2021). Residential Programs Net-to-Gross Research of RCD and Select Products Measures: Results Memo 2021_Guidehouse_Res_NTG_Final_Results_Memo
10 : NMR Group, Inc. (2021). Residential Products NTG Report.
2021_NMR_Res_Products_NTG_Report

1.35 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	Residential Turnkey Solutions (5+ units) (RES_TSMF)	EA1c015
Low-Flow Showerhead with TSV	Residential Turnkey Solutions (5+ units) (RES_TSMF)	GA1c012
Low-Flow Showerhead with TSV	Residential Rebates (RES_REB)	EA1d045
Low-Flow Showerhead with TSV	Residential Rebates (RES_REB)	GA1d018

Algorithms for Calculating Primary Energy Impact:

Unit savings are deemed based on 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	Core Initiative	ΔkWh	ΔkW	Δ MMBtu
Low-Flow Showerhead with TSV, Electric	RES_TSMF	237	0.06	
Low-Flow Showerhead with TSV, Gas	RES_TSMF			1.3
Low-Flow Showerhead with TSV, Oil	RES_TSMF			1.4
Low-Flow Showerhead with TSV, Other	RES_TSMF			1.3
Low-Flow Showerhead with TSV, Electric	RES_REB	247	0.06	
Low-Flow Showerhead with TSV, Gas	RES_REB			1.22
Low-Flow Showerhead with TSV, Oil	RES_REB			1.32
Low-Flow Showerhead with TSV, Other	RES_REB			1.22

Weighted averages for BC model

Measure Name	BCR ID	ΔkWh	ΔkW	Δ Oil MMBTUs	Δ Propane MMBTUs
Low-Flow Showerhead with TSV	EA1c015	192	0.05	0.17	0.1
Low-Flow Showerhead with TSV	EA1d045	200	0.05	0.16	0.1

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.[4]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Low-Flow Showerhead with TSV	RES_TSMF RES_REB	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.[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 with TSV	RES_TSMF	All	1.00	1.00	1.00	1.00	1.00	0.30	0.62
Low-Flow Showerhead with TSV	RES_REB	All	0.78	1.00	1.00	1.00	1.00	0.30	0.62

In-Service Rates:

In-Service rate for Res Retail is based on evaluation results.[6]

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.[7]

Impact Factors for Calculating Net Savings:

Net to gross factors are based on evaluation results.[8] [9]

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Low-Flow Showerhead with TSV	RES_TSMF	All	0.14	0.0	0.0	0.86
Low-Flow Showerhead with TSV	RES_REB	All	0.04	0.0	0.00	0.96

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	RES_REB	All		$0.03				
Low-Flow Showerhead with TSV	RES_TSMF	All	$0.58					

Endnotes:

1 : Guidehouse (2021). Comprehensive TRM Review. 2021_Guidehouse_TRM_Final_Report
2 : Guidehouse (2024). Massachusetts Income-Eligible and Residential Coordinated Delivery Multifamily Impact Evaluation 2024_Guidehouse_MF_Impact_Report
3 : Guidehouse (2023). MA RBUECS Demand Impact Model 2023_Guidehouse_MA_RBUECS_Demand_Impact_Model
4 : Guidehouse (2021). Comprehensive TRM Review. 2021_Guidehouse_TRM_Final_Report
5 : National_Grid_2014_ShowerStart_Savings_Final_2015-2-9
6 : NMR Group Inc. (2021). Residential Products In-Service Rates Memo. 2021_NMR_Products_ISR
7 : Guidehouse (2023). MA RBUECS Demand Impact Model 2023_Guidehouse_MA_RBUECS_Demand_Impact_Model
8 : Guidehouse (2021). Residential Programs Net-to-Gross Research of RCD and Select Products Measures: Results Memo 2021_Guidehouse_Res_NTG_Final_Results_Memo
9 : NMR Group, Inc. (2021). Residential Products NTG Report. 2021_NMR_Res_Products_NTG_Report

1.36 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 wraps.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Pipe Insulation	Residential Rebates (RES_REB)	GA1d014
Pipe Insulation	Residential Rebates (RES_REB)	EA1d084

Algorithms for Calculating Primary Energy Impact:

Unit kWh and MMBtu savings are based on the hot water pipe wrap insulation from the 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]

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_REB	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_REB	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_REB	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 (2023). MA RBUECS Demand Impact Model
2023_Guidehouse_MA_RBUECS_Demand_Impact_Model
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 (2023). MA RBUECS Demand Impact Model
2023_Guidehouse_MA_RBUECS_Demand_Impact_Model

1.37 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)	Residential Turnkey Solutions (1-4 units) (RES_TSSF)	EA1b017
Pipe Wrap (Water Heating)	Residential Turnkey Solutions (1-4 units) (RES_TSSF)	GA1b007
Pipe Wrap (Water Heating)	Residential Turnkey Solutions (5+ units) (RES_TSMF)	EA1c011
Pipe Wrap (Water Heating)	Residential Turnkey Solutions (5+ units) (RES_TSMF)	GA1c005

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 for Single Family,[1] and deemed per linear foot of pipe insulation for Multifamily[2]. Demand savings are derived from the demand impact model which is developed as part of the Residential Baseline Study.[3]

Measure Name	Core Initiative	ΔkWh	ΔkW	Δ MMBtu
Pipe Wrap (Water Heating), Electric	RES_TSSF	42	0.01	
Pipe Wrap (Water Heating), Gas	RES_TSSF			0.3
Pipe Wrap (Water Heating), Oil	RES_TSSF			0.5
Pipe Wrap (Water Heating), Other	RES_TSSF			0.3
Pipe Wrap (Water Heating), Electric	RES_TSMF	9	0.01	
Pipe Wrap (Water Heating), Gas	RES_TSMF			0.06
Pipe Wrap (Water Heating), Oil	RES_TSMF			0.07
Pipe Wrap (Water Heating), Other	RES_TSMF			0.06

Weighted averages for Electric BC model

Measure Name	BCR ID	ΔkWh	ΔkW	Δ Oil MMBTUs	Δ Propane MMBTUs
Pipe Wrap (Water Heating)	EA1b017	34	0.01	0.10	0.02
Pipe Wrap (Water Heating)	EA1c011	7.3	0.002	0.01	0.005

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_TSSF RES_TSMF	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)	RES_TSSF	All	1.00	1.00	1.00	1.00	1.00	0.30	0.62
Pipe Wrap (Water Heating)	RES_TSMF	All	1.00	1.00	1.00	1.00	1.00	0.30	0.62

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)	RES_TSSF	All	0.04	0.12	0.00	1.08
Pipe Wrap (Water Heating)	RES_TSMF	All	0.14	0.0	0.0	0.86

Non-Energy Impacts:

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

Endnotes:

1 : Guidehouse (2024). Massachusetts Residential Coordinated Delivery Single Family Impact Evaluation 2024_Guidehouse_RCD_SF_Impact_Eval
2 : Guidehouse (2024). Massachusetts Income-Eligible and Residential Coordinated Delivery Multifamily Impact Evaluation 2024_Guidehouse_MF_Impact_Report
3 : Guidehouse (2023). MA RBUECS Demand Impact Model
2023_Guidehouse_MA_RBUECS_Demand_Impact_Model
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 (2023). MA RBUECS Demand Impact Model
2023_Guidehouse_MA_RBUECS_Demand_Impact_Model
6 : Guidehouse (2021). Residential Programs Net-to-Gross Research of RCD and Select Products Measures: Results Memo 2021_Guidehouse_Res_NTG_Final_Results_Memo

1.38 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	Residential Turnkey Solutions (5+ units) (RES_TSMF)	EA1c016
Thermostatic Shut-off Valve	Residential Turnkey Solutions (5+ units) (RES_TSMF)	GA1c013
Thermostatic Shut-off Valve	Residential Rebates (RES_REB)	EA1d046
Thermostatic Shut-off Valve	Residential Rebates (RES_REB)	GA1d019

Algorithms for Calculating Primary Energy Impact:

The unit savings are deemed based on engineering analysis and 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	Core Initiative	ΔkWh	ΔkW	Δ MMBtu
Thermostatic Shut-off Valve, Electric	RES_TSMF	76	0.02	
Thermostatic Shut-off Valve, Gas	RES_TSMF			0.38
Thermostatic Shut-off Valve, Oil	RES_TSMF			0.43
Thermostatic Shut-off Valve, Other	RES_TSMF			0.38
Thermostatic Shutoff Valve, Elec	RES_REB	76	0.02	
Thermostatic Shutoff Valve, Gas	RES_REB			0.38
Thermostatic Shutoff Valve, Oil	RES_REB			0.43
Thermostatic Shutoff Valve, Other	RES_REB			0.38

Weighted averages for Electric BC model

Measure Name	BCR ID	ΔkWh	ΔkW	Δ Oil MMBTUs	Δ Propane MMBTUs
Thermostatic Shutoff Valve	EA1c016	62	0.02	0.05	0.03
Thermostatic Shutoff Valve	EA1d046	62	0.02	0.05	0.03

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.[4]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Thermostatic Shut-off Valve	RES_TSMF RES_REB	All	15	n/a	n/a	15

Other Resource Impacts:

In RES_REB the water savings are 621 gallons per unit. In TSMF the water savings are 558 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}
Thermostatic Shut-off Valve	RES_TSMF	All	1.00	1.00	1.00	1.00	1.00	0.30	0.62
Thermostatic Shut-off Valve	RES_REB	All	0.78	1.00	1.00	1.00	1.00	0.30	0.62

In-Service Rates:

In TSMF all installations have 100% in service rate. Res Rebate 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 based on evaluation results.[7] [8]

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Thermostatic Shut-off Valve	RES_TSMF	All	0.14	0.0	0.0	0.86
Thermostatic Shutoff Valve	RES_REB	All	0.04	0.00	0.00	0.96

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 : Guidehouse (2024). Massachusetts Income-Eligible and Residential Coordinated Delivery Multifamily Impact Evaluation 2024_Guidehouse_MF_Impact_Report
3 : Guidehouse (2023). MA RBUECS Demand Impact Model
2023_Guidehouse_MA_RBUECS_Demand_Impact_Model
4 : Guidehouse (2021). Comprehensive TRM Review. 2021_Guidehouse_TRM_Final_Report
5 : 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 : Guidehouse (2023). MA RBUECS Demand Impact Model
2023_Guidehouse_MA_RBUECS_Demand_Impact_Model
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

1.39 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
Lighting Occupancy Sensor, Common Area	Residential Turnkey Solutions (1-4 units) (RES_TSSF)	EA1b025
Lighting Occupancy Sensor, Common Area	Residential Turnkey Solutions (5+ units) (RES_TSMF)	EA1c021

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	0.32	0.22

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 from the C&I Impact Shape Study.[1]

Impact Factors for Calculating Net Savings:

Net to gross factors for Residential Coordinated Delivery are from the Guidehouse NTG evaluation.[2]

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Lighting Occupancy Sensor, Common Area	RES_TSSF	All				1.080
Lighting Occupancy Sensor, Common Area	RES_TSMF	All	0.14			0.860
Lighting Occupancy Sensor, Common Area	CI_MF	All	0.14			0.860

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_TSSF, RES_TSMF	All						

Endnotes:

1 : DNV (2024). C&I Impact Shape Study 2024_DNV_C&I_Impact Shape Study

2 : Guidehouse (2021). Massachusetts Residential Programs Net-to-Gross Research of RCD and Select Products Measures. 2021_Guidehouse_MA_Res_NTG_Final_Report

1.40 Lighting - Residential

Measure Code	RES-L-LEDB
Market	Residential
Program Type	Lost Opportunity, 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 Fixture, Indoor Common Area	Residential Turnkey Solutions (5+ units) (RES_TSMF)	EA1c039
LED Fixture, Linear Indoor Common Area	Residential Turnkey Solutions (5+ units) (RES_TSMF)	EA1c040
LED Fixture, Outdoor Common Area	Residential Turnkey Solutions (5+ units) (RES_TSMF)	EA1c041

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, 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 Fixture, Indoor Common Area LED Fixture, Linear Indoor Common Area LED Fixture, Outdoor Common Area	RES_TSMF	Vendor Input	Varies by Space Type	Calculated	Calculated
LED Fixture, Indoor Common Area LED Fixture, Linear Indoor Common Area LED Fixture, Outdoor Common Area	CI_MF	Vendor Input	Varies by Space Type	Calculated	Calculated

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 all Common Area 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 Fixture, Indoor Common Area	RES_TSMF, CI_MF	All	6	n/a	n/a	6
LED Fixture, Linear Indoor Common Area	RES_TSMF, CI_MF	All	8	n/a	n/a	8
LED Fixture, Outdoor Common Area	RES_TSMF, CI_MF	All	11	n/a	n/a	11

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 Fixture, Indoor Common Area LED Fixture, Linear Indoor Common Area	RES_TSMF, CI_MF	All	1.00	1.00	1.00	1.00	1.00	0.88	0.71
LED Fixture, Outdoor Common Area	RES_TSMF, CI_MF	All	1.00	1.00	1.00	1.00	1.00	0.32	0.86

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 and the C&I Impact Shape Study.[7] [8]

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.[9]

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
LED Fixture, Indoor Common Area LED Fixture, Linear Indoor Common Area LED Fixture, Outdoor Common Area	RES_TSMF	All	0.14			0.86

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
LED Fixture, Indoor Common Area LED Fixture, Linear Indoor Common Area LED Fixture, Outdoor Common Area	CI_MF	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
LED Fixture, Indoor Common Area	RES_TSMF	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_TSMF	All			$0.027			
LED Fixture, Outdoor Common Area	RES_TSMF	All			$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 : DNV (2024). C&I Impact Shape Study 2024_DNV_C&I_Impact Shape Study
9 : Guidehouse (2021). Massachusetts Residential Programs Net-to-Gross Research of RCD and Select Products Measures. 2021_Guidehouse_MA_Res_NTG_Final_Report

1.41 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
HP Pool Heater displacing Electric Heat	Residential Rebates (RES_REB)	EA1d043
HP Pool Heater displacing Propane	Residential Rebates (RES_REB)	EA1d044

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	1.5	
Heat Pump Pool Heater displacing propane	-340	-0.28	7.68

Baseline Efficiency:

The baseline efficiency case is 83% efficient propane pool heater or a 98% efficient electric 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_REB	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_REB	All	1.00	1.00	n/a	1.00	1.00	0.82	0.00
Heat Pump Pool Heater displacing propane	RES_REB	All	1.00	1.00	n/a	1.00	1.00	0.82	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_REB	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.eia.gov/consumption/residential/data/2015/
2 : Guidehouse (2023). MA RBUECS Demand Impact Model
2023_Guidehouse_MA_RBUECS_Demand_Impact_Model
3 : Brookhaven National Laboratory (2009)
4 : NY and NH TRMs
5 : Guidehouse (2023). MA RBUECS Demand Impact Model
2023_Guidehouse_MA_RBUECS_Demand_Impact_Model

1.42 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	Residential Rebates (RES_REB)	EA1d057

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	0.12

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_REB	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_REB	All	1.00	1.00	n/a	1.00	1.00	0.82	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]

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Pool Pump	RES_REB	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 (2023). MA RBUECS Demand Impact Model 2023_Guidehouse_MA_RBUECS_Demand_Impact_Model
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 (2023). MA RBUECS Demand Impact Model 2023_Guidehouse_MA_RBUECS_Demand_Impact_Model
6 : NMR Group, Inc. (2021). Residential Products NTG Report. 2021_NMR_Res_Products_NTG_Report

1.43 Other - Standards Adoption

Measure Code	RES-CM-CSA
Market	Residential
Program Type	Lost Opportunity, New Construction
Category	Other

Measure Description:

Standards Advocacy work focuses on engaging with stakeholders to advocate for higher appliance standards. This Advocacy is on both the state and federal level.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Standards Adoption	Residential Rebates (RES_REB)	EA1d080
Standards Adoption	Residential Rebates (RES_REB)	GA1d033

Algorithms for Calculating Primary Energy Impact:

2025-2027 savings are based on Program Administrator activity in advocating for the passage of appliance standards passed in the 2021 Climate Act and are based on study results.[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

Savings (kWh)			
PA	**2025**	**2026**	**2027**
CLC	49,057	48,732	48,410
Eversource	301,246	299,252	297,271
National Grid	326,834	324,671	322,522
Unitil	7,077	7,030	6,984

Savings (MMBtu)			
PA	**2025**	**2026**	**2027**
Berkshire Gas	0.02	0.02	0.02
Eversource Gas of Massachusetts	0.19	0.19	0.19
Eversource Gas	0.17	0.17	0.17
Liberty Utilities	0.04	0.04	0.04
National Grid	0.57	0.57	0.57
Unitil	0.01	0.01	0.01

Baseline Efficiency:

The baseline level of efficiency for would correspond to the appliance standard that would have been in place without the intervention of the Program Administrators.

High Efficiency:

The high efficiency case would be the appliance standard that was advocated for by the Program Administrators.

Measure Life:

Measure lives for Standards Adoption are based on evaluation results.[3]

Measure Name	Core Initiative	PA	2025	2026	2027
Standards Adoption, Electric	RES_REB	All	8	8	8
Standards Adoption, Gas	RES_REB	All	11	10	10

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}
Standards Adoption	RES_REB	All	1.00	1.00	1.00	1.00	1.00	0.65	0.80

In-Service Rates:
All PAs use 100% in service rate.

Realization Rates:
All PAs use 100% realization rates.

Coincidence Factors:
Coincidence Factors are based on study results.[4]

Impact Factors for Calculating Net Savings:

The attribution factor is based on study results.[5]

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Standards Adoption	RES_REB	All	n/a	n/a	n/a	0.20

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 (2023). Appliance Standards Gross Savings. 2023_NMR_MA23X12-B-ASGS_Appliance Standards Gross Savings Report_FINAL_2023
4 : Guidehouse (2020). Residential Baseline Study Phase 4
2020_Guidehouse_Residential_Baseline_Phase_4
5 : NMR (2023). Standards Promulgation Attribution Report. 2023_NMR_MA22X01-B-SPA_Standards Promulgation Attribution Report FINAL_19may23

1.44 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 Turnkey Solutions (1-4 units) (RES_TSSF)	EA1b026
Smart Strip, Tier 1	Residential Turnkey Solutions (1-4 units) (RES_TSSF)	GA1b015
Smart Strip, Tier 1	Residential Turnkey Solutions (5+ units) (RES_TSMF)	EA1c019
Smart Strip, Tier 1	Residential Turnkey Solutions (5+ units) (RES_TSMF)	GA1c017
Smart Strip, Tier 1	Residential Rebates (RES_REB)	EA1d058
Smart Strip, Tier 2	Residential Rebates (RES_REB)	EA1d059

Algorithms for Calculating Primary Energy Impact:

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

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, Tier 1 Smart Strip, Tier 2	All	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_TSSF RES_TSMF	All	0.73	0.92	n/a	0.92	0.92	1.00	1.00
Smart Strip, Tier 2	RES_TSSF RES_TSMF	All	0.73	0.92	0.92	0.92	0.92	1.00	1.00
Smart Strip, Tier 1	RES_REB	All	0.83	0.92	0.92	0.92	0.92	1.00	1.00
Smart Strip, Tier 2	RES_REB	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.[2] [3] For Retail In-service rates are based on consumer surveys, as found in the referenced study.[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 from the referenced study.[6]

Impact Factors for Calculating Net Savings:

Net to gross factors are based on study results.[7] 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.

Measure	Core Initiative	PA	NTG
Smart Strip, Tier 1	RES_TSSF, RES_TSMF	All	0.92

Measure	Core Initiative	PA	NTG
Smart Strip, Tier 2	RES_TSSF, RES_TSMF	All	0.92
Smart Strip, Tier 1	RES_REB	All	0.88
Smart Strip, Tier 2	RES_REB	All	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 (2021). Virtual Home Energy Assessment Study. 2021_Guidehouse_VHEA_Report_FINAL
3 : Guidehouse (2021). RCD ISR Analysis. 2021_Guidehouse_RCD ISR 2020 Analysis_FINAL
4 : NMR Group Inc. (2021). Residential Products In-Service Rates Memo. 2021_NMR_Products_ISR
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
7 : NMR Group, Inc. (2021). Residential Products NTG Report. 2021_NMR_Res_Products_NTG_Report

1.45 Plug Load - Small Equipment Electrification

Measure Code	RES-HVAC-ELEC
Market	Residential
Program Type	Lost Opportunity
Category	Plug Load

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 Rebates (RES_REB)	EA1d068
Electric Leaf blower	Residential Rebates (RES_REB)	EA1d069
Electric Trimmer	Residential Rebates (RES_REB)	EA1d070
Electric Chainsaw	Residential Rebates (RES_REB)	EA1d071

Algorithms for Calculating Primary Energy Impact:

Unit kWh savings are deemed 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	ΔkWh	ΔkW
Electric Lawnmower	RES_REB	-38	-0.011
Electric Leaf blower	RES_REB	-12	-0.004
Electric Trimmer	RES_REB	-10	-0.003
Electric Chainsaw	RES_REB	-19	-0.006

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_REB	All	7	n/a	n/a	7
Electric Leaf blower	RES_REB	All	8	n/a	n/a	8
Electric Trimmer	RES_REB	All	8	n/a	n/a	8
Electric Chainsaw	RES_REB	All	8	n/a	n/a	8

Other Resource Impacts:

Measure Name	Core Initiative	PA	Gasoline (MMBTUs)[4]
Electric Lawnmower	RES_REB	All	0.54
Electric Leaf blower	RES_REB	All	0.16
Electric Trimmer	RES_REB	All	0.14
Electric Chainsaw	RES_REB	All	0.28

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_REB	All	1.00	1.00	1.00	1.00	1.00	0.38	0.78
Electric Leaf blower	RES_REB	All	1.00	1.00	1.00	1.00	1.00	0.38	0.78
Electric Trimmer	RES_REB	All	1.00	1.00	1.00	1.00	1.00	0.38	0.78
Electric Chainsaw	RES_REB	All	1.00	1.00	1.00	1.00	1.00	0.38	0.78

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[6]
Electric Lawnmower	RES_REB	All				0.75
Electric Leaf blower	RES_REB	All				0.79
Electric Trimmer	RES_REB	All				0.70
Electric Chainsaw	RES_REB	All				0.70

Non-Energy Impacts:

There are no non-energy impacts for this measure.

Endnotes:

1 : Guidehouse (2024). Small Equipment Electrification Measure Assessment
2024_Guidehouse_Small_Equipment_Electrification_Measure_Assessment
2 : Guidehouse (2023). MA RBUECS Demand Impact Model
2023_Guidehouse_MA_RBUECS_Demand_Impact_Model
3 : Vermont Act 56 Tier III Technical Advisory Group 2020 Annual Report
4 : Guidehouse (2024). Small Equipment Electrification Measure Assessment
2024_Guidehouse_Small_Equipment_Electrification_Measure_Assessment
5 : Guidehouse (2023). MA RBUECS Demand Impact Model
2023_Guidehouse_MA_RBUECS_Demand_Impact_Model
6 : Guidehouse (2024). Small Equipment Electrification Measure Assessment
2024_Guidehouse_Small_Equipment_Electrification_Measure_Assessment

1.46 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 Turnkey Solutions (1-4 units) (RES_TSSF)	EA1b028
Vending Misers	Residential Turnkey Solutions (5+ units) (RES_TSMF)	EA1c022

Algorithms for Calculating Primary Energy Impact:

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	Core Initiative	ΔkWh	ΔkW
Vending Misers	RES_TSSF RES_TSMF	1,612	0.32

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.[4]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Vending Misers	RES_TSSF RES_TSMF	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_TSSF RES_TSMF	All	1.00	1.00	n/a	1.00	1.00	0.68	0.72

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. [5] [6]

Coincidence Factors:

Coincidence factors are estimated using the demand allocation methodology described in the Demand Impact Model.[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
Vending Misers	RES_TSSF	All	0.04	0.12	0.00	1.08
Vending Misers	RES_TSMF	All	0.14	0.00	0.00	0.86

Non-Energy Impacts:

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

Endnotes:

1 : Guidehouse (2024). Massachusetts Residential Coordinated Delivery Single Family Impact Evaluation 2024_Guidehouse_RCD_SF_Impact_Eval

2 : Guidehouse (2024). Massachusetts Income-Eligible and Residential Coordinated Delivery

Multifamily Impact Evaluation 2024_Guidehouse_MF_Impact_Report
3 : Guidehouse (2023). MA RBUECS Demand Impact Model
2023_Guidehouse_MA_RBUECS_Demand_Impact_Model
4 : Energy & Resource Solutions (2005). Measure Life Study. ERS_2005_Measure_Life_Study
5 : Guidehouse (2024). Massachusetts Residential Coordinated Delivery Single Family Impact Evaluation 2024_Guidehouse_RCD_SF_Impact_Eval
6 : Guidehouse (2024). Massachusetts Income-Eligible and Residential Coordinated Delivery Multifamily Impact Evaluation 2024_Guidehouse_MF_Impact_Report
7 : Guidehouse (2023). MA RBUECS Demand Impact Model
2023_Guidehouse_MA_RBUECS_Demand_Impact_Model
8 : Guidehouse (2021). Residential Programs Net-to-Gross Research of RCD and Select Products.
2021_Guidehouse_MA_Res_NTG_Final_Report

1.47 Whole Building - Embodied Carbon

Measure Code	RES-WB-EC
Market	Residential
Program Type	Carbon Mitigation
Category	Whole Building

Measure Description:

Measures that reduce the cradle-to-gate (materials and construction phase) GWP intensity of a structure.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Embodied Carbon	RES_NH&R	EA1a008

Algorithms for Calculating Primary Energy Impact:

No primary energy impacts.

Baseline Efficiency:

The baseline case is whatever materials would be used for the structure absent the program.

High Efficiency:

The high efficiency case is the bill of materials for the structure post program.

Measure Life:

This measure reflects the GWP of the structure once completed, it is cradle-to-gate and so does not include use-phase impacts. As such there is no meaningful measure life.

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Embodied Carbon	RES_NH&R	Statewide	1	n/a	n/a	1

Other Resource Impacts:

This measure is claiming credit for reduced GWP intensity of the built structure, as compared to the baseline case (e.g., from using locally sourced materials with fewer transport-associated GHG emissions, or using low- or zero-carbon concrete, etc.).

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}
Embodied Carbon	RES_NH&R	Statewide	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Impact Factors for Calculating Net Savings:

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Embodied Carbon	RES_NH&R	Statewide	n/a	n/a	n/a	1.0

Non-Energy Impacts:

This measure reflects only Social Cost of Carbon impacts from reduced GWP intensity.

1.48 Whole Building - Residential New Construction

Measure Code	RES-BE-RNC
Market	Residential
Program Type	New Construction
Category	Whole Building

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 Low Rise (Single Family)	Residential New Homes & Renovations (RES_NH&R)	EA1a001
RNC Low Rise (Multifamily)	Residential New Homes & Renovations (RES_NH&R)	EA1a002
RNC High Rise (Multifamily)	Residential New Homes & Renovations (RES_NH&R)	EA1a003
RNC Electrification (Single Family)	Residential New Homes & Renovations (RES_NH&R)	EA1a005
R&A	Residential New Homes & Renovations (RES_NH&R)	EA1a006
RNC Electrification (Multifamily)	Residential New Homes & Renovations (RES_NH&R)	EA1a007

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] For Single Family, space heating saves 35 MMBTU of gas and 21 MMBTU of propane with a 7,490 kWh electric penalty; water heating saves 7 MMBTU of gas and 4 MMBTU of propane with a 1,110 kWh electric penalty. For Multifamily, space heating saves 32 MMBTU of gas and 1 MMBTU of propane with a 3,522 kWh electric penalty; water heating saves 7 MMBTU of gas and 0 MMBTU of propane with a 898 kWh electric penalty.[2] Program attribution is adjusted using net-to-gross factors, the kW-per-kWh = 0.00049[3]

Baseline Efficiency:

The User-Defined Reference Home (UDRH) is used for low-rise projects. The single-family values were updated in early 2020[4] and adjustments were made for low-rise multifamily in starting in 2022.[5]

The Multifamily High-Rise baseline is evaluated separately.[6]

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.[7]

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
RNC Low Rise (Single Family) RNC Low Rise (Multifamily) RNC High Rise (Multifamily) RNC Electrification (Single Family) RNC Electrification (Multifamily) R&A	RES_NH&R	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	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
RNC Low Rise (Single Family) RNC Low Rise (Multifamily) RNC High Rise (Multifamily) RNC Electrification (Single Family) RNC Electrification (Multifamily) R&A	RES_NH&R	All	1.00	1.00	1.00	1.00	1.00	0.54	0.58

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 MA RBUECS Demand Impact Model.[8]

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 set to 100% since this is a market transformation initiative and per The Resolution of the Energy Efficiency Advisory Council Regarding 2025-2027 Three-Year Plan Evaluation, Measurement and Verification Principles and Policy memo market transformation initiatives may not be subject to net-to-gross factors.[9]

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
RNC Low Rise (Single Family) RNC Low Rise (Multifamily) RNC High Rise (Multifamily) RNC Electrification (Single Family) RNC Electrification (Multifamily) R&A	RES_NH&R	All	1.00	0.00	1.00	1.00

Non-Energy Impacts:

NEI values are rolled up, component values can be found in Appendix B.[10] 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
RNC Low Rise (Single Family) RNC Low Rise (Multifamily) R&A	RES_NH&R	All	$142.33					

Endnotes:

1 : NMR (2024). MA RNC UDRH Ad Hoc Memo on Standard Practice Fuel Choices for Heating and Water Heating. 2024_NMR_RNC_UDRH_Memo
2 : MA RNC Electrification Savings Analysis for 2025-2027 Plan .
MA_RNC_Electrification_SavingsAnalysis_2025-27
3 : Guidehouse (2023). MA RBUECS Demand Impact Model
2023_Guidehouse_MA_RBUECS_Demand_Impact_Model
4 : NMR Group, Inc. (2019). 2019 Residential New Construction Baseline/Compliance Study.
2019_NMR_RNC-LowRise-UDRH_Baseline
5 : NMR Group Inc. (2022). Massachusetts Multifamily Low-Rise New Construction Baseline Study.
2022_NMR_RNC MF LowRise Baseline Study
6 : NMR Group Inc. (2017). Massachusetts Multifamily High Rise Baseline Study.
NMR_2017_MA_MFHR_Baseline
7 : NMR Group, Inc. (2019). Renovations and Additions Market Characterization and Potential Savings Study. 2019_NMR_R&A-Market-Potential
8 : Guidehouse (2023). MA RBUECS Demand Impact Model
2023_Guidehouse_MA_RBUECS_Demand_Impact_Model
9 : https://ma-eeac.org/wp-content/uploads/2025-2027-Three-Year-Plan-EMV-Policy-Memo-FINAL-1.pdf
10 : NMR Group, Inc. (2021). Residential New Construction NEI Quick Hit Assessment.
2021_NMR_RNC_NEI_Quick Hit_Study

2. Low-Income Efficiency Measures

2.1 Appliance - Dehumidifier

Measure Code	IE-PL-ERDH
Market	Low-Income
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
Dehumidifier	Low Income - Single Family (1-4 units) (LI_SF)	EB1a029
Dehumidifier	Low Income - Multifamily (5+ units) (LI_MF)	EB1b073

Algorithms for Calculating Primary Energy Impact:

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

ΔkWh = Dehumidification Load * ((1/EffRETIRE)-(1/EffEE))

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)
EffEE = Efficiency of ENERGY STAR® model, in Liters/kWh (3.3 Liters/kWh)

Unit kWh savings are deemed based on study results.[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
Early Retirement Dehumidifier (Single Family)	489	0.12
Early Retirement Dehumidifier (Multifamily)	320	0.08

Baseline Efficiency:

The baseline efficiency is a unit that is approximately 8 years old, meeting the standard that was in place at the time.[4]

High Efficiency:

The high efficiency case is a new ENERGY STAR® unit.[5]

Measure Life:

The measure life is 12 years.[6]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Early Retirement Dehumidifier	LI_SF, LI_MF	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	LI_SF, LI_MF	All	1.00	1.00	n/a	1.00	1.00	0.87	0.22

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.[7]

Impact Factors for Calculating Net Savings:

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Early Retirement Dehumidifier	LI_SF, LI_MF	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 (2024). Massachusetts Low-Income Single Family Impact Evaluation 2024_Guidehouse_Income_Eligible_Single_Family_Impact_Report
3 : Guidehouse (2024). Massachusetts Income-Eligible and Residential Coordinated Delivery Multifamily Impact Evaluation 2024_Guidehouse_MF_Impact_Report
4 : 2023_Guidehouse_MA_RBUECS_Demand_Impact_Model
4 : 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
5 : 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_Specification_Final.pdf
6 : Environmental Protection Agency (2018). Savings Calculator for ENERGY STAR Qualified Appliances. Energy_Star_2018_Consumer_Appliance_Calc
7 : Guidehouse (2023). MA RBUECS Demand Impact Model 2023_Guidehouse_MA_RBUECS_Demand_Impact_Model

2.2 Appliance - Early Retirement Clothes Washer

Measure Code	IE-A-ERCW
Market	Low-Income
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
CW Electric & Dryer Electric	Low Income - Single Family (1-4 units) (LI_SF)	EB1a055
CW Gas & Dryer Electric	Low Income - Single Family (1-4 units) (LI_SF)	EB1a056
CW Electric & Dryer Gas	Low Income - Single Family (1-4 units) (LI_SF)	EB1a057
CW Gas & Dryer Gas	Low Income - Single Family (1-4 units) (LI_SF)	EB1a058
CW Oil & Dryer Electric	Low Income - Single Family (1-4 units) (LI_SF)	EB1a059
CW Propane & Dryer Electric	Low Income - Single Family (1-4 units) (LI_SF)	EB1a060
CW Electric & Dryer Electric	Low Income - Multifamily (5+ units) (LI_MF)	EB1b074
CW Gas & Dryer Electric	Low Income - Multifamily (5+ units) (LI_MF)	EB1b075
CW Electric & Dryer Gas	Low Income - Multifamily (5+ units) (LI_MF)	EB1b076
CW Gas & Dryer Gas	Low Income - Multifamily (5+ units) (LI_MF)	EB1b077
CW Oil & Dryer Electric	Low Income - Multifamily (5+ units) (LI_MF)	EB1b078
CW Propane & Dryer Electric	Low Income - Multifamily (5+ units) (LI_MF)	EB1b079

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 3.38 ft3, new standard efficiency top loading washer is 3.90 ft3, ENERGY STAR front loading is 3.90 ft
IMEF = Integrated Modified Energy Factor and is measured in ft3 /kWh/cycle
Ncycles = 295 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 = 0.85; recovery energy factor used to account for the difference in recovery efficiencies of electric and gas/oil/propane hot water heaters.
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 (for fossil fuel DHW)	8%	32%	60%	1.29	8.40	3.38
Existing-Top Loading CW (for electric DHW)	9%	26%	65%	1.29	8.40	3.38
New-Federal Standard	3%	40%	56%	1.57	6.47	3.90
New-Energy Star Standard	4%	31%	65%	2.06	3.20	3.90

Savings from Early Retirement of Clothes Washers

Measure Name	ΔkWh	ΔkW[3]	ΔMMBtu
Early Retirement CW Elec DHW & Elec Dryer	214	0.07	0.00
Early Retirement CW Gas DHW & Elec Dryer	140	0.04	0.22
Early Retirement CW Elec DHW & Gas Dryer	75	0.02	0.48
Early Retirement CW Oil DHW & Elec Dryer	140	0.01	0.22
Early Retirement CW Gas DHW & Gas Dryer	39	0.04	0.56
Early Retirement CW Propane DHW & Elec Dryer	140	0.04	0.22

Baseline Efficiency:

It is assumed that the existing top loading clothes washer met the 2015 federal standard which was an IMEF > 1.29 and WF < 8.40. A new standard efficiency clothes washer meets the federal standard as of 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 washer with a minimum IMEF > 2.06 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, Low-Income customers would have purchased a used clothes washer meeting the 2015 federal standards, so the savings are counted for the full lifetime of the measure.

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
CW Electric & Dryer Electric CW Gas & Dryer Electric CW Electric & Dryer Gas CW Gas & Dryer Gas CW Oil & Dryer Electric CW Propane & Dryer Electric	LI_SF LI_MF	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 4,694 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}
CW Electric & Dryer Electric CW Gas & Dryer Electric CW Electric & Dryer Gas CW Gas & Dryer Gas CW Oil & Dryer Electric CW Propane & Dryer Electric	LI_SF LI_MF	All	1.00	1.00	n/a	1.00	1.00	0.42	0.60

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
CW Electric & Dryer Electric CW Gas & Dryer Electric CW Electric & Dryer Gas CW Gas & Dryer Gas CW Oil & Dryer Electric CW Propane & Dryer Electric	LI_SF LI_MF	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
CW Electric & Dryer Electric CW Gas & Dryer Electric CW Electric & Dryer Gas CW Gas & Dryer Gas CW Oil & Dryer Electric CW Propane & Dryer Electric	LI_SF LI_MF	All			Varies by PA	0.01		

Endnotes:

1 : DOE (2012). Technical Support Document: Energy Efficiency Program for Consumer Products and Commercial and Industrial Equipment: Residential Clothes Washers.
DOE_2012_Technical_Support_Document_Clothes_Washers
2 : DOE (2012). Residential Clothes Washers Direct Final Rule Technical Support Document; Chapter 7. DOE_2012_Technical_Support_Document_Clothes_Washers
3 : Guidehouse (2023). MA RBUECS Demand Impact Model
2023_Guidehouse_MA_RBUECS_Demand_Impact_Model

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 (2023). MA RBUECS Demand Impact Model 2023_Guidehouse_MA_RBUECS_Demand_Impact_Model

2.3 Appliance - Freezer Replacement

Measure Code	IE-A-FR
Market	Low-Income
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	Low Income - Single Family (1-4 units) (LI_SF)	EB1a025
Freezer Replacement	Low Income - Multifamily (5+ units) (LI_MF)	EB1b045

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]

Measure Name	Core Initiative	ΔkWh	ΔkW
Freezer Replacement	LI_SF	713	0.14
Freezer Replacement	LI_MF	713	0.14

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.[4]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Freezer Replacement	LI_SF	All	12	n/a	n/a	12
Freezer Replacement	LI_MF	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	LI_SF	All	1.00	1.00	n/a	1.00	1.00	0.70	0.90
Freezer Replacement	LI_MF	All	1.00	1.00	n/a	1.00	1.00	0.70	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 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
Freezer Replacement	LI_SF LI_MF	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	LI_SF	All	$1.40		Varies by PA	$0.01		
Freezer Replacement	LI_MF	All	$20.29		Varies by PA	$0.01		

Endnotes:

1 : Guidehouse (2024). Massachusetts Low-Income Single Family Impact Evaluation 2024_Guidehouse_Income_Eligible_Single_Family_Impact_Report
2 : Guidehouse (2024). Massachusetts Income-Eligible and Residential Coordinated Delivery Multifamily Impact Evaluation 2024_Guidehouse_MF_Impact_Report
3 : Guidehouse (2023). MA RBUECS Demand Impact Model 2023_Guidehouse_MA_RBUECS_Demand_Impact_Model
4 : Environmental Protection Agency (2018). Savings Calculator for Energy Star Qualified Appliances. Energy_Star_2018_Consumer_Appliance_Calc
5 : Guidehouse (2023). MA RBUECS Demand Impact Model 2023_Guidehouse_MA_RBUECS_Demand_Impact_Model

2.4 Appliance - Refrigerator Replacement - IE Multi-Family

Measure Code	IE-A-RR-MF
Market	Low-Income
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	Low Income - Multifamily (5+ units) (LI_MF)	EB1b046

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
Refrigerator Replacement	LI_MF	390	0.07

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.[3]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Refrigerator Replacement	LI_MF	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	LI_MF	All	1.00	1.00	n/a	1.00	1.00	0.70	0.90

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 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
Refrigerator Replacement	LI_MF	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
Refrigerator Replacement	LI_MF	All	$20.29	$0.00	Varies by PA	$0.01	$0.00	$0.00

Endnotes:

1 : Guidehouse (2024). Massachusetts Income-Eligible and Residential Coordinated Delivery Multifamily Impact Evaluation 2024_Guidehouse_MF_Impact_Report
2 : Guidehouse (2023). MA RBUECS Demand Impact Model 2023_Guidehouse_MA_RBUECS_Demand_Impact_Model
3 : Environmental Protection Agency (2018). Savings Calculator for Energy Star Qualified Appliances. Energy_Star_2018_Consumer_Appliance_Calc

4 : Guidehouse (2023). MA RBUECS Demand Impact Model
2023_Guidehouse_MA_RBUECS_Demand_Impact_Model
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

2.5 Appliance - Refrigerator Replacement - IE Single Family

Measure Code	IE-A-RR-SF
Market	Low-Income
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)	Low Income - Single Family (1-4 units)	EB1a026

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)	651	0.12

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)	LI_SF	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)	LI_SF	All	1.00	1.00	n/a	1.00	1.00	0.70	0.90

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)	LI_SF	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 Family)	LI_SF	All	$1.40	$0.00	Varies by PA	$0.01	$0.00	$0.00

Endnotes:

1 : Guidehouse (2024). Massachusetts Residential Coordinated Delivery Single Family Impact Evaluation 2024_Guidehouse_Income_Eligible_Single_Family_Impact_Report
2 : Guidehouse (2023). MA RBUECS Demand Impact Model 2023_Guidehouse_MA_RBUECS_Demand_Impact_Model
3 : Environmental Protection Agency (2018). Savings Calculator for Energy Star Qualified Appliances. Energy_Star_2018_Consumer_Appliance_Calc
4 : Guidehouse (2023). MA RBUECS Demand Impact Model 2023_Guidehouse_MA_RBUECS_Demand_Impact_Model

2.6 Appliance - Secondary Refrigerator/Freezer Removal

Measure Code	IE-A-AR
Market	Low-Income
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	Low Income - Single Family (1-4 units) (LI_SF)	EB1a027
Appliance Removal	Low Income - Multifamily (5+ units) (LI_MF)	EB1b044

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]

Measure Name	Core Initiative	ΔkWh	ΔkW
Appliance Removal	LI_SF	968	0.18
Appliance Removal	LI_MF	968	0.18

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	LI_SF, LI_MF	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	LI_SF, LI_MF	All	1.00	1.00	1.00	1.00	1.00	0.70	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 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	LI_SF, LI_MF	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	LI_SF, LI_MF	All			Varies by PA	$0.01		

Endnotes:

1 : Guidehouse (2024). Massachusetts Low-Income Single Family Impact Evaluation 2024_Guidehouse_Income_Eligible_Single_Family_Impact_Report
2 : Guidehouse (2024). Massachusetts Income-Eligible and Residential Coordinated Delivery Multifamily Impact Evaluation 2024_Guidehouse_MF_Impact_Report
3 : Guidehouse (2023). MA RBUECS Demand Impact Model 2023_Guidehouse_MA_RBUECS_Demand_Impact_Model
3 : Massachusetts Common Assumption.
4 : Guidehouse (2023). MA RBUECS Demand Impact Model 2023_Guidehouse_MA_RBUECS_Demand_Impact_Model

2.7 Appliance - Shared Clothes Washer

Measure Code	IE-A-SCW
Market	Low-Income
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
Efficient Commercial Clothes Washer (w/ electric dryer)	Low Income - Multifamily (5+ Units) (LI_MF)	EB1b082
Efficient Commercial Clothes Washer (w/ gas dryer)	Low Income - Multifamily (5+ Units) (LI_MF)	GB1b036

Algorithms for Calculating Primary Energy Impact:

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

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. Capacity is equal to 3.3 ft3
IMEF = Integrated Modified Energy Factor and is measured in ft3 /kWh/cycle
Ncycles = 936 loads per year

%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

Savings from Early Retirement of Clothes Washers

Measure Name	ΔkWh	ΔkW[2]	ΔMMBtu
Efficient Commercial Clothes Washer (w/ electric dryer)	1,277	0.4	0.3
Efficient Commercial Clothes Washer (w/ gas dryer)	162	0.05	38.3

Baseline Efficiency:

It is assumed that the existing top loading clothes washer met the 2010 federal standard which was an IMEF > 1.15 and WF < 8.9.[4]

MEF is Modified Energy Factor and is measured in ft^5/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 washer with a minimum IMEF > 2.2 and IWF < 4.0.[5]

Measure Life:

The effective useful life of the new clothes washer is assumed to be 11 years.[6]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Efficient Commercial Clothes Washer	LI_MF	All	11	n/a	n/a	11

Other Resource Impacts:

Water savings are calculated using the following algorithm:
ΔWater (gallons) = (Capacity * (IWFbase - IWFeff)) * Ncycles
Total water savings are 15,142 gallons.

Impact Factors for Calculating Adjusted Gross Savings:

Measure Name	Core Initiative	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Efficient Commercial Clothes Washer	LI_MF	1.00	1.00	1.00	1.00	1.00	0.42	0.60

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.[7]

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
Efficient Commercial Clothes Washer	LI_MF	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
Efficient Commercial Clothes Washer (w/ electric dryer)	LI_MF	All			Varies by PA	0.01		
Efficient Commercial Clothes Washer (w/ gas dryer)	LI_MF	All					Varies by PA	0.08

Endnotes:

1 : Engineering analysis and common assumptions (2024).
2024_MF_Commercial_CW_Savings_Analysis
2 : Guidehouse (2023). MA RBUECS Demand Impact Model
2023_Guidehouse_MA_RBUECS_Demand_Impact_Model
4 : Engineering analysis and common assumptions (2024).
2024_MF_Commercial_CW_Savings_Analysis

5 : Engineering analysis and common assumptions (2024).
2024_MF_Commercial_CW_Savings_Analysis
6 : SAHF (2017). Efficiency Opportunities in Multifamily Common Area Laundry Facilities. efficiency-common-laundry-areas-sahf-20170327
7 : Guidehouse (2023). MA RBUECS Demand Impact Model
2023_Guidehouse_MA_RBUECS_Demand_Impact_Model

2.8 Behavior - Basic Educational Measures

Measure Code	IE-A-BEM
Market	Low-Income
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	Low Income - Single Family (1-4 units) (LI_SF)	EB1a001
TLC Kit	Low Income - Single Family (1-4 units) (LI_SF)	EB1a002
Participants	Low Income - Single Family (1-4 units) (LI_SF)	GB1a001
Participants	Low Income - Multifamily (5+ units) (LI_MF)	EB1b001
TLC Kit	Low Income - Multifamily (5+ units) (LI_MF)	EB1b002
Participants	Low Income - Multifamily (5+ units) (LI_MF)	GB1b001

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]

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.[4]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
All Measures	LI_SF, LI_MF	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)	LI_SF	All	1.00	1.00	n/a	1.00	1.00	0.65	0.80
TLC Kit (Multifamily)	LI_MF	All	1.00	1.00	n/a	1.00	1.00	0.65	0.80

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
TLC Kit (Single Family)	LI_SF	All	0.00	0.00	0.00	1.00
TLC Kit (Multifamily)	LI_MF	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)	LI_SF	All	$0.00	$0.00	Varies by PA	$0.01	$0.00	$0.00

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 (Multifamily)	LI_MF	All	$0.00	$0.00	Varies by PA	$0.01	$0.00	$0.00
Participant/TLC Kit, Gas	LI_SF,LI_MF	All	$7.70	$0.00	$0.00	$0.00	$0.00	$0.00
Participants (Single Family)	LI_SF	All	$10.37	$0.00	$0.00	$0.00	$0.00	$0.00
Participants (Multifamily)	LI_MF	All	$7.70	$0.00	$0.00	$0.00	$0.00	$0.00

Endnotes:

1 : Guidehouse (2024). Massachusetts Low-Income Single Family Impact Evaluation 2024_Guidehouse_Income_Eligible_Single_Family_Impact_Report
2 : Guidehouse (2024). Massachusetts Income-Eligible and Residential Coordinated Delivery Multifamily Impact Evaluation 2024_Guidehouse_MF_Impact_Report
3 : Guidehouse (2023). MA RBUECS Demand Impact Model 2023_Guidehouse_MA_RBUECS_Demand_Impact_Model
4 : Massachusetts Common Assumption.
5 : Guidehouse (2023). MA RBUECS Demand Impact Model 2023_Guidehouse_MA_RBUECS_Demand_Impact_Model

2.9 Building Shell - Air Sealing - IE Multi-Family

Measure Code	IE-BS-AS-MF
Market	Low-Income
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	Low Income - Multifamily (5+ units) (LI_MF)	EB1b006
Air Sealing, Oil	Low Income - Multifamily (5+ units) (LI_MF)	EB1b007
Air Sealing, Other	Low Income - Multifamily (5+ units) (LI_MF)	EB1b008
Air Sealing, Gas	Low Income - Multifamily (5+ units) (LI_MF)	GB1b003

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 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-to ceiling 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.
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: 0.00049 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

TMYx - City/Station	HDD	CDH
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	LI_MF	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 (Multifamily)	LI_MF	All	1.00	1.00	n/a	1.00	1.00	0.00	0.58

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Air Sealing, Gas (Multifamily)	LI_MF	Berkshire	1.00	n/a	0.80	n/a	n/a	n/a	n/a
Air Sealing, Gas (Multifamily)	LI_MF	Eversource	1.00	n/a	1.05	n/a	n/a	n/a	n/a
Air Sealing, Gas (Multifamily)	LI_MF	Liberty	1.00	n/a	0.96	n/a	n/a	n/a	n/a
Air Sealing, Gas (Multifamily)	LI_MF	National Grid	1.00	n/a	0.75	n/a	n/a	n/a	n/a
Air Sealing, Gas (Multifamily)	LI_MF	Unitil	1.00	n/a	0.96	n/a	n/a	n/a	n/a
Air Sealing, Oil (Multifamily)	LI_MF	All	1.00	n/a	1.00	n/a	n/a	n/a	n/a
Air Sealing, Other (Multifamily)	LI_MF	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 study results and are applied to the vendor estimated savings.[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:

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Air Sealing (Multifamily)	LI_MF	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)	LI_MF	All	$389.29	$0.00	Varies by PA	$0.01	$0.00	$0.00
Air Sealing, Gas (Multifamily)	LI_MF	All	$389.29	$0.00	$0.00	$0.00	Varies by PA	$0.08
Air Sealing, Oil (Multifamily)	LI_MF	All	$389.29	$0.00	$0.00	$0.00	$0.00	$0.00
Air Sealing, Other (Multifamily)	LI_MF	All	$389.29	$0.00	$0.00	$0.00	$0.00	$0.00

Endnotes:

1 : Guidehouse (2023). MA RBUECS Demand Impact Model
2023_Guidehouse_MA_RBUECS_Demand_Impact_Model
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
4 : The Cadmus Group (2015). Massachusetts Low-Income Multifamily Initiative Impact Evaluation.
CADMUS_2015_Low_Income_Multifamily_Impact_Evaluation
5 : Guidehouse (2023). MA RBUECS Demand Impact Model
2023_Guidehouse_MA_RBUECS_Demand_Impact_Model
7 : NMR Group, Inc. (2021). Low Income Multifamily Non-Energy Impact Study
2021_NMR_LIMF_NEI_Study_TXC50

2.10 Building Shell - IE Window

Measure Code	IE-BS-WIN
Market	Low-Income
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
Windows	Low Income - Single Family (1-4 units) (LI_SF)	EB1a012
Windows	Low Income - Single Family (1-4 units) (LI_SF)	GB1a018
Windows	Low Income - Multifamily (5+ units) (LI_MF)	EB1b012
Windows	Low Income - Multifamily (5+ units) (LI_MF)	GB1b028

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

Heating Fuel Type	Gross Annual kWh Saved	Maximum Load Reduction (kW)	Savings (MMBtu / Year)
Window - Electric Resistance Heating	254	0.15	-
Window - Heat Pump*	127	0.07	-
Window - Gas Heating	7	0.00	1.3
Window - Oil/Propane Heating	7	0.00	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.[3] The window AC savings are assumed to be 28.3% of the central cooling savings[4] 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[5])	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.[5]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Window	LI_SF; LI_MF	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 Heat	LI_SF; LI_MF	All	1.00	1.00	n/a	1.00	1.00	0.54	0.19
Window - Gas Heating	LI_SF; LI_MF	All	1.00	1.00	n/a	1.00	1.00	0.54	0.00
Window - Oil/Propane Heating	LI_SF; LI_MF	All	1.00	1.00	n/a	1.00	1.00	0.54	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.[6]

Impact Factors for Calculating Net Savings:

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Window	LI_SF; LI_MF	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
Window	LI_SF; LI_MF	All	$0.19		Varies by PA	$0.01	Varies by PA	$0.08

Endnotes:

1 : Lawrence Berkeley National Laboratory, RESFEN 5.0 computer software, May 12, 2005. http://windows.lbl.gov/software.
2 : Guidehouse (2023). MA RBUECS Demand Impact Model
2023_Guidehouse_MA_RBUECS_Demand_Impact_Model
3 : Guidehouse (2020). Residential Baseline Study Phase 4.
2020_Guidehouse_Residential_Baseline_Phase_4
4 : Nexant Market Research Inc. (2007). Market Assessment for ENERGY STAR Room Air Conditioners in Connecticut.
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 : Guidehouse (2023). MA RBUECS Demand Impact Model.
2023_Guidehouse_MA_RBUECS_Demand_Impact_Model
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

2.11 Building Shell - Insulation - IE Multi-Family

Measure Code	IE-BS-I
Market	Low-Income
Program Type	Retrofit
Category	Building Shell

Measure Description:

Shell insulation installed in low-income multi-family buildings.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Insulation, Electric	Low Income - Multifamily (5+ units) (LI_MF)	EB1b009
Insulation, Oil	Low Income - Multifamily (5+ units) (LI_MF)	EB1b010
Insulation, Other	Low Income - Multifamily (5+ units) (LI_MF)	EB1b011
Insulation, Gas	Low Income - Multifamily (5+ units) (LI_MF)	GB1b004

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)	0.00049
Insulation (Gas, Oil, Other FF)	0.00058

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: 0.00049 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
η_{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: 0.00049 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 (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 (Rexist) 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	LI_MF	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	LI_MF	All	1.00	1.00	1.00	1.00	1.00	0.00	0.58
Insulation, Oil	LI_MF	All	1.00	1.00	1.00	1.00	1.00	0.54	0.00
Insulation, Other	LI_MF	All	1.00	1.00	1.00	1.00	1.00	0.54	0.00
Insulation, Gas	LI_MF	Berkshire	1.00	1.00	0.80	1.00	1.00	0.54	0.00
Insulation, Gas	LI_MF	Columbia	1.00	1.00	0.96	1.00	1.00	0.54	0.00
Insulation, Gas	LI_MF	Eversource	1.00	1.00	1.05	1.00	1.00	0.54	0.00
Insulation, Gas	LI_MF	Liberty	1.00	1.00	0.96	1.00	1.00	0.54	0.00
Insulation, Gas	LI_MF	National Grid	1.00	1.00	0.75	1.00	1.00	0.54	0.00
Insulation, Gas	LI_MF	Unitil	1.00	1.00	0.96	1.00	1.00	0.54	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 and are applied to the vendor estimated savings.[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)	LI_MF	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	LI_MF	All	$391.20		Varies by PA	$0.01		
Insulation, Oil	LI_MF	All	$391.20					
Insulation, Other	LI_MF	All	$391.20					
Insulation, Gas	LI_MF	All	$391.20				Varies by PA	$0.08

Endnotes:

1 : Guidehouse (2023). MA RBUECS Demand Impact Model
2023_Guidehouse_MA_RBUECS_Demand_Impact_Model
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 (2023). MA RBUECS Demand Impact Model
2023_Guidehouse_MA_RBUECS_Demand_Impact_Model
8 : NMR Group, Inc. (2021). Low Income Multifamily Non-Energy Impact Study
2021_NMR_LIMF_NEI_Study_TXC50

2.12 Building Shell - Weatherization

Measure Code	IE-BS-W
Market	Low-Income
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	Low Income - Single Family (1-4 units) (LI_SF)	EB1a003
Weatherization, Oil	Low Income - Single Family (1-4 units) (LI_SF)	EB1a004
Weatherization, Other	Low Income - Single Family (1-4 units) (LI_SF)	EB1a005
Air Sealing, Electric	Low Income - Single Family (1-4 units) (LI_SF)	EB1a006
Air Sealing, Oil	Low Income - Single Family (1-4 units) (LI_SF)	EB1a007
Air Sealing, Other	Low Income - Single Family (1-4 units) (LI_SF)	EB1a008
Insulation, Electric	Low Income - Single Family (1-4 units) (LI_SF)	EB1a009
Insulation, Oil	Low Income - Single Family (1-4 units) (LI_SF)	EB1a010
Insulation, Other	Low Income - Single Family (1-4 units) (LI_SF)	EB1a011
Weatherization	Low Income - Single Family (1-4 units) (LI_SF)	GB1a002
Air Sealing, Gas	Low Income - Single Family (1-4 units) (LI_SF)	GB1a003
Insulation, Gas	Low Income - Single Family (1-4 units) (LI_SF)	GB1a004
Weatherization, Electric	Low Income - Multifamily (5+ units) (LI_MF)	EB1b003
Weatherization, Oil	Low Income - Multifamily (5+ units) (LI_MF)	EB1b004
Weatherization, Other	Low Income - Multifamily (5+ units) (LI_MF)	EB1b005
Weatherization, Gas	Low Income - Multifamily (5+ units) (LI_MF)	GB1b002

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	1931	0.95	
Weatherization, Oil (Single Family)	All	Oil	130	0.12	19.6
Weatherization, Other (Single Family)	All	Propane	125	0.12	20.3
Weatherization, Gas (Single Family)	All	Gas	147	0.14	17.4
Air Sealing, Electric (Single Family)	All	Electric	246	0.12	
Air Sealing, Oil (Single Family)	All	Oil	4	0.00	2.5
Air Sealing, Other (Single Family)	All	Propane	4	0.00	2.6
Air Sealing, Gas (Single Family)	All	Gas	5	0.00	2.3
Insulation, Electric (Single Family)	All	Electric	1685	0.83	
Insulation, Oil (Single Family)	All	Oil	126	0.12	16.9
Insulation, Other (Single Family)	All	Propane	121	0.11	17.6
Insulation, Gas (Single Family)	All	Gas	142	0.13	15.1

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.[4] 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	LI_SF, LI_MF	All	15	n/a	n/a	15
Insulation	LI_SF, LI_MF	All	25	n/a	n/a	25
Weatherization	LI_SF, LI_MF	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)	LI_SF	All	1.00	1.00	n/a	1.00	1.00	0.00	0.58
Weatherization, Oil (Single Family)	LI_SF	All	1.00	1.00	1.00	1.00	1.00	0.54	0.00
Weatherization, Other (Single Family)	LI_SF	All	1.00	1.00	1.00	1.00	1.00	0.54	0.00
Weatherization, Gas (Single Family)	LI_SF	All	1.00	1.00	1.00	1.00	1.00	0.54	0.00
Air Sealing, Electric (Single Family)	LI_SF	All	1.00	1.00	n/a	1.00	1.00	0.00	0.58
Air Sealing, Oil (Single Family)	LI_SF	All	1.00	n/a	1.00	n/a	n/a	0.54	0.00
Air Sealing, Other (Single Family)	LI_SF	All	1.00	n/a	1.00	n/a	n/a	0.54	0.00
Air Sealing, Gas (Single Family)	LI_SF	All	1.00	n/a	1.00	n/a	n/a	0.00	0.00
Insulation, Electric (Single Family)	LI_SF	All	1.00	1.00	n/a	1.00	1.00	0.00	0.58
Insulation, Oil (Single Family)	LI_SF	All	1.00	1.00	1.00	1.00	1.00	0.54	0.00
Insulation, Other (Single Family)	LI_SF	All	1.00	1.00	1.00	1.00	1.00	0.54	0.00
Insulation, Gas (Single Family)	LI_SF	All	1.00	1.00	1.00	1.00	1.00	0.54	0.00
Weatherization, Electric (Multi Family)	LI_MF	CLC	1.00	1.00	n/a	1.00	1.00	0.00	0.58
Weatherization, Oil (Multi Family)	LI_MF	CLC	1.00	1.00	1.00	1.00	1.00	0.54	0.00
Weatherization, Propane (Multi Family)	LI_MF	CLC	1.00	1.00	1.00	1.00	1.00	0.54	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
Weatherization, Electric (Single Family)	LI_SF	All	0.00	0.00	0.00	1.00
Weatherization, Oil (Single Family)	LI_SF	All	0.00	0.00	0.00	1.00
Weatherization, Other (Single Family)	LI_SF	All	0.00	0.00	0.00	1.00
Weatherization, Gas (Single Family)	LI_SF	All	0.00	0.00	0.00	1.00
Air Sealing, Electric (Single Family)	LI_SF	All	0.00	0.00	0.00	1.00
Air Sealing, Oil (Single Family)	LI_SF	All	0.00	0.00	0.00	1.00
Air Sealing, Other (Single Family)	LI_SF	All	0.00	0.00	0.00	1.00
Air Sealing, Gas (Single Family)	LI_SF	All	0.00	0.00	0.00	1.00
Insulation, Electric (Single Family)	LI_SF	All	0.00	0.00	0.00	1.00
Insulation, Oil (Single Family)	LI_SF	All	0.00	0.00	0.00	1.00
Insulation, Other (Single Family)	LI_SF	All	0.00	0.00	0.00	1.00
Insulation, Gas (Single Family)	LI_SF	All	0.00	0.00	0.00	1.00
Weatherization, Electric (Multi Family)	LI_MF	CLC	0.00	0.00	0.00	1.00
Weatherization, Oil (Multi Family)	LI_MF	CLC	0.00	0.00	0.00	1.00
Weatherization, Propane (Multi Family)	LI_MF	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.[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
Weatherization, Electric (Single Family)	LI_SF	All	$558.21		$0.07	$0.01		
Weatherization, Oil (Single Family)	LI_SF	All	$558.21		$0.07	$0.01		
Weatherization, Other (Single Family)	LI_SF	All	$558.21		$0.07	$0.01		
Weatherization, Gas (Single Family)	LI_SF	All	$558.21				$0.31	$0.08
Air Sealing, Electric (Single Family)	LI_SF	All	$295.21		$0.07	$0.01		
Air Sealing, Oil (Single Family)	LI_SF	All	$295.21		$0.07	$0.01		
Air Sealing, Other (Single Family)	LI_SF	All	$295.21		$0.07	$0.01		
Air Sealing, Gas (Single Family)	LI_SF	All	$295.21				$0.31	$0.08
Insulation, Electric (Single Family)	LI_SF	All	$263.00		$0.07	$0.01		
Insulation, Oil (Single Family)	LI_SF	All	$263.00		$0.07	$0.01		
Insulation, Other (Single Family)	LI_SF	All	$263.00		$0.07	$0.01		
Insulation, Gas (Single Family)	LI_SF	All	$263.00				$0.31	$0.08
Weatherization, Electric (Multi Family)	LI_MF	CLC	$771.73		$0.07	$0.01		
Weatherization, Oil (Multi Family)	LI_MF	CLC	$771.73		$0.07	$0.01		
Weatherization, Other (Multi Family)	LI_MF	CLC	$771.73		$0.07	$0.01		

Endnotes:

1 : Guidehouse (2024). Massachusetts Low-Income Single Family Impact Evaluation 2024_Guidehouse_Income_Eligible_Single_Family_Impact_Report
2 : Guidehouse (2023). MA RBUECS Demand Impact Model 2023_Guidehouse_MA_RBUECS_Demand_Impact_Model
4 : Massachusetts Common Assumption.
5 : Guidehouse (2023). MA RBUECS Demand Impact Model 2023_Guidehouse_MA_RBUECS_Demand_Impact_Model
6 : 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

2.13 Custom - Low-Income

Measure Code	IE-CM-CMIE
Market	Low-Income
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
Custom - HVAC	Low Income - Multifamily (5+ units) (LI_MF)	EB1b063
Custom - Hot Water	Low Income - Multifamily (5+ units) (LI_MF)	EB1b064
Custom - Other	Low Income - Multifamily (5+ units) (LI_MF)	EB1b065
Custom - Building Shell	Low Income - Multifamily (5+ units) (LI_MF)	EB1b066
Custom - Motors & VFD	Low Income - Multifamily (5+ units) (LI_MF)	EB1b067
Custom - HPWH	Low Income - Multifamily (5+ units) (LI_MF)	EB1b068
Custom - Heating Systems Replacement	Low Income - Multifamily (5+ units) (LI_MF)	EB1b069
Custom - Deep Energy Retrofit - Energy Efficiency Savings	Low Income - Multifamily (5+ units) (LI_MF)	EB1b070
Custom - Deep Energy Retrofit - Electrification Savings	Low Income - Multifamily (5+ units) (LI_MF)	EB1b071
Boiler Reset Control	Low Income - Multifamily (5+ units) (LI_MF)	GB1b021
Demand Circulator	Low Income - Multifamily (5+ units) (LI_MF)	GB1b022
Custom - Heat Pumps Displacing Gas	Low Income - Multifamily (5+ units) (LI_MF)	GB1b023
Custom - HVAC	Low Income - Multifamily (5+ units) (LI_MF)	GB1b030
Custom - Hot Water	Low Income - Multifamily (5+ units) (LI_MF)	GB1b031

Measure Name	Core Initiative	BCR Measure ID
Custom - Other	Low Income - Multifamily (5+ units) (LI_MF)	GB1b032
Custom - Deep Energy Retrofit - Energy Efficiency Savings	Low Income - Multifamily (5+ units) (LI_MF)	GB1b033
Custom - Deep Energy Retrofit - Electrification Savings	Low Income - Multifamily (5+ units) (LI_MF)	GB1b034
Custom - Building Shell	Low Income - Multifamily (5+ units) (LI_MF)	GB1b037
Custom - Heating Systems Replacement	Low Income - Multifamily (5+ units) (LI_MF)	GB1b038

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
Custom - HVAC	LI_MF	All	custom	n/a	n/a	custom
Custom - Hot Water	LI_MF	All	custom	n/a	n/a	custom
Custom - Other	LI_MF	All	custom	n/a	n/a	custom
Custom - Building Shell	LI_MF	All	custom	n/a	n/a	custom
Custom - Motors & VFD	LI_MF	All	custom	n/a	n/a	custom
Custom - HPWH	LI_MF	All	custom	n/a	n/a	custom
Custom - Heating Systems Replacement	LI_MF	All	custom	n/a	n/a	custom

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Custom - Deep Energy Retrofit - Energy Efficiency Savings	LI_MF	All	18	n/a	n/a	18
Custom - Deep Energy Retrofit - Electrification Savings	LI_MF	All	18	n/a	n/a	18
Demand Circulator	LI_MF	All	15	n/a	n/a	15
Boiler Reset Control	LI_MF	All	15[1]	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}
Custom, Electric	LI_MF	All	1.00	1.00	1.00	1.00	1.00	custom	custom
Custom, Gas	LI_MF	Berkshire	1.00	n/a	0.80	n/a	n/a	n/a	n/a
Custom, Gas	LI_MF	Columbia	1.00	n/a	0.96	n/a	n/a	n/a	n/a
Custom, Gas	LI_MF	Eversource	1.00	n/a	1.05	n/a	n/a	n/a	n/a
Custom, Gas	LI_MF	Liberty	1.00	n/a	0.96	n/a	n/a	n/a	n/a
Custom, Gas	LI_MF	National Grid	1.00	n/a	0.75	n/a	n/a	n/a	n/a
Custom, Gas	LI_MF	Unitil	1.00	n/a	0.96	n/a	n/a	n/a	n/a
Custom - Deep Energy Retrofit - Energy Efficiency Savings	LI_MF	All	1.00	1.00	1.00	1.00	1.00	custom	custom
Custom - Deep Energy Retrofit - Electrification Savings	LI_MF	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 PA programs include verification of equipment installations.

Realization Rates:

Realization rates are based on an evaluation study and are applied to custom savings.[2]

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:

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
All Measures	LI_MF	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.[4] Custom - HVAC NEI values for Multifamily are based on 2021 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
Gas Measures	LI_MF	All					Varies by PA	$0.08
Electric Measures	LI_MF	All			Varies by PA	$0.01		
Custom - HVAC	LI_MF	All	$836.39					
Custom - HPWH	LI_MF	All	$5.02					
Custom - Deep Energy Retrofit - Energy Efficiency Savings	LI_MF	All	$1,608.12					

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
4 : 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
5 : NMR Group, Inc. (2021). Low Income Multifamily Non-Energy Impact Study 2021_NMR_LIMF_NEI_Study_TXC50

2.14 HVAC - Boiler Reset Control

Measure Code	IE-HVAC-BSC
Market	Low-Income
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	Low Income - Single Family (1-4 units) (LI_SF)	EB1a045
Boiler Reset Control	Low Income - Single Family (1-4 units) (LI_SF)	GB1a015

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)	LI_SF	3.4
Boiler Reset Control, Gas (Single Family)	LI_SF	3.3

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 Initiative	PA	EUL	OYF	RUL	AML
Boiler Reset Control, Oil (Single Family)	LI_SF	All	15	n/a	n/a	15
Boiler Reset Control, Gas (Single Family)	LI_SF	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)	LI_SF	All	1.00	n/a	1.00	n/a	n/a	n/a	n/a
Boiler Reset Control, Gas (Single Family)	LI_SF	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)	LI_SF	All	0.00	0.00	0.00	1.00
Boiler Reset Control, Gas (Single Family)	LI_SF	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 Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per kWh	Annual $ per Therm	One-time $ per Therm
Boiler Reset Control, Oil (Single Family)	LI_SF	All						
Boiler Reset Control, Gas (Single Family)	LI_SF	All					Varies by PA	$0.08

Endnotes:

1 : Guidehouse (2024). Massachusetts Low-Income Single Family Impact Evaluation
2024_Guidehouse_Income_Eligible_Single_Family_Impact_Report
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	Low-Income
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
Boiler Replacement, Oil	Low Income - Single Family (1-4 units) (LI_SF)	EB1a030
Boiler Replacement, Other	Low Income - Single Family (1-4 units) (LI_SF)	EB1a031
Heating System Retrofit, Boiler	Low Income - Single Family (1-4 units) (LI_SF)	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	Oil	6.1
Heating System Retrofit, Boiler, Other	Propane	11.4
Heating System Retrofit, Boiler, Gas	Gas	11.4

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	LI_SF	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	LI_SF	All	1.00	1.00	1.00	1.00	1.00	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	LI_SF	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, Oil	LI_SF	All	$310.82		Varies by PA	$0.01		
Heating System Retrofit, Boiler, Other	LI_SF	All	$310.82		Varies by PA	$0.01		
Heating System Retrofit, Boiler, Gas	LI_SF	All	$310.82				Varies by PA	$0.08

Endnotes:

1 : Guidehouse (2024). Massachusetts Low-Income Single Family Impact Evaluation 2024_Guidehouse_Income_Eligible_Single_Family_Impact_Report

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

2.16 HVAC - CVEO Solar PV

Measure Code	IE-HVAC-CVEO-SOLPV
Market	Low-Income
Program Type	Early Replacement
Category	Heating Ventilation and Air Conditioning

Measure Description:

Solar photovoltaics (PV) system sized to a participant's load to minimize excess generation. This is a CLC specific measure.

BCR Measure IDs:

Measure	Core Initiative	BCR Measure ID
CVEO Low Income - Solar PV	Low Income - Single Family (1-4 units) (LI_SF)	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	LI_SF	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	LI_SF	CLC	1.00	1.00	1.00	1.00	1.00	0.80	0.00

In-Service Rates:

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

Realization Rates:

100% realization rates are assumed because savings are deemed.

Coincidence Factors:

Coincidence factors are PA-determined assumptions.

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	LI_SF	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	LI_SF	CLC			$0.07	$0.01		

2.17 HVAC - Communicating Thermostat

Measure Code	IE-HVAC-WT
Market	Low-Income
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	Low Income - Single Family (1-4 units) (LI_SF)	EB1a024
Wi-Fi Thermostat	Low Income - Single Family (1-4 units) (LI_SF)	GB1a014
Wi-Fi Thermostat	Low Income - Multifamily (5+ units) (LI_MF)	EB1b022
Wi-Fi Thermostat	Low Income - Multifamily (5+ units) (LI_MF)	GB1b020

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]

Measure Name	Core Initiative	ΔkWh	ΔkW	Fuel Oil Δ MMBtu	Propane Δ MMBtu	Gas Δ MMBtu
Wi-Fi Thermostat, Electric	LI_SF	18	0.02			
Wi-Fi Thermostat, Electric (AC Only)	LI_SF	310	0.18			
Wi-Fi Thermostat, Oil	LI_SF	18	0.02	2.4		
Wi-Fi Thermostat, Other	LI_SF	18	0.02		2.2	
Wi-Fi Thermostat, Gas	LI_SF	18	0.02	n/a	n/a	2.2
Wi-Fi Thermostat, AC Only	LI_MF	20	0.02	n/a	n/a	n/a

Measure Name	Core Initiative	ΔkWh	ΔkW	Fuel Oil Δ MMBtu	Propane Δ MMBtu	Gas Δ MMBtu
Wi-Fi Thermostat, Oil	LI_MF	20	0.02	1.7	n/a	n/a
Wi-Fi Thermostat, Other	LI_MF	20	0.02	n/a	1.5	n/a
Wi-Fi Thermostat, Gas	LI_MF	20	0.02	n/a	n/a	1.5

Weighted averages for BC model

Measure Name	Core Initiative	BCR ID	ΔkWh	ΔkW	Δ Oil MMBTUs	Δ Propane MMBTUs
Wi-Fi Thermostat	LI_SF	EB1a024	7.2	0.01	1.2	0.22
Wi-Fi Thermostat	LI_MF	EB1b022	24	0.02	0.85	0.15

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_SF IE_MF	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_SF	All	1.00	1.00	1.00	1.00	1.00	0.54	0.00
Wi-Fi Thermostat, Gas	IE_SF	All	1.00	1.00	1.00	1.00	1.00	0.54	0.00
Wi-Fi Thermostat	IE_MF	All	1.00	1.00	1.00	1.00	1.00	0.54	0.00
Wi-Fi Thermostat, Gas	IE_MF	All	1.00	1.00	1.00	1.00	1.00	0.54	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_SF IE_MF	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 Low-Income, 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	IE_SF	All	$10.01		Varies by PA	$0.01		
Wi-Fi Thermostat, Gas	IE_SF	All	$44.53				Varies by PA	$0.08
Wi-Fi Thermostat	IE_MF	All	$4.38		Varies by PA	$0.01		
Wi-Fi Thermostat, Gas	IE_MF	All	$16.02				Varies by PA	$0.08

Endnotes:

1 : Guidehouse (2024). Massachusetts Low-Income Single Family Impact Evaluation 2024_Guidehouse_Income_Eligible_Single_Family_Impact_Report
2 : Guidehouse (2024). Massachusetts Income-Eligible and Residential Coordinated Delivery Multifamily Impact Evaluation 2024_Guidehouse_MF_Impact_Report
3 : Guidehouse (2023). MA RBUECS Demand Impact Model 2023_Guidehouse_MA_RBUECS_Demand_Impact_Model
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 (2023). MA RBUECS Demand Impact Model 2023_Guidehouse_MA_RBUECS_Demand_Impact_Model

2.18 HVAC - Duct Insulation

Measure Code	IE-HVAC-DI
Market	Low-Income
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	Low Income - Single Family (1-4 units) (LI_SF)	EB1a014
Duct Insulation	Low Income - Single Family (1-4 units) (LI_SF)	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	35	0.02	
Duct Insulation, Oil			0.8
Duct Insulation, Other			0.9
Duct Insulation, Gas			0.9

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	LI_SF	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	LI_SF	All	1.00	1.00	1.00	1.00	1.00	0.54	0.19

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	LI_SF	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	LI_SF	All	6.21		Varies by PA	$0.01	Varies by PA	$0.08

Endnotes:

1 : Guidehouse (2024). Massachusetts Low-Income Single Family Impact Evaluation
2024_Guidehouse_Income_Eligible_Single_Family_Impact_Report
2 : Guidehouse (2023). MA RBUECS Demand Impact Model
2023_Guidehouse_MA_RBUECS_Demand_Impact_Model
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 (2023). MA RBUECS Demand Impact Model
2023_Guidehouse_MA_RBUECS_Demand_Impact_Model

2.19 HVAC - Duct Insulation - IE Multi-Family

Measure Code	IE-HVAC-DI-MF
Market	Low-Income
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	Low Income - Multifamily (5+ units) (LI_MF)	EB1b014
Duct Insulation	Low Income - Multifamily (5+ units) (LI_MF)	GB1b009

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	LI_MF	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	LI_MF	All	1.00	1.00	n/a	1.00	1.00	0.54	0.19
Duct Insulation, Oil	LI_MF	All	1.00	n/a	1.00	n/a	n/a	n/a	n/a
Duct Insulation, Other	LI_MF	All	1.00	n/a	1.00	n/a	n/a	n/a	n/a
Duct Insulation, Gas	LI_MF	Berkshire	1.00	n/a	0.80	n/a	n/a	n/a	n/a
Duct Insulation, Gas	LI_MF	Eversource	1.00	n/a	1.05	n/a	n/a	n/a	n/a
Duct Insulation, Gas	LI_MF	Liberty	1.00	n/a	0.96	n/a	n/a	n/a	n/a
Duct Insulation, Gas	LI_MF	National Grid	1.00	n/a	0.75	n/a	n/a	n/a	n/a
Duct Insulation, Gas	LI_MF	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 programs include verification of equipment installations.

Realization Rates:

Realization rates are based on evaluation results and are applied to the vendor estimated savings.[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	LI_MF	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, Elec	LI_MF	All			Varies by PA	$0.01		
Duct Insulation, Gas	LI_MF	All					Varies by PA	$0.08

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 (2023). MA RBUECS Demand Impact Model
2023_Guidehouse_MA_RBUECS_Demand_Impact_Model

2.20 HVAC - Duct Sealing - IE Multi-Family

Measure Code	IE-HVAC-DSAF-MF
Market	Low-Income
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	Low Income - Multifamily (5+ units) (LI_MF)	EB1b013
Duct Sealing	Low Income - Multifamily (5+ units) (LI_MF)	GB1b008

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	LI_MF	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	LI_MF	All	1.00	1.00	n/a	1.00	1.00	0.54	0.19
Duct Sealing, Oil	LI_MF	All	1.00	n/a	1.00	n/a	n/a	n/a	n/a
Duct Sealing, Other	LI_MF	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}
Duct Sealing, Gas	LI_MF	Berkshire	1.00	n/a	0.80	n/a	n/a	n/a	n/a
Duct Sealing, Gas	LI_MF	Eversource	1.00	n/a	1.05	n/a	n/a	n/a	n/a
Duct Sealing, Gas	LI_MF	Liberty	1.00	n/a	0.96	n/a	n/a	n/a	n/a
Duct Sealing, Gas	LI_MF	National Grid	1.00	n/a	0.75	n/a	n/a	n/a	n/a
Duct Sealing, Gas	LI_MF	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 programs include verification of equipment installations.

Realization Rates:

Realization rates are based on evaluation results and are applied to the vendor estimated savings.[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	LI_MF	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, Oil, Propane	LI_MF	All	$1.04		Varies by PA	$0.01		
Duct Sealing, Gas	LI_MF	All	$1.04				Varies by PA	$0.08

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 (2023). MA RBUECS Demand Impact Model
2023_Guidehouse_MA_RBUECS_Demand_Impact_Model

2.21 HVAC - Duct Sealing - IE Single Family

Measure Code	IE-HVAC-DSAF
Market	Low-Income
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	Low Income - Single Family (1-4 units) (LI_SF)	EB1a013
Duct Sealing	Low Income - Single Family (1-4 units) (LI_SF)	GB1a007

Algorithms for Calculating Primary Energy Impact:

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

Measure Name	ΔkWh	ΔkW[2]	Δ MMBtu
Duct Sealing, Electric	22	0.01	
Duct Sealing, Oil			0.7
Duct Sealing, Other			0.7
Duct Sealing, Gas			0.7

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	LI_SF	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	LI_SF	All	1.00	1.00	1.00	1.00	1.00	0.54	0.19

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	LI_SF	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	LI_SF	All			Varies by PA	$0.01		
Duct Sealing, Gas	LI_SF	All	$6.21				Varies by PA	$0.08

Endnotes:

1 : Guidehouse (2024). Massachusetts Low-Income Single Family Impact Evaluation
2024_Guidehouse_Income_Eligible_Single_Family_Impact_Report
2 : Guidehouse (2023). MA RBUECS Demand Impact Model
2023_Guidehouse_MA_RBUECS_Demand_Impact_Model
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 (2023). MA RBUECS Demand Impact Model
2023_Guidehouse_MA_RBUECS_Demand_Impact_Model

2.22 HVAC - Furnace Retrofit

Measure Code	IE-HVAC-FR
Market	Low-Income
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
Furnace Replacement, Oil	Low Income - Single Family (1-4 units) (LI_SF)	EB1a032
Furnace Replacement, Other	Low Income - Single Family (1-4 units) (LI_SF)	EB1a033
Furnace Replacement	Low Income - Single Family (1-4 units) (LI_SF)	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]
Furnace Replacement, Oil	Oil	3.7	34	0.02
Furnace Replacement, Other	Propane	10.5	92	0.05
Furnace Replacement, Gas	Gas	10.5	92	0.05

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
Furnace Replacement	LI_SF	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}
Furnace Replacement	LI_SF	All	1.00	1.00	1.00	1.00	1.00	0.00	0.58

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
Furnace Replacement	LI_SF	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_SF	All	$310.82		Varies by PA	$0.01		
Heating System Retrofit, Furnace, Gas	IE_SF	All	$310.82				Varies by PA	$0.08

Endnotes:

1 : Guidehouse (2024). Massachusetts Low-Income Single Family Impact Evaluation 2024_Guidehouse_Income_Eligible_Single_Family_Impact_Report
2 : Guidehouse (2023). MA RBUECS Demand Impact Model 2023_Guidehouse_MA_RBUECS_Demand_Impact_Model
3 : Guidehouse (2021). Comprehensive TRM Review. 2021_Guidehouse_TRM_Final_Report
4 : Guidehouse (2023). MA RBUECS Demand Impact Model 2023_Guidehouse_MA_RBUECS_Demand_Impact_Model

2.23 HVAC - Heat Pump - IE - Custom

Measure Code	IE-HVAC-HP-C
Market	Low-Income
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	Low Income - Multifamily (5+ units) (LI_MF)	EB1b060
Custom - Heat Pumps displacing Oil	Low Income - Multifamily (5+ units) (LI_MF)	EB1b061
Custom - Heat Pumps displacing Propane	Low Income - Multifamily (5+ units) (LI_MF)	EB1b062
Custom - Heat Pumps displacing Gas	Low Income - Multifamily (5+ units) (LI_MF)	GB1b023

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	LI_MF	All	1.00	1.00	1.00	1.00	1.00	0.00	0.58
Custom Heat Pumps, Displacing Oil	LI_MF	All	1.00	1.00	1.00	1.00	1.00	0.0	0.58
Custom Heat Pumps, Displacing Propane	LI_MF	All	1.00	1.00	1.00	1.00	1.00	0.0	0.58
Custom - Heat Pumps displacing Gas	LI_MF	All	1.00	1.00	1.00	1.00	1.00	0.0	0.58

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:

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Custom Heat Pumps	LI_MF	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	LI_MF	All	$392.92		Varies	$0.01		
Custom Heat Pumps, Displacing Oil	LI_MF	All	$392.92		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
Custom Heat Pumps, Displacing Propane	LI_MF	All	$392.92		Varies	$0.01		
Custom Heat Pumps, Displacing Gas	LI_MF	All	$392.92				Varies	$0.076

Endnotes:

1 : Guidehouse (2023). MA RBUECS Demand Impact Model 2023_Guidehouse_MA_RBUECS_Demand_Impact_Model

2 : NMR Group, Inc. (2023). Residential Heat Pump NEIs Study. 2022_NMR_MA21X21-E-RHPNEI_Residential Heat Pump NEIs Study Final Report_2023

2.24 HVAC - Heat Pump Displacing Existing Electric Resistance Heat

Measure Code	IE-HVAC-FS-DMSDEH
Market	Low-Income
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
CVEO Low Income - MSHP displacing Electric Heat (Single Family)	Low Income - Single Family (1-4 units) (LI_SF)	CVEO9
Central HP displacing Electric Resistance	Low Income - Single Family (1-4 units) (LI_SF)	EB1a035
Minisplit HP displacing Electric Resistance	Low Income - Single Family (1-4 units) (LI_SF)	EB1a036
Central HP displacing Electric Resistance	Low Income - Multifamily (5+ units) (LI_MF)	EB1b050
Minisplit HP displacing Electric Resistance	Low Income - Multifamily (5+ units) (LI_MF)	EB1b051

Algorithms for Calculating Primary Energy Impact:

Unit savings are deemed based on a per ton savings. Savings were developed from the Massachusetts and Connecticut Heat Pump Metering Study (MA22R51-B-HPMS)[1] which metered heat pump usage and performance in homes across MA and CT. Heating and cooling baseline weights were developed based on participant survey responses.

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
Central HP displacing Electric Resistance	n/a	1.52	2,537
Minisplit HP displacing Electric Resistance	n/a	1.34	2,547

Baseline Efficiency:

For displacement of electric heat, the equivalent HSPF for electric resistance heat is assumed to be 3.41 COP.[2]

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.[3]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Central HP displacing Electric Resistance	IE_SF IE_MF	All	17	N/A	N/A	17
Minisplit HP displacing Electric Resistance	IE_SF IE_MF	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)

Measure	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Central HP displacing Electric Resistance	IE_SF IE_MF	All	1.00	1.00	1.00	1.00	1.00	0.05	0.44
MSHP displacing Electric Resistance	IE_SF IE_MF	All	1.00	1.00	1.00	1.00	1.00	0.06	0.44

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 set to 100% since this is a market transformation initiative and per The Resolution of the Energy Efficiency Advisory Council Regarding 2025-2027 Three-Year Plan Evaluation, Measurement and Verification Principles and Policy memo market transformation initiative may not be subject to net-to-gross factors.[5]

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Central HP displacing Electric Resistance	IE_SF IE_MF	All	0.00	0.00	0.00	1.00
MSHP displacing Electric Resistance	IE_SF IE_MF	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 [6]. 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 HP displacing Electric Resistance	LI_SF	All	$196.46		$0.07	$0.01		
Minisplit HP displacing Electric Resistance	LI_SF	All	$196.46		$0.07	$0.01		
Central HP displacing Electric Resistance	LI_MF	All	$196.46		$0.07	$0.01		
Minisplit HP displacing Electric Resistance	LI_MF	All	$196.46		$0.07	$0.01		
CVEO MSHP displacing Electric Heat (Single Family)	LI_SF	All						

Endnotes:

1 : Guidehouse (2024). Heat Pump Metering Study 2024_Guidehouse_Resi_Heat Pump Metering Study
2 : The Cadmus Group, Inc. (2016). Ductless Mini Split Heat Pump Impact Evaluation Cadmus_2016_DMSHP_Impact_Evaluation
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 (2023). Residential Baseline Demand Impact Model

2023_Guidehouse_MA_RBUECS_Demand_Impact_Model

5 : The Resolution of the Energy Efficiency Advisory Council Regarding 2025-2027 Three-Year Plan Evaluation, Measurement and Verification Principles and Policy memo - https://ma-eeac.org/wp-content/uploads/2025-2027-Three-Year-Plan-EMV-Policy-Memo-FINAL-1.pdf

6 : The following study supplied the NEIs for market rate customers but recommends these NEIs be applied to the similar Low-Income measure offering. 2022_NMR_MA21X21-E-RHPNEI_Residential Heat Pump NEIs Study Final Report_2023

2.25 HVAC - Heat Pump Fully Displacing Existing Boiler

Measure Code	IE-HVAC-FS-DMSHP
Market	Low-Income
Program Type	Retrofit
Category	Heating Ventilation and Air Conditioning

Measure Description:

Full displacement of a boiler with a high efficiency ductless mini split heat pump for heating.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
CVEO Low Income - MSHP fully displacing Oil Heat (Single Family)	Low Income - Single Family (1-4 units) (LI_SF)	CVEO34
CVEO Low Income - MSHP fully displacing Propane Heat (Single Family)	Low Income - Single Family (1-4 units) (LI_SF)	CVEO35
Minisplit HP displacing Oil - Full	Low Income - Single Family (1-4 units) (LI_SF)	EB1a040
Minisplit HP displacing Propane - Full	Low Income - Single Family (1-4 units) (LI_SF)	EB1a044
Minisplit HP Displacing Gas - Full	Low Income - Single Family (1-4 units) (LI_SF)	GB1a022
Minisplit HP displacing Oil - Full	Low Income - Multifamily (5+ units) (LI_MF)	EB1b055
Minisplit HP displacing Propane - Full	Low Income - Multifamily (5+ units) (LI_MF)	EB1b059
Minisplit HP Displacing Gas - Full	Low Income - Multifamily (5+ units) (LI_MF)	GB1b027

Algorithms for Calculating Primary Energy Impact:

Unit savings are deemed based on a per ton savings. Savings were developed from the Massachusetts and Connecticut Heat Pump Metering Study (MA22R51-B-HPMS)[1] which metered heat pump usage and performance in homes across MA and CT. Heating and cooling baseline weights were developed based on participant survey responses.

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	17.1	-1.00	-1,208
MSHP Fully Displacing Propane Heat	17.5	-1.00	-1,206
MSHP fully displacing Gas Heat	17.5	-1.00	-1,206

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[2]	OYF	RUL	AML
MSHP Fully Displacing Any Fuel Heating	LI_SF LI_MF	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}
Minisplit HP displacing Oil - Full	LI_SF	All	1.00	1.00	1.00	1.00	1.00	-0.07	0.32
Minisplit HP displacing Propane - Full	LI_SF	All	1.00	1.00	1.00	1.00	1.00	-0.07	0.32
Minisplit HP displacing Oil - Full	LI_MF	All	1.00	1.00	1.00	1.00	1.00	-0.11	0.27
Minisplit HP displacing Propane - Full	LI_MF	All	1.00	1.00	1.00	1.00	1.00	-0.07	0.32
CVEO MSHP fully displacing Oil Heat	LI_SF	All	1.00	1.00	1.00	1.00	1.00	-0.07	0.32
CVEO MSHP fully displacing Propane Heat	LI_SF	All	1.00	1.00	1.00	1.00	1.00	-0.07	0.32
Minisplit HP Displacing Gas - Full	LI_SF	All	1.00	1.00	1.00	1.00	1.00	-0.07	0.32
Minisplit HP Displacing Gas - Full	LI_MF	All	1.00	1.00	1.00	1.00	1.00	-0.07	0.32

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[3]:

Coincidence factors are custom calculated.

Impact Factors for Calculating Net Savings:

Net to gross factors are set to 100% since this is a market transformation initiative and per The Resolution of the Energy Efficiency Advisory Council Regarding 2025-2027 Three-Year Plan Evaluation, Measurement and Verification Principles and Policy memo market transformation initiative may not be subject to net-to-gross factors.[4]

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG[5]
MSHP Fully Displacing Any Fuel Heating	LI_SF LI_MF	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 [6]. 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
Minisplit HP displacing Oil - Full	LI_SF	All	$94.14		$0.07	$0.01		
Minisplit HP displacing Propane - Full	LI_SF	All	$94.14		$0.07	$0.01		
Minisplit HP displacing Oil - Full	LI_MF	All	$94.14		$0.07	$0.01		
Minisplit HP displacing Propane - Full	LI_MF	All	$94.14		$0.07	$0.01		
CVEO MSHP fully displacing Oil Heat	LI_SF	All			$0.07	$0.01		
CVEO MSHP fully displacing Propane Heat	LI_SF	All			$0.07	$0.01		
Minisplit HP Displacing Gas - Full	LI_SF	All	$94.14				$0.31	$0.08
Minisplit HP Displacing Gas - Full	LI_MF	All	$94.14				$0.31	$0.08

Endnotes:

1 : Guidehouse (2024). Heat Pump Metering Study 2024_Guidehouse_Resi_Heat Pump Metering Study
2 : 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
3 : Guidehouse (2023). Baseline Demand Impact Model
2023_Guidehouse_MA_RBUECS_Demand_Impact_Model
4 : The Resolution of the Energy Efficiency Advisory Council Regarding 2025-2027 Three-Year Plan Evaluation, Measurement and Verification Principles and Policy memo - https://ma-eeac.org/wp-content/uploads/2025-2027-Three-Year-Plan-EMV-Policy-Memo-FINAL-1.pdf
5 : The Low-Income sector assumes a 100% NTG value.
6 : Study recommended that the NEIs used for market rate heat pumps would also be applicable for the similar measures in the Low-Income and moderate income program offerings. 2022_NMR_MA21X21-E-RHPNEI_Residential Heat Pump NEIs Study Final Report_2023

2.26 HVAC - Heat Pump Fully Displacing Existing Furnace

Measure Code	IE-HVAC-FSHP
Market	Low-Income
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
CVEO Low Income - Central Heat Pump fully displacing Oil Heat (Single Family)	Low Income - Single Family (1-4 units) (LI_SF)	CVEO32
CVEO Low Income - Central Heat Pump fully displacing Propane Heat (Single Family)	Low Income - Single Family (1-4 units) (LI_SF)	CVEO33
Central HP displacing Oil - Full	Low Income - Single Family (1-4 units) (LI_SF)	EB1a038
Central HP displacing Propane - Full	Low Income - Single Family (1-4 units) (LI_SF)	EB1a042
Central HP Displacing Gas - Full	Low Income - Single Family (1-4 units) (LI_SF)	GB1a021
Central HP displacing Oil - Full	Low Income - Multifamily (5+ units) (LI_MF)	EB1b053
Central HP displacing Propane - Full	Low Income - Multifamily (5+ units) (LI_MF)	EB1b057
Central HP Displacing Gas - Full	Low Income - Multifamily (5+ units) (LI_MF)	GB1b026

Algorithms for Calculating Primary Energy Impact:

Unit savings are deemed based on a per ton savings. Savings were developed from the Massachusetts and Connecticut Heat Pump Metering Study (MA22R51-B-HPMS)[1] which metered heat pump usage and performance in homes across MA and CT. Heating and cooling baseline weights were developed based on participant survey responses.

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
Central Heat Pump fully displacing Oil Heat	16.6	-1.83	-1,238
Central Heat Pump fully displacing Propane Heat	15.5	-1.84	-1,249
Central Heat Pump fully displacing Gas Heat	15.5	-1.84	-1,249

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. [2]

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[3]	OYF	RUL	AML
Central Heat Pump Fully Displacing Any Fuel Heating	LI_SF LI_MF	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 HP displacing Oil - Full	LI_SF	All	1.00	1.00	1.00	1.00	1.00	-0.04	0.19
Central HP displacing Propane - Full	LI_SF	All	1.00	1.00	1.00	1.00	1.00	-0.03	0.19
Central HP displacing Oil - Full	LI_MF	All	1.00	1.00	1.00	1.00	1.00	-0.04	0.19
Central HP displacing Propane - Full	LI_MF	All	1.00	1.00	1.00	1.00	1.00	-0.03	0.19
CVEO Central Heat Pump fully displacing Oil Heat (Single Family)	LI_SF	All	1.00	1.00	1.00	1.00	1.00	-0.04	0.19
CVEO Central Heat Pump fully displacing Propane Heat (Single Family)	LI_SF	All	1.00	1.00	1.00	1.00	1.00	-0.03	0.19
Central HP Displacing Gas - Full	LI_SF	All	1.00	1.00	1.00	1.00	1.00	-0.03	0.19
Central HP Displacing Gas - Full	LI_MF	All	1.00	1.00	1.00	1.00	1.00	-0.03	0.19

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[4]:

Coincidence factors are calculated to reflect blend of heating and cooling.

Impact Factors for Calculating Net Savings:

Net to gross factors are set to 100% since this is a market transformation initiative and per The Resolution of the Energy Efficiency Advisory Council Regarding 2025-2027 Three-Year Plan Evaluation, Measurement and Verification Principles and Policy memo market transformation initiative may not be subject to net-to-gross factors.[5]

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Central Heat Pump Fully Displacing Any Fuel Heating	IE_SF IE_MF	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 [6]. 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 HP displacing Oil - Full	LI_SF	All	$64.24		$0.07	$0.01		
Central HP displacing Propane - Full	LI_SF	All	$64.24		$0.07	$0.01		
Central HP displacing Oil - Full	LI_MF	All	$64.24		$0.07	$0.01		
Central HP displacing Propane - Full	LI_MF	All	$64.24		$0.07	$0.01		
CVEO Central Heat Pump fully displacing Oil Heat (Single Family)	LI_SF	All						
CVEO Central Heat Pump fully displacing Propane Heat (Single Family)	LI_SF	All			$0.07	$0.01		
Central HP Displacing Gas - Full	LI_SF	All	$67.24				$0.31	$0.08
Central HP Displacing Gas - Full	LI_MF	All	$67.24				$0.31	$0.08

Endnotes:

1 : Guidehouse (2024). Heat Pump Metering Study 2024_Guidehouse_Resi_Heat Pump Metering Study
2 : Further information on the methodology used to calculate the overall savings can be found here: 2021_Guidehouse_Fuel Displacement Report_HP
3 : 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
4 : Guidehouse (2023). Baseline Demand Impact Model
2023_Guidehouse_MA_RBUECS_Demand_Impact_Model
5 : The Resolution of the Energy Efficiency Advisory Council Regarding 2025-2027 Three-Year Plan Evaluation, Measurement and Verification Principles and Policy memo - https://ma-eeac.org/wp-content/uploads/2025-2027-Three-Year-Plan-EMV-Policy-Memo-FINAL-1.pdf
6 : The following study supplied the NEIs for market rate customers but recommends these NEIs be applied to the similar Low-Income measure offering. 2022_NMR_MA21X21-E-RHPNEI_Residential Heat Pump NEIs Study Final Report_2023

2.27 HVAC - Heat Pump Partially Displacing Existing Boiler

Measure Code	IE-HVAC-FS-DMSHP-P
Market	Low-Income
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
Minisplit HP displacing Oil - Partial	Low Income - Single Family (1-4 units) (LI_SF)	EB1a039
Minisplit HP displacing Propane - Partial	Low Income - Single Family (1-4 units) (LI_SF)	EB1a043
Minisplit HP Displacing Gas - Partial	Low Income - Single Family (1-4 units) (LI_SF)	GB1a020
Minisplit HP displacing Oil - Partial	Low Income - Multifamily (5+ units) (LI_MF)	EB1b054
Minisplit HP displacing Propane - Partial	Low Income - Multifamily (5+ units) (LI_MF)	EB1b058
Minisplit HP Displacing Gas - Partial	Low Income - Multifamily (5+ units) (LI_MF)	GB1b025

Algorithms for Calculating Primary Energy Impact:

Unit savings are deemed based on a per ton savings. Savings were developed from the Massachusetts and Connecticut Heat Pump Metering Study (MA22R51-B-HPMS)[1] which metered heat pump usage and performance in homes across MA and CT. Heating and cooling baseline weights were developed based on participant survey responses.

Savings on a per tonnage basis are 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	15.9	-1.06	-961
MSHP partially displacing Propane Heat	16.3	-1.06	-960
MSHP partially displacing Gas Heat	16.3	-1.06	-960

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 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[2]	OYF	RUL	AML
MSHP partially displacing Any Fuel Heat	LI_SF LI_MF	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}
Minisplit HP displacing Oil - Partial	LI_SF	All	1.00	1.00	1.00	1.00	1.00	-0.11	0.27
Minisplit HP displacing Propane - Partial	LI_SF	All	1.00	1.00	1.00	1.00	1.00	-0.11	0.27
Minisplit HP displacing Oil - Partial	LI_MF	All	1.00	1.00	1.00	1.00	1.00	-0.11	0.27
Minisplit HP displacing Propane - Partial	LI_MF	All	1.00	1.00	1.00	1.00	1.00	-0.11	0.27

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Minisplit HP Displacing Gas - Partial	LI_SF	All	1.00	1.00	1.00	1.00	1.00	-0.11	0.27
Minisplit HP Displacing Gas - Partial	LI_MF	All	1.00	1.00	1.00	1.00	1.00	-0.11	0.27

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[3]:

Coincidence factors are custom calculated.

Impact Factors for Calculating Net Savings:

Net to gross factors are set to 100% since this is a market transformation initiative and per The Resolution of the Energy Efficiency Advisory Council Regarding 2025-2027 Three-Year Plan Evaluation, Measurement and Verification Principles and Policy memo market transformation initiative may not be subject to net-to-gross factors.[4]

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
MSHP partially displacing Any Fuel Heat	LI_SF LI_MF	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
Minisplit HP displacing Oil - Partial	LI_SF	All	$104.35		$0.07	0.01		
Minisplit HP displacing Propane - Partial	LI_SF	All	$104.35		$0.07	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
Minisplit HP displacing Oil - Partial	LI_MF	All	$104.35		$0.07	0.01		
Minisplit HP displacing Propane - Partial	LI_MF	All	$104.35		$0.07	0.01		
Minisplit HP Displacing Gas - Partial	LI_SF	All	$104.35				$0.31	$0.08
Minisplit HP Displacing Gas - Partial	LI_MF	All	$104.35				$0.31	$0.08

Endnotes:

1 : Guidehouse (2024). Heat Pump Metering Study 2024_Guidehouse_Resi_Heat Pump Metering Study
2 : 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
3 : Guidehouse (2023). Baseline Demand Impact Model
2023_Guidehouse_MA_RBUECS_Demand_Impact_Model
4 : The Resolution of the Energy Efficiency Advisory Council Regarding 2025-2027 Three-Year Plan Evaluation, Measurement and Verification Principles and Policy memo - https://ma-eeac.org/wp-content/uploads/2025-2027-Three-Year-Plan-EMV-Policy-Memo-FINAL-1.pdf
5 : The following study supplied the NEIs for market rate customers but recommends these NEIs be applied to the similar Low-Income measure offering. 2022_NMR_MA21X21-E-RHPNEI_Residential Heat Pump NEIs Study Final Report_2023

2.28 HVAC - Heat Pump Partially Displacing Existing Furnace

Measure Code	IE-HVAC-FSHP-P
Market	Low-Income
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 HP displacing Oil - Partial	Low Income - Single Family (1-4 units) (LI_SF)	EB1a037
Central HP displacing Propane - Partial	Low Income - Single Family (1-4 units) (LI_SF)	EB1a041
Central HP Displacing Gas - Partial	Low Income - Single Family (1-4 units) (LI_SF)	GB1a019
Central HP displacing Oil - Partial	Low Income - Multifamily (5+ units) (LI_MF)	EB1b052
Central HP displacing Propane - Partial	Low Income - Multifamily (5+ units) (LI_MF)	EB1b056
Central HP Displacing Gas - Partial	Low Income - Multifamily (5+ units) (LI_MF)	GB1b024

Algorithms for Calculating Primary Energy Impact:

Unit savings are deemed based on a per ton savings. Savings were developed from the Massachusetts and Connecticut Heat Pump Metering Study (MA22R51-B-HPMS)[1] which metered heat pump usage and performance in homes across MA and CT. Heating and cooling baseline weights were developed based on participant survey responses.

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	10.5	-0.89	-832
Central Heat Pump Partially Displacing Propane Heat	9.8	-0.89	-839
Central Heat Pump partially displacing Gas Heat	9.8	-0.89	-839

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. [2]

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[3]	OYF	RUL	AML
Central Ducted Heat Pump Partially Displacing Any Fuel Heating	IE_SF IE_MF	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 HP displacing Oil - Partial	LI_SF	All	1.00	1.00	1.00	1.00	1.00	-0.06	0.25
Central HP displacing Propane - Partial	LI_SF	All	1.00	1.00	1.00	1.00	1.00	-0.06	0.25
Central HP displacing Oil - Partial	LI_MF	All	1.00	1.00	1.00	1.00	1.00	-0.06	0.25
Central HP displacing Propane - Partial	LI_MF	All	1.00	1.00	1.00	1.00	1.00	-0.06	0.25
Central HP Displacing Gas - Partial	LI_SF	All	1.00	1.00	1.00	1.00	1.00	-0.06	0.25

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Central HP Displacing Gas - Partial	LI_MF	All	1.00	1.00	1.00	1.00	1.00	-0.06	0.25

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[4]:

Coincidence factors are calculated to reflect blend of heating and cooling.

Impact Factors for Calculating Net Savings:

Net to gross factors are set to 100% since this is a market transformation initiative and per The Resolution of the Energy Efficiency Advisory Council Regarding 2025-2027 Three-Year Plan Evaluation, Measurement and Verification Principles and Policy memo market transformation initiative may not be subject to net-to-gross factors.[4]

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Central Ducted Heat Pump Partially Displacing Any Fuel Heating	IE_SF IE_MF	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 [6]. 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 HP displacing Oil - Partial	LI_SF	All	$56.18		$0.07	$0.01		
Central HP displacing Propane - Partial	LI_SF	All	$56.18		$0.07	$0.01		
Central HP displacing Oil - Partial	LI_MF	All	$56.18		$0.07	$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
Central HP displacing Propane - Partial	LI_MF	All	$56.18		$0.07	$0.01		
Central HP Displacing Gas - Partial	LI_SF	All	$56.18				$0.31	$0.08
Central HP Displacing Gas - Partial	LI_MF	All	$56.18				$0.31	$0.08

Endnotes:

1 : Guidehouse (2024). Heat Pump Metering Study 2024_Guidehouse_Resi_Heat Pump Metering Study
2 : Further information on the baseline and the associated baseline weights can be found in the following report: 2021_Guidehouse_Fuel Displacement Report_HP
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 (2023). Baseline Demand Impact Model
2023_Guidehouse_MA_RBUECS_Demand_Impact_Model
4 : The Resolution of the Energy Efficiency Advisory Council Regarding 2025-2027 Three-Year Plan Evaluation, Measurement and Verification Principles and Policy memo - https://ma-eeac.org/wp-content/uploads/2025-2027-Three-Year-Plan-EMV-Policy-Memo-FINAL-1.pdf
6 : The following study supplied the NEIs for market rate customers but recommends these NEIs be applied to the similar Low-Income measure offering. 2022_NMR_MA21X21-E-RHPNEI_Residential Heat Pump NEIs Study Final Report_2023

2.29 HVAC - Heating System

Measure Code	IE-HVAC-HS
Market	Low-Income
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
Boiler Replacement, Gas	Low Income - Multifamily (5+ units) (LI_MF)	GB1b005
Furnace Replacement	Low Income - Multifamily (5+ units) (LI_MF)	GB1b006
Commercial Boiler, Gas	Low Income - Multifamily (5+ units) (LI_MF)	GB1b007

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	LI_MF	All	23	n/a	n/a	23
Heating System Retrofit, Furnace	LI_MF	All	17	n/a	n/a	17
Heating System Retrofit, Commercial Boiler	LI_MF	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, Gas	LI_MF	Berkshire	1.00	n/a	0.80	n/a	n/a	n/a	n/a
Heating System, Gas	LI_MF	Columbia	1.00	n/a	0.96	n/a	n/a	n/a	n/a
Heating System, Gas	LI_MF	Eversource	1.00	n/a	1.05	n/a	n/a	n/a	n/a
Heating System, Gas	LI_MF	Liberty	1.00	n/a	0.96	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}
Heating System, Gas	LI_MF	National Grid	1.00	n/a	0.75	n/a	n/a	n/a	n/a
Heating System, Gas	LI_MF	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	LI_MF	All	0.00	0.00	0.00	1.00
Heating System Retrofit, Furnace	LI_MF	All	0.00	0.00	0.00	1.00
Heating System Retrofit, Commercial Boiler	LI_MF	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	LI_MF	All	$836.39				Varies by PA	$0.08
Heating System Retrofit, Furnace	LI_MF	All	$836.39				Varies by PA	$0.08
Heating System Retrofit, Commercial Boiler	LI_MF	All	$836.39				Varies by PA	$0.08

Endnotes:

1 : Guidehouse (2021). Comprehensive TRM Review. 2021_Guidehouse_TRM_Final_Report
2 : The Cadmus Group (2015). Massachusetts Low-Income Multifamily Initiative Impact Evaluation. CADMUS_2015_Low_Income_Multifamily_Impact_Evaluation

2.30 HVAC - Pipe Wrap (Heating)

Measure Code	IE-HVAC-PW
Market	Low-Income
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)	Low Income - Single Family (1-4 units) (LI_SF)	EB1a016
Pipe Wrap (Heating)	Low Income - Single Family (1-4 units) (LI_SF)	GB1a010
Pipe Wrap (Heating)	Low Income - Multifamily (5+ units) (LI_MF)	EB1b016
Pipe Wrap (Heating)	Low Income - Multifamily (5+ units) (LI_MF)	GB1b011

Algorithms for Calculating Primary Energy Impact:

MMBtu savings are deemed based on study results where unit is a household with pipe wrap installed on heating pipes for Single Family[1], and deemed per linear foot of pipe insulation for Multifamily[2].

Measure Name	Core Initiative	Δ MMBtu
Pipe Wrap (Heating), Oil	LI_SF	1.0
Pipe Wrap (Heating), Oil	LI_MF	0.03
Pipe Wrap (Heating), Gas	LI_MF	0.02

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.[3]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Pipe Wrap (Heating)	LI_SF	All	20	n/a	n/a	20
Pipe Wrap (Heating)	LI_MF	All	15	n/a	n/a	15
Pipe Wrap Gas (Heating)	LI_SF	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)	LI_SF, LI_MF	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)	LI_MF	All	0.00	0.00	0.00	1.00
Pipe Wrap (Heating)	LI_SF	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	LI_SF	All	$48.94				Varies by PA	$0.08

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	LI_MF	All	$6.61				Varies by PA	$0.08
Pipe Wrap (Heating), Oil	LI_SF	All	$48.94					
Pipe Wrap (Heating), Oil	LI_MF	All	$6.61					

Endnotes:

1 : Guidehouse (2024). Massachusetts Low-Income Single Family Impact Evaluation 2024_Guidehouse_Income_Eligible_Single_Family_Impact_Report

2 : Guidehouse (2024). Massachusetts Income-Eligible and Residential Coordinated Delivery Multifamily Impact Evaluation 2024_Guidehouse_MF_Impact_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

2.31 HVAC - Programmable Thermostat

Measure Code	IE-HVAC-PT
Market	Low-Income
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	Low Income - Single Family (1-4 units) (LI_SF)	EB1a023
Programmable Thermostat	Low Income - Single Family (1-4 units) (LI_SF)	GB1a013
Programmable Thermostat	Low Income - Multifamily (5+ units) (LI_MF)	EB1b021
Programmable Thermostat	Low Income - Multifamily (5+ units) (LI_MF)	GB1b019

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	Core Initiative	ΔkWh	ΔkW	ΔMMBtu
Programmable Thermostat, Electric	LI_SF	280	0.14	
Programmable Thermostat, Gas	LI_SF		0.02	2.0
Programmable Thermostat, Oil	LI_SF			2.3
Programmable Thermostat, Other	LI_SF			2.0
Programmable Thermostat, Electric	LI_MF	276	0.14	n/a
Programmable Thermostat, Gas	LI_MF	13	0.01	1.3
Programmable Thermostat, Oil	LI_MF	13	0.01	1.3
Programmable Thermostat, Other	LI_MF	13	0.01	1.3

Weighted averages for Electric BC model

Measure Name	BCR ID	ΔkWh	ΔkW	Δ Oil MMBTUs	Δ Propane MMBTUs
Programmable Thermostat	EB1a023	112	0.05	1.15	0.20
Programmable Thermostat	EB1b021	120.8	0.06	0.65	0.13

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.[6]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Programmable Thermostat	LI_SF, LI_MF	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	LI_SF	All	1.00	1.00	n/a	1.00	1.00	0.00	0.58
Programmable Thermostat, Gas	LI_SF	All	1.00	n/a	1.00	n/a	n/a	0.54	0.00
Programmable Thermostat, Oil	LI_SF	All	1.00	n/a	1.00	n/a	n/a	n/a	n/a
Programmable Thermostat, Other	LI_SF	All	1.00	n/a	1.00	n/a	n/a	n/a	n/a
Programmable Thermostat, Electric	LI_MF	All	1.00	1.00	n/a	1.00	1.00	0.00	0.58
Programmable Thermostat, Gas	LI_MF	All	1.00	n/a	1.00	n/a	n/a	0.54	0.00
Programmable Thermostat, Oil	LI_MF	All	1.00	n/a	1.00	n/a	n/a	n/a	n/a
Programmable Thermostat, Other	LI_MF	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.[7]

Impact Factors for Calculating Net Savings:

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Programmable Thermostat	IE_SF, IE_MF	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 Low-Income, 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	LI_SF	All	$44.53		Varies by PA	$0.01		
Programmable Thermostat, Gas	LI_SF	All	$44.53				Varies by PA	$0.08
Programmable Thermostat, Oil	LI_SF	All	$44.53					
Programmable Thermostat, Other	LI_SF	All	$44.53					
Programmable Thermostat, Electric	LI_MF	All	$16.02		Varies by PA	$0.01		
Programmable Thermostat, Gas	LI_MF	All	$16.02				Varies by PA	$0.08
Programmable Thermostat, Oil	LI_MF	All	$16.02					
Programmable Thermostat, Other	LI_MF	All	$16.02					

Endnotes:

1 : Guidehouse (2024). Massachusetts Low-Income Single Family Impact Evaluation 2024_Guidehouse_Income_Eligible_Single_Family_Impact_Report
2 : Guidehouse (2024). Massachusetts Income-Eligible and Residential Coordinated Delivery Multifamily Impact Evaluation 2024_Guidehouse_MF_Impact_Report
3 : Guidehouse (2023). MA RBUECS Demand Impact Model 2023_Guidehouse_MA_RBUECS_Demand_Impact_Model
6 : Guidehouse (2021). Comprehensive TRM Review. 2021_Guidehouse_TRM_Final_Report
7 : Guidehouse (2023). MA RBUECS Demand Impact Model 2023_Guidehouse_MA_RBUECS_Demand_Impact_Model

2.32 HVAC - Window AC Replacement (Retrofit)

Measure Code	IE-HVAC-WACR
Market	Low-Income
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	Low Income - Single Family (1-4 units) (LI_SF)	EB1a053
Window AC Replacement	Low Income - Multifamily (5+ units) (LI_MF)	EB1b047

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]

Measure Name	Core Initiative	ΔkWh	ΔkW
Window AC Replacement	LI_SF	48	0.05
Window AC Replacement	LI_MF	48	0.05

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	LI_SF, LI_MF	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	LI_SF, LI_MF	All	1.00	1.00	n/a	1.00	1.00	0.54	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	LI_SF, LI_MF	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	LI_SF	All	$49.50		Varies by PA	$0.01		
Window AC Replacement	LI_MF	All	$49.50		Varies by PA	$0.01		

Endnotes:

1 : Guidehouse (2024). Massachusetts Low-Income Single Family Impact Evaluation 2024_Guidehouse_Income_Eligible_Single_Family_Impact_Report

2 : Guidehouse (2024). Massachusetts Income-Eligible and Residential Coordinated Delivery Multifamily Impact Evaluation 2024_Guidehouse_MF_Impact_Report

3 : Guidehouse (2023). MA RBUECS Demand Impact Model
2023_Guidehouse_MA_RBUECS_Demand_Impact_Model
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 (2023). MA RBUECS Demand Impact Model
2023_Guidehouse_MA_RBUECS_Demand_Impact_Model

2.33 Hot Water - Faucet Aerator

Measure Code	IE-WH-FA
Market	Low-Income
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	Low Income - Single Family (1-4 units) (LI_SF)	EB1a018
Faucet Aerator	Low Income - Single Family (1-4 units) (LI_SF)	GB1a011
Faucet Aerator	Low Income - Multifamily (5+ units) (LI_MF)	EB1b020
Faucet Aerator	Low Income - Multifamily (5+ units) (LI_MF)	GB1b015

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	Core Initiative	ΔkWh	ΔkW	Δ MMBtu
Faucet Aerator, Electric	LI_SF	63	0.02	
Faucet Aerator, Gas	LI_SF			0.30
Faucet Aerator, Oil	LI_SF			0.4
Faucet Aerator, Other	LI_SF			0.3
Faucet Aerator, Electric	LI_MF	34.0	0.01	
Faucet Aerator, Gas	LI_MF			0.20
Faucet Aerator, Oil	LI_MF			0.02
Faucet Aerator, Other	LI_MF			0.02

Weighted averages for BC model

Measure Name	BCR ID	ΔkWh	ΔkW	Δ Oil MMBTUs	Δ Propane MMBTUs
Faucet Aerator	EB1a018	51	0.01	0.05	0.02
Faucet Aerator	EB1b020	34	0.01	0.02	0.02

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	LI_SF, LI_MF	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	LI_SF, LI_MF	All	1.00	1.00	1.00	1.00	1.00	0.30	0.62

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	LI_SF, LI_MF	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	LI_SF	All			Varies by PA	$0.01		
Faucet Aerator, Gas	LI_SF	All					Varies by PA	$0.08
Faucet Aerator, Electric	LI_MF	All	$0.58		Varies by PA	$0.01		
Faucet Aerator, Gas	LI_MF	All	$0.58				Varies by PA	$0.08
Faucet Aerator, Oil	LI_MF	All	$0.58					
Faucet Aerator, Other	LI_MF	All	$0.58					

Endnotes:

1 : Guidehouse (2024). Massachusetts Low-Income Single Family Impact Evaluation 2024_Guidehouse_Income_Eligible_Single_Family_Impact_Report
2 : Guidehouse (2024). Massachusetts Income-Eligible and Residential Coordinated Delivery Multifamily Impact Evaluation 2024_Guidehouse_MF_Impact_Report
3 : Guidehouse (2023). MA RBUECS Demand Impact Model 2023_Guidehouse_MA_RBUECS_Demand_Impact_Model
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

2.34 Hot Water - Heat Pump Water Heater

Measure Code	IE-WH-HPWH
Market	Low-Income
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
HP Water Heater - Small	Low Income - Single Family (1-4 units) (LI_SF)	EB1a046
HP Water Heater - Large	Low Income - Single Family (1-4 units) (LI_SF)	EB1a047
HP Water Heater displacing Oil - Small	Low Income - Single Family (1-4 units) (LI_SF)	EB1a048
HP Water Heater displacing Oil - Large	Low Income - Single Family (1-4 units) (LI_SF)	EB1a049
HP Water Heater displacing Propane - Small	Low Income - Single Family (1-4 units) (LI_SF)	EB1a050
HP Water Heater displacing Propane - Large	Low Income - Single Family (1-4 units) (LI_SF)	EB1a051
HP Water Heater - Small	Low Income - Multifamily (5+ units) (LI_MF)	EB1b038
HP Water Heater - Large	Low Income - Multifamily (5+ units) (LI_MF)	EB1b039
HP Water Heater displacing Oil - Small	Low Income - Multifamily (5+ units) (LI_MF)	EB1b040
HP Water Heater displacing Oil - Large	Low Income - Multifamily (5+ units) (LI_MF)	EB1b041
HP Water Heater displacing Propane - Small	Low Income - Multifamily (5+ units) (LI_MF)	EB1b042
HP Water Heater displacing Propane - Large	Low Income - Multifamily (5+ units) (LI_MF)	EB1b043

Algorithms for Calculating Primary Energy Impact:

Unit savings are deemed based on study results for single family.[1] [2] For multifamily, savings are custom calculated[3] .

Small is equivalent to <55 gallon and Large is >55 gallon.

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	1755	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.[4]

Measure Life:

The measure life is 13 years.[5]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Heat Pump Water Heater	LI_SF, LI_MF	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}
Heat Pump Water Heater	LI_SF, LI_MF	All	1.00	1.00	1.00	1.00	1.00	0.30	0.62

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.[6]

Impact Factors for Calculating Net Savings:

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Heat Pump Water Heater	LI_SF, LI_MF	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	LI_SF, LI_MF	All	$4.64		Varies by PA	$0.01		
Heat Pump Water Heater, Multifamily	LI_SF, LI_MF	All	$5.02		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 : Guidehouse (2024). Massachusetts Low-Income Single Family Impact Evaluation 2024_Guidehouse_Income_Eligible_Single_Family_Impact_Report
3 : Guidehouse (2024). Massachusetts Income-Eligible and Residential Coordinated Delivery Multifamily Impact Evaluation
4 : Energy Star is 2.0 UEF but no models exist that the efficiency level. Lowest available if 2.45 UEF.
5 : Navigant Consulting (2018). Water Heating, Boiler, and Furnace Cost Study (RES 19) Add-On

Task7: Residential Water Heater Analysis Memo. 2018_Navigant_Water_Heater_Analysis_Memo
6 : Navigant Consulting (2018). Water Heating, Boiler, and Furnace Cost Study (RES 19) Add-On
Task7: Residential Water Heater Analysis Memo. 2018_Navigant_Water_Heater_Analysis_Memo

2.35 Hot Water - Low-Flow Showerhead

Measure Code	IE-WH-S
Market	Low-Income
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	Low Income - Single Family (1-4 units) (LI_SF)	EB1a017
Low-Flow Showerhead	Low Income - Single Family (1-4 units) (LI_SF)	GB1a012
Low-Flow Showerhead	Low Income - Multifamily (5+ units) (LI_MF)	EB1b017
Low-Flow Showerhead	Low Income - Multifamily (5+ units) (LI_MF)	GB1b016

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	Core Initiative	ΔkWh	ΔkW	Δ MMBtu
Low-Flow Showerhead, Electric	LI_SF	152	0.04	
Low-Flow Showerhead, Gas	LI_SF			1.4
Low-Flow Showerhead, Oil	LI_SF			0.1
Low-Flow Showerhead, Other	LI_SF			0.1
Low-Flow Showerhead, Electric	LI_MF	165	0.04	
Low-Flow Showerhead, Gas	LI_MF			1.1
Low-Flow Showerhead, Oil	LI_MF			0.14
Low-Flow Showerhead, Other	LI_MF			0.09

Weighted averages for BC model

Measure Name	BCR ID	ΔkWh	ΔkW	Δ Oil MMBTUs	Δ Propane MMBTUs
Low-Flow Showerhead	EB1a017	152	0.02	0.1	0.1
Low-Flow Showerhead	EB1b017	165	0.04	0.14	0.09

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	LI_SF, LI_MF	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	LI_SF	All	1.00	1.00	n/a	1.00	1.00	0.30	0.62
Low-Flow Showerhead, Gas	LI_SF	All	1.00	n/a	1.00	n/a	n/a	n/a	n/a
Low-Flow Showerhead, Oil	LI_SF	All	1.00	n/a	1.00	n/a	n/a	n/a	n/a
Low-Flow Showerhead, Other	LI_SF	All	1.00	n/a	1.00	n/a	n/a	n/a	n/a
Low-Flow Showerhead, Electric	LI_MF	All	1.00	1.00	n/a	1.00	1.00	0.30	0.62
Low-Flow Showerhead, Gas	LI_MF	All	1.00	n/a	1.00	n/a	n/a	n/a	n/a
Low-Flow Showerhead, Oil	LI_MF	All	1.00	n/a	1.00	n/a	n/a	n/a	n/a
Low-Flow Showerhead, Other	LI_MF	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:

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.[7]

Impact Factors for Calculating Net Savings:

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Low-Flow Showerhead	LI_SF LI_MF	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, Electric	LI_SF	All		$1.72	Varies by PA	$0.01		
Low-Flow Showerhead, Gas	LI_SF	All		$1.72			Varies by PA	$0.08
Low-Flow Showerhead, Oil	LI_SF	All		$1.72				
Low-Flow Showerhead, Other	LI_SF	All		$1.72				
Low-Flow Showerhead, Electric	LI_MF	All	$0.58		Varies by PA	$0.01		
Low-Flow Showerhead, Gas	LI_MF	All	$0.58				Varies by PA	$0.08
Low-Flow Showerhead, Oil	LI_MF	All	$0.58					
Low-Flow Showerhead, Other	LI_MF	All	$0.58					

Endnotes:

1 : Guidehouse (2024). Massachusetts Low-Income Single Family Impact Evaluation 2024_Guidehouse_Income_Eligible_Single_Family_Impact_Report
2 : Guidehouse (2024). Massachusetts Income-Eligible and Residential Coordinated Delivery Multifamily Impact Evaluation 2024_Guidehouse_MF_Impact_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.
6 : The Cadmus Group (2015). Massachusetts Low-Income Multifamily Initiative Impact Evaluation. CADMUS_2015_Low_Income_Multifamily_Impact_Evaluation
7 : Guidehouse (2023). MA RBUECS Demand Impact Model 2023_Guidehouse_MA_RBUECS_Demand_Impact_Model

2.36 Hot Water - Low-Flow Showerhead with Thermostatic Valve

Measure Code	IE-WH-STV
Market	Low-Income
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	Low Income - Multifamily (5+ units) (LI_MF)	EB1b018
Low-Flow Showerhead with TSV	Low Income - Multifamily (5+ units) (LI_MF)	GB1b017

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	266	0.07	
Low-Flow Showerhead with TSV, Gas			1.5
Low-Flow Showerhead with TSV, Oil			1.5
Low-Flow Showerhead with TSV, Other			1.5

Weighted averages for BC model

Measure Name	BCR ID	ΔkWh	ΔkW	Δ Oil MMBTUs	Δ Propane MMBTUs
Low-Flow Showerhead with TSV	EB1b018	215	0.05	0.18	0.12

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)	LI_MF	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	LI_MF	All	1.00	1.00	n/a	1.00	1.00	0.30	0.62
Low-Flow Showerhead with TSV, Gas	LI_MF	All	1.00	n/a	1.00	n/a	n/a	n/a	n/a
Low-Flow Showerhead with TSV, Oil	LI_MF	All	1.00	n/a	1.00	n/a	n/a	n/a	n/a
Low-Flow Showerhead with TSV, Other	LI_MF	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	LI_MF	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	LI_MF	All	$0.58		Varies by PA	$0.01		
Low-Flow Showerhead with TSV, Gas	LI_MF	All	$0.58				Varies by PA	$0.08
Low-Flow Showerhead with TSV, Oil	LI_MF	All	$0.58					
Low-Flow Showerhead with TSV, Other	LI_MF	All	$0.58					

Endnotes:

1 : Guidehouse (2024). Massachusetts Income-Eligible and Residential Coordinated Delivery Multifamily Impact Evaluation 2024_Guidehouse_MF_Impact_Report
2 : Guidehouse (2023). MA RBUECS Demand Impact Model 2023_Guidehouse_MA_RBUECS_Demand_Impact_Model
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 (2023). MA RBUECS Demand Impact Model 2023_Guidehouse_MA_RBUECS_Demand_Impact_Model

2.37 Hot Water - Pipe Wrap (Water Heating)

Measure Code	IE-WH-PW
Market	Low-Income
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)	Low Income - Single Family (1-4 units) (LI_SF)	EB1a015
Pipe Wrap (Water Heating)	Low Income - Single Family (1-4 units) (LI_SF)	GB1a009
Pipe Wrap (Water Heating)	Low Income - Multifamily (5+ units) (LI_MF)	EB1b015
Pipe Wrap (Water Heating)	Low Income - Multifamily (5+ units) (LI_MF)	GB1b010

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 for Single Family[1], and deemed per linear foot of pipe insulation for Multifamily[2] .Demand savings are derived from the demand impact model which is developed as part of the Residential Baseline Study.[3]

Measure Name	Core Initiative	ΔkWh	ΔkW	Δ MMBtu
Pipe Wrap (Water Heating), Electric	LI_SF	73	0.02	
Pipe Wrap (Water Heating), Gas	LI_SF			0.3
Pipe Wrap (Water Heating), Oil	LI_SF			1.1
Pipe Wrap (Water Heating), Other	LI_SF			0.3
Pipe Wrap (Water Heating), Electric	LI_MF	7	0.00	
Pipe Wrap (Water Heating), Gas	LI_MF			0.06
Pipe Wrap (Water Heating), Oil	LI_MF			0.01
Pipe Wrap (Water Heating), Other	LI_MF			0.00

Weighted averages for Electric BC model

Measure Name	BCR ID	ΔkWh	ΔkW	Δ Oil MMBTUs	Δ Propane MMBTUs
Pipe Wrap (Water Heating)	EB1a015	59	0.01	0.04	0.02
Pipe Wrap (Water Heating)	EB1b015	7.3	0.01	0.01	0.00

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	PA	Core Initiative	EUL	OYF	RUL	AML
Pipe Wrap (Water Heating)	All	LI_SF, LI_MF	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	LI_SF, LI_MF	All	1.00	1.00	1.00	1.00	1.00	0.30	0.62

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:

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Pipe Wrap (Water Heating)	LI_SF, LI_MF	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)	LI_SF	All	$48.94		Varies by PA	$0.01		
Pipe Wrap (Water Heating), Gas (Single Family)	LI_SF	All	$48.94				Varies by PA	$0.08
Pipe Wrap (Water Heating), Oil (Single Family)	LI_SF	All	$48.94					
Pipe Wrap (Water Heating), Other (Single Family)	LI_SF	All	$48.94					
Pipe Wrap (Water Heating), Electric (Multifamily)	LI_MF	All	$6.61		Varies by PA	$0.01		
Pipe Wrap (Water Heating), Gas (Multifamily)	LI_MF	All	$6.61				Varies by PA	$0.08
Pipe Wrap (Water Heating), Oil (Multifamily)	LI_MF	All	$6.61					
Pipe Wrap (Water Heating), Other (Multifamily)	LI_MF	All	$6.61					

Endnotes:

1 : Guidehouse (2024). Massachusetts Low-Income Single Family Impact Evaluation 2024_Guidehouse_Income_Eligible_Single_Family_Impact_Report
2 : Guidehouse (2024). Massachusetts Income-Eligible and Residential Coordinated Delivery Multifamily Impact Evaluation 2024_Guidehouse_MF_Impact_Report
3 : Guidehouse (2023). MA RBUECS Demand Impact Model 2023_Guidehouse_MA_RBUECS_Demand_Impact_Model
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 (2023). MA RBUECS Demand Impact Model 2023_Guidehouse_MA_RBUECS_Demand_Impact_Model

2.38 Hot Water - Solar Hot Water

Measure Code	IE-S-HW
Market	Low-Income
Program Type	Early Replacement
Category	Hot Water

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	Low Income - Single Family (1-4 units) (LI_SF)	EB1a052

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.

Measure Name	kWh	kW
Solar Hot Water	2,314	0.58

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	LI_SF	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	LI_SF	All	1.00	1.00	1.00	1.00	1.00	0.30	0.62

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	LI_SF	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 Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per KWh	Annual $ per Therm	One-time $ per Therm
Solar Hot Water	LI_SF	All			$0.07	$0.01		

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). Residential and Commercial/ Industrial Lighting and HVAC Measures. GDS_2007_Measure_Life_Report_Residential_and_CI_Lighting_and_HVAC_Measures
3 : 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

2.39 Hot Water - Thermostatic Valve

Measure Code	IE-WH-TV
Market	Low-Income
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	Low Income - Multifamily (5+ units) (LI_MF)	EB1b019
Thermostatic Shut-off Valve	Low Income - Multifamily (5+ units) (LI_MF)	GB1b018

Algorithms for Calculating Primary Energy Impact:

The unit kWh and MMBtu savings are 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
Thermostatic Shut-off Valve, Electric	85	0.02	
Thermostatic Shut-off Valve, Gas			0.5
Thermostatic Shut-off Valve, Oil			0.5
Thermostatic Shut-off Valve, Other			0.5

Weighted averages for BC model

Measure Name	BCR ID	ΔkWh	ΔkW	Δ Oil MMBTUs	Δ Propane MMBTUs
Thermostatic Shut-off Valve	EB1b019	69	0.02	0.06	0.04

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	LI_MF	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	LI_MF	All	1.00	1.00	n/a	1.00	1.00	0.30	0.62
Thermostatic Shut-off Valve, Gas	LI_MF	All	1.00	1.00	1.00	n/a	n/a	n/a	n/a
Thermostatic Shut-off Valve, Oil	LI_MF	All	1.00	1.00	1.00	n/a	n/a	n/a	n/a
Thermostatic Shut-off Valve, Other	LI_MF	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	LI_MF	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	LI_MF	All			Varies by PA	$0.01		
Thermostatic Shut-off Valve, Gas	LI_MF	All					Varies by PA	$0.08
Thermostatic Shut-off Valve, Oil	LI_MF	All						
Thermostatic Shut-off Valve, Other	LI_MF	All						

Endnotes:

1 : Guidehouse (2024). Massachusetts Income-Eligible and Residential Coordinated Delivery Multifamily Impact Evaluation 2024_Guidehouse_MF_Impact_Report
2 : Guidehouse (2023). MA RBUECS Demand Impact Model 2023_Guidehouse_MA_RBUECS_Demand_Impact_Model
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 (2023). MA RBUECS Demand Impact Model 2023_Guidehouse_MA_RBUECS_Demand_Impact_Model

2.40 Hot Water - Water Heating System

Measure Code	IE-WH-WHS
Market	Low-Income
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
Indirect Water Heater	Low Income - Single Family (1-4 units) (LI_SF)	GB1a016
Standalone Water Heater	Low Income - Single Family (1-4 units) (LI_SF)	GB1a017
Tankless Water Heater, Oil	Low Income - Multifamily (5+ units) (LI_MF)	EB1b033
Tankless Water Heater, Other	Low Income - Multifamily (5+ units) (LI_MF)	EB1b034
Indirect Water Heater, Other	Low Income - Multifamily (5+ units) (LI_MF)	EB1b035
Standalone Water Heater, Oil	Low Income - Multifamily (5+ units) (LI_MF)	EB1b036
Standalone Water Heater, Other	Low Income - Multifamily (5+ units) (LI_MF)	EB1b037
On Demand Water Heater	Low Income - Multifamily (5+ units) (LI_MF)	GB1b012
Indirect Water Heater	Low Income - Multifamily (5+ units) (LI_MF)	GB1b013
Standalone Water Heater	Low Income - Multifamily (5+ units) (LI_MF)	GB1b014

Algorithms for Calculating Primary Energy Impact:

Single Family:

MMBtu savings are deemed based on study results.[1]

Measure Name	Core Initiative	Δ MMBTu
Indirect Water Heater, gas	LI_SF	9.0
Stand Alone Water Heater, gas	LI_SF	6.0

Multifamily:

Eversource:

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:

$MMBtu = Units \times 18MMBtu/unit \times (1/EF_{BASE}) - (1/EF_{EE})$

Where:
Unit = Total number of dwelling units utilizing the water heater
18 MMBtu/Unit = Average annual water heating energy demand per dwelling unit [2]
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.[3]

High Efficiency:

The high efficiency case is a stand-alone storage water heater with an energy factor >= 0.66.[4]

Measure Life:

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Indirect Water Heater	LI_SF, LI_MF	All	20[5]	n/a	n/a	20

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Stand Alone Water Heater	LI_SF, LI_MF	All	13[6]	n/a	n/a	13
On Demand/Tankless Water Heater	LI_MF	All	20[7]	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)	LI_MF	Berkshire	1.00	n/a	0.80	n/a	n/a	n/a	n/a
Water Heater, Gas (Multifamily)	LI_MF	Eversource	1.00	n/a	1.05	n/a	n/a	n/a	n/a
Water Heater, Gas (Multifamily)	LI_MF	Liberty	1.00	n/a	0.96	n/a	n/a	n/a	n/a
Water Heater, Gas (Multifamily)	LI_MF	National Grid	1.00	n/a	0.75	n/a	n/a	n/a	n/a
Water Heater, Gas (Multifamily)	LI_MF	Unitil	1.00	n/a	0.96	n/a	n/a	n/a	n/a
Water Heater, Oil (Multifamily)	LI_MF	All	1.00	n/a	1.00	n/a	n/a	n/a	n/a
Water Heater, Other (Multifamily)	LI_MF	All	1.00	n/a	1.00	n/a	n/a	n/a	n/a
Water Heater, Gas (Single family)	LI_SF	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 for singlefamily[8] . Realization rates are based on evaluation results for multifamily and are applied to the vendor estimated savings.[9]

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	LI_SF, LI_MF	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)	LI_SF	All	$1.30				$0.36	$0.08
Indirect Water Heater (Single Family)	LI_SF	All	$0.70				$0.36	$0.08
Water Heater, Gas (Multifamily)	LI_MF	All	$1.19				Varies by PA	$0.08
Water Heater, Oil/Other (Multifamily)	LI_MF	All	$1.19					

Endnotes:

1 : Guidehouse (2024). Massachusetts Low-Income Single Family Impact Evaluation 2024_Guidehouse_Income_Eligible_Single_Family_Impact_Report
2 : GDS Associates, Inc. (2009). Natural Gas Energy Efficiency Potential in Massachusetts. GDS_2009_Natural_Gas_Energy_Efficiency_Potential_in_MA
3 : 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
4 : 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
5 : GDS Associates, Inc. (2009). Natural Gas Energy Efficiency Potential in Massachusetts. GDS_2009_Natural_Gas_Energy_Efficiency_Potential_in_MA
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 : 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
8 : Guidehouse (2024). Massachusetts Low-Income Single Family Impact Evaluation 2024_Guidehouse_Income_Eligible_Single_Family_Impact_Report
9 : The Cadmus Group (2015). Massachusetts Low-Income Multifamily Initiative Impact Evaluation. CADMUS_2015_Low_Income_Multifamily_Impact_Evaluation

2.41 Lighting - Low-Income

Measure Code	IE-L-LEDB
Market	Low-Income
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	Low Income - Single Family (1-4 units) (LI_SF)	EB1a019
LED Bulb (Specialty)	Low Income - Single Family (1-4 units) (LI_SF)	EB1a020
LED Bulb (Reflectors)	Low Income - Single Family (1-4 units) (LI_SF)	EB1a021
Indoor Fixture	Low Income - Single Family (1-4 units) (LI_SF)	EB1a022
LED Bulb	Low Income - Multifamily (5+ units) (LI_MF)	EB1b023
LED Bulb (Specialty)	Low Income - Multifamily (5+ units) (LI_MF)	EB1b024
LED Bulb (Reflectors)	Low Income - Multifamily (5+ units) (LI_MF)	EB1b025
LED Fixture, Indoor In Unit	Low Income - Multifamily (5+ units) (LI_MF)	EB1b026
LED Fixture, Outdoor In Unit	Low Income - Multifamily (5+ units) (LI_MF)	EB1b027
LED Bulb, Common Area	Low Income - Multifamily (5+ units) (LI_MF)	EB1b028
LED Fixture, Indoor Common Area	Low Income - Multifamily (5+ units) (LI_MF)	EB1b029
LED Fixture, Linear Indoor Common Area	Low Income - Multifamily (5+ units) (LI_MF)	EB1b030
LED Fixture, Outdoor Common Area	Low Income - Multifamily (5+ units) (LI_MF)	EB1b031

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 Low-Income In-Unit Fixtures, vendors reference the 2014 Northeast HOU Study (see table below).[3] For Low-Income 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)	LI_SF	43	949	1	40.8	0.01
LED Bulb (Specialty) (Single Family)	LI_SF	36	949	1	34.2	0.01
LED Bulb (Reflectors) (Single Family)	LI_SF	45	949	1	42.7	0.01
LED Bulb (Multifamily)	LI_MF	43	949	1	40.8	0.01
LED Bulb (Specialty) (Multifamily)	LI_MF	36	949	1	34.2	0.01
LED Bulb (Reflectors) (Multifamily)	LI_MF	45	949	1	42.7	0.1
LED Bulb, Common Area (Multifamily)	LI_MF	Vendor Input	Varies by Space Type	N/A	Vendor Calculated	Calculated
Indoor Fixture (Single Family)	LI_SF				62	0.02
LED Fixture, Indoor In Unit (Multifamily)	LI_MF	37.63	803	1.49	41	0.01
LED Fixture, Outdoor In Unit (Multifamily)	LI_MF	37.63	803	2	55	0.01
LED Fixture, Indoor Common Area (Multifamily)	LI_MF	Vendor Calc	6388	Vendor Calc	Vendor Calc	Calculated

Measure Name	Core Initiative	Δ Watts	Annual HOU	# of Bulbs	ΔKWh	ΔkW
LED Fixture, Linear Indoor Common Area (Multifamily)	LI_MF	Vendor Calc	6388	Vendor Calc	Vendor Calc	Calculated
LED Fixture, Outdoor Common Area (Multifamily)	LI_MF	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)	LI_SF, LI_MF	All	15	n/a	n/a	1
LED Bulb, Common Area (Multifamily)	LI_MF	All	3	n/a	n/a	1
LED Fixture, Indoor In Unit (Multifamily) LED Fixture, Outdoor In Unit (Multifamily)	LI_MF	All	20	n/a	n/a	5
LED Fixture, Indoor Common Area (Multifamily)	LI_MF	All	6	n/a	n/a	6
LED Fixture, Linear Indoor Common Area (Multifamily)	LI_MF	All	8	n/a	n/a	8
LED Fixture, Outdoor Common Area (Multifamily)	LI_MF	All	11	n/a	n/a	11
Indoor Fixture (Single Family)	LI_SF	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)	LI_SF, LI_MF	All	1.00	1.01	1.00	1.20	0.93	0.55	0.85
LED Bulb, Common Area (Multifamily)	LI_MF	All	1.00	Varies by PA	Varies by PA	Varies by PA	Varies by PA	0.88	0.71
Indoor Fixture (Single Family)	LI_SF	All	1.00	1.01	1.00	1.20	0.93	0.55	0.85

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
LED Fixture, Indoor In Unit (Multifamily)	LI_MF	All	1.00	1.01	1.00	1.20	0.93	0.55	0.85
LED Fixture, Outdoor In Unit (Multifamily)	LI_MF	All	1.00	1.01	1.00	1.20	0.93	0.55	0.85
LED Fixture, Indoor Common Area (Multifamily)	LI_MF	All	1.00	PA Specific	PA Specific	PA Specific	PA Specific	0.88	0.71
LED Fixture, Linear Indoor Common Area (Multifamily)	LI_MF	All	1.00	PA Specific	PA Specific	PA Specific	PA Specific	0.88	0.71
LED Fixture, Outdoor Common Area (Multifamily)	LI_MF	All	1.00	PA Specific	PA Specific	PA Specific	PA Specific	0.32	0.86

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] [6]

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.[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 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)	LI_SF, LI_MF	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)	LI_SF, LI_MF	All			Rate Discount NEI; Varies by PA	$0.005		
LED Bulb, Common Area (Multifamily)	LI_MF	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	$0.005		
Indoor Fixture (Single Family)	LI_SF	All			Rate Discount NEI; Varies by PA	$0.01		
LED Fixture, Indoor In Unit (Multifamily)	LI_MF	All			Rate Discount NEI; Varies by PA	$0.01		
LED Fixture, Outdoor In Unit (Multifamily)	LI_MF	All			Rate Discount NEI; Varies by PA	$0.01		
LED Fixture, Indoor Common Area (Multifamily)	LI_MF	All	$26/Unit. Values are applied per fixture in the BC model, and adjusted for the		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
			number of fixtures/unit.					
LED Fixture, Linear Indoor Common Area (Multifamily)	LI_MF	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, Outdoor Common Area (Multifamily)	LI_MF	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 : Guidehouse (2024). Massachusetts Low-Income Single Family Impact Evaluation
6 : Guidehouse (2024). Massachusetts Income-Eligible and Residential Coordinated Delivery Multifamily Impact Evaluation
7 : Cadmus (2016). Lighting Interactive Effects Memo. Cadmus_2016_MA_Lighting_Interactive_Effects_Final
8 : Guidehouse (2023). MA RBUECS Demand Impact Model 2023_Guidehouse_MA_RBUECS_Demand_Impact_Model

2.42 Lighting - Occupancy Sensors

Measure Code	IE-L-OS
Market	Low-Income
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	Low Income - Multifamily (5+ units) (LI_MF)	EB1b032

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	0.32	0.22

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	LI_MF	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
Occupancy Sensor, Common Area	LI_MF	All			Varies by PA	$0.01		

Endnotes:

1 : Guidehouse (2023). MA RBUECS Demand Impact Model
2023_Guidehouse_MA_RBUECS_Demand_Impact_Model

2.43 Plug Load - Advanced Power Strip

Measure Code	IE-PL-APS
Market	Low-Income
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	Low Income - Single Family (1-4 units) (LI_SF)	EB1a028
Smart Strip	Low Income - Multifamily (5+ units) (LI_MF)	EB1b072

Algorithms for Calculating Primary Energy Impact:

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

Savings for Smart Strips

Measure Name	Core Initiative	kWh	kW
Smart Strip	All	105	0.01

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	LI_SF LI_MF	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_SF IE_MF	All	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
Smart Strip	LI_SF	All			Varies by PA	$0.01		
Smart Strip	LI_MF	All			Varies by PA	$0.01		

Endnotes:

1 : NMR Group, Inc. (2019). Advanced Power Strip Metering Study.
2019_NMR_APSMeteringReport_Revised
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 : Guidehouse (2023). MA RBUECS Demand Impact Model
2023_Guidehouse_MA_RBUECS_Demand_Impact_Model

2.44 Refrigeration - Vending Miser

Measure Code	IE-R-VM
Market	Low-Income
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	Low Income - Multifamily (5+ units) (LI_MF)	EB1b048

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
Vending Misers	LI_MF	1,612	0.32

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.[3]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Vending Misers	LI_MF	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	LI_MF	All	1.00	1.00	1.00	1.00	1.00	0.68	0.72

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 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	LI_MF	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 Misers	LI_MF	All			Varies by PA	$0.01		

Endnotes:

1 : Guidehouse (2024). Massachusetts Income-Eligible and Residential Coordinated Delivery Multifamily Impact Evaluation 2024_Guidehouse_MF_Impact_Report
2 : Guidehouse (2023). MA RBUECS Demand Impact Model

2023_Guidehouse_MA_RBUECS_Demand_Impact_Model
3 : Energy & Resource Solutions (2005). Measure Life Study. ERS_2005_Measure_Life_Study

3. Commercial & Industrial Efficiency Measures

3.1 Appliance - High-Frequency Battery Charger

Measure Code	COM-A-BC
Market	Commercial
Program Type	Behavior
Category	Appliances

Measure Description:

Installation of a high-frequency battery charger.

BCR Measure IDs:

Measure	Core Initiative	BCR Measure ID
High-Frequency Battery Charger	C&I Equipment Rebates & Instant Incentives (CI_ERII)	EC1e034

Algorithms for Calculating Primary Energy Impact:

Unit savings are deemed [1]

Measure Name	Core Initiative	ΔkWh	ΔkW
High-Frequency Battery Charger	CI_ERII	547	0

Baseline Efficiency:

Baseline efficiency is assumed to be 85%[2]

High Efficiency:

High efficiency case is a 3-phase high frequency charger with power conversion efficiency of >=90% and a power factor of >=90% replacing existing ferroresonant or SCR charger, minimum one 8-hour shift per day in a 5 day work week

Measure Life:

Measure life is shown below.[3]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
High-Frequency Battery Charger	CI_ERII	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:

Impact factors for calculating adjusted gross savings are assumed to be 100% absent evaluation as savings are deemed.

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
High-Frequency Battery Charger	CI_ERII	All	1.00	1.00	1.00	1.00	1.00	1.00	1.00

Impact Factors for Calculating Net Savings:

NTG values from 2024 Omnibus NTG study[4]

Measure Name	Core Initiative	PA	NTG
High-Frequency Battery Charger	CI_ERII	All	0.877

Non-Energy Impacts:

There are no non-energy impacts for this measure.

Endnotes:

1 : IL TRM, 2009 PG&E study
2 : 2009 PG&E study
3 : IL TRM
4 : (2024) NMR C&I Omnibus Net-to-Gross (NTG) Study 2024_NMR_C&I_Omnibus_Study

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

Measure Description:

Recycling of a qualified refrigerator or freezer.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Freezer Recycling	C&I Small Business Turnkey Retrofit (CI_SBTR)	EC1c029
Refrigerator Recycling	C&I Small Business Turnkey Retrofit (CI_SBTR)	EC1c030

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	753	0.14
Refrigerator Recycling	1,005	0.19

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	CI_SBTR	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	CI_SBTR	All	1.00	0.83	0.83	0.83	0.83	0.70	0.90
Refrigerator Recycling	CI_SBTR	All	1.00	0.88	0.88	0.88	0.88	0.70	0.90

In-Service Rates:

Measure leveraging default 100% in-service rate.

Realization Rates:

Realization rates are set to the residential impact factors for the same measures.

Coincidence Factors:

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.[1]

Impact Factors for Calculating Net Savings:

All PAs use Statewide prescriptive net-to-gross results.[2]

Measure	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Freezer/Refrigerator Recycling	CI_SBTR	All	0.0	0.0	0.0	0.964

Non-Energy Impacts:

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

Endnotes:

1 : Guidehouse (2023). MA RBUECS Demand Impact Model
2023_Guidehouse_MA_RBUECS_Demand_Impact_Model
2 : NMR (2024). C&I Prescriptive and Custom Electric Net-to-Gross Omnibus Study Final Report
2024_NMR_C&I_Omnibus_Study

3.3 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
Building Operator Certification	C&I Existing Buildings (CI_EXST)	EC1b024
Building Operator Certification	C&I Existing Buildings (CI_EXST)	GC1b001
Building Operator Certification Plus	C&I Existing Buildings (CI_EXST)	GC1b002

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

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_EXST	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_EXST	All	1.00	1.00	1.00	1.00	1.00	0.28	0.07

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 C&I Loadshape study.[3]

Impact Factors for Calculating Net Savings:

All PAs use statewide net-to-gross results.

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Building Operator Certification, Electric	CI_EXST	All				0.88[5]
Building Operator Certification, Gas	CI_EXST	All				0.81[6]

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 : DNV (2024). C&I Impact Shape Study 2024_DNV_C&I_Impact Shape Study
5 : NMR (2024). C&I Prescriptive and Custom Electric Net-to-Gross Omnibus Study Final Report 2024_NMR_C&I_Omnibus_Study
6 : NMR Group, Inc. (2024). C&I Omnibus Gas Net-to-Gross Study. 2024_NMR_C&I_Omnibus_Study

3.4 Building Shell - Air Curtains

Measure Code	COM-BS-ACUR
Market	Commercial
Program Type	Retrofit
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 Curtain	C&I Equipment Rebates & Instant Incentives (CI_ERII)	EC1e009
Air Curtain	C&I Equipment Rebates & Instant Incentives (CI_ERII)	GC1e007

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_ERII	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 Curtains, Electric	CI_ERII	All	1.00	1.00	1.00	1.00	1.00	0.31	0.81
Air Curtains, Oil	CI_ERII	All	1.00	1.00	1.00	n/a	n/a	n/a	n/a
Air Curtains, Propane	CI_ERII	All	1.00	1.00	1.00	n/a	n/a	n/a	n/a
Air Curtains, Gas	CI_ERII	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.

Coincidence Factors:

Coincidence factors based on IL TRM.[3]

Impact Factors for Calculating Net Savings:

Net to gross factors are based on the 2024 Omnibus NTG Study[4]

Measure Name	Core Initiative	PA	NTG
Air Curtains, Electric	CI_ERII	All	0.877
Air Curtains, Oil	CI_ERII	All	0.877
Air Curtains, Propane	CI_ERII	All	0.877
Air Curtains, Gas	CI_ERII	All	1.038

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 : 2024 C&I Prescriptive and Custom Net-to-Gross Omnibus Study (NMR)
2024_NMR_C&I_Omnibus_Study
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

3.5 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	C&I Multifamily (CI_MF)	EC1d001
Air Sealing, Oil	C&I Multifamily (CI_MF)	EC1d002
Air Sealing, Other	C&I Multifamily (CI_MF)	EC1d003
Moderate Income Qualified - Air Sealing, Electric	C&I Multifamily (CI_MF)	EC1d033
Moderate Income Qualified - Air Sealing, Oil	C&I Multifamily (CI_MF)	EC1d034
Moderate Income Qualified - Air Sealing, Other	C&I Multifamily (CI_MF)	EC1d035
Air Sealing, Gas	C&I Multifamily (CI_MF)	GC1d001
Moderate Income Qualified - Air Sealing, Gas	C&I Multifamily (CI_MF)	GC1d024

Algorithms for Calculating Primary Energy Impact:

Unit savings are calculated using the following algorithms and assumptions:

kWh = (Vol x ACH x 0.018 x HDD x 24/nheating) / 3,413
MMBtu = (Vol x ACH x 0.018 x HDD x 24/nheating) / 1,000,000
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-to-ceiling 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.
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
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	CI_MF	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	CI_MF	All	1.00	0.86	n/a	0.86	0.86	0.00	0.58
Air Sealing, Oil	CI_MF	All	1.00	0.86	0.86	n/a	n/a	n/a	n/a
Air Sealing, Other	CI_MF	All	1.00	0.86	0.86	n/a	n/a	n/a	n/a
Moderate Income Qualified - Air Sealing, Electric	CI_MF	All	1.00	0.86	n/a	0.86	0.86	0.00	0.58
Moderate Income Qualified - Air Sealing, Oil	CI_MF	All	1.00	0.86	0.86	n/a	n/a	n/a	n/a
Moderate Income Qualified - Air Sealing, Other	CI_MF	All	1.00	0.86	0.86	n/a	n/a	n/a	n/a
Air Sealing, Gas	CI_MF	All	1.00	0.86	0.86	n/a	n/a	n/a	n/a
Moderate Income Qualified - Air Sealing, Gas	CI_MF	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 and are applied to the vendor estimated savings.[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	CI_MF	All	0.14	0.0	0.0	0.86
Moderate Income Air Sealing	CI_MF	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] Moderate Income uses Low Income NEIs per agreement with DOER.

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	CI_MF	All	19.35					
Moderate Income Air Sealing	CI_MF	All	389.29					

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 (2023). MA RBUECS Demand Impact Model
2023_Guidehouse_MA_RBUECS_Demand_Impact_Model
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

3.6 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	C&I Multifamily (CI_MF)	EC1d004
Insulation, Gas	C&I Multifamily (CI_MF)	EC1d005
Insulation, Oil	C&I Multifamily (CI_MF)	EC1d006
Insulation, Other	C&I Multifamily (CI_MF)	EC1d007
Moderate Income Qualified - Insulation, Electric	C&I Multifamily (CI_MF)	EC1d036
Moderate Income Qualified - Insulation, Oil	C&I Multifamily (CI_MF)	EC1d037
Moderate Income Qualified - Insulation, Other	C&I Multifamily (CI_MF)	EC1d038
Insulation, Gas	C&I Multifamily (CI_MF)	GC1d002
Moderate Income Qualified - Insulation, Gas	C&I Multifamily (CI_MF)	GC1d025

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:

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

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

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
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

TMYx - City/Station	HDD	CDH
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 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 (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 (Rexist) 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_MF	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	CI_MF	All	1.00	0.86	n/a	0.86	0.86	0.00	0.58
Insulation, Gas	CI_MF	All	1.00	n/a	0.86	n/a	n/a	n/a	n/a
Insulation, Oil	CI_MF	All	1.00	n/a	0.86	n/a	n/a	0.54	0.00
Moderate Income Qualified - Insulation, Electric	CI_MF	All	1.00	0.86	n/a	0.86	0.86	0.00	0.58
Moderate Income Qualified - Insulation, Oil	CI_MF	All	1.00	n/a	0.86	n/a	n/a	n/a	n/a
Moderate Income Qualified - Insulation, Other	CI_MF	All	1.00	n/a	0.86	n/a	n/a	0.54	0.00
Insulation, Other	CI_MF	All	1.00	n/a	0.86	n/a	n/a	0.54	0.00
Moderate Income Qualified - Insulation, Gas	CI_MF	All	1.00	n/a	0.86	n/a	n/a	0.54	0.00

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 and are applied to the vendor estimated savings.[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	CI_MF	All	0.14	0.0	0.0	0.86
Moderate Income Insulation	CI_MF	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. Moderate Income uses Low Income NEIs per agreement with DOER.

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	CI_MF	All	$47.31					
Moderate Income Insulation	CI_MF	All	$391.20					

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 (2023). MA RBUECS Demand Impact Model
2023_Guidehouse_MA_RBUECS_Demand_Impact_Model
8 : Guidehouse (2021). Residential Programs Net-to-Gross Research of RCD and Select Products.
2021_Guidehouse_MA_Res_NTG_Final_Report

3.7 Building Shell - Prescriptive Air Sealing

Measure Code	COM-BS-AS
Market	Commercial
Program Type	Retrofit
Category	Building Shell

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 Buildings (CI_EXST)	EC1b025
Prescriptive Air Sealing, Oil	C&I Existing Buildings (CI_EXST)	EC1b026
Prescriptive Air Sealing, Propane	C&I Existing Buildings (CI_EXST)	EC1b027
Prescriptive Air Sealing, Electric	C&I Small Business Turnkey Retrofit (CI_SBTR)	EC1c013
Prescriptive Air Sealing, Oil	C&I Small Business Turnkey Retrofit (CI_SBTR)	EC1c014
Prescriptive Air Sealing, Propane	C&I Small Business Turnkey Retrofit (CI_SBTR)	EC1c015
Prescriptive Air Sealing	C&I Existing Buildings (CI_EXST)	GC1b018
Prescriptive Air Sealing	C&I Small Business Turnkey Retrofit (CI_SBTR)	GC1c003
Prescriptive Air Sealing	C&I Equipment Rebates & Instant Incentives (CI_ERII)	GC1e025

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. The savings in the BC models are PA specific.

Deemed Savings (per hour of air sealing work)

Measure Name	Electric Savings - Annual kWh	Oil Savings - MMBtu per year	Propane Savings - MMBtu per year	Gas Savings - MMBtu per year
Prescriptive Air Sealing, Electric	175.95	n/a	n/a	n/a
Prescriptive Air Sealing, Oil	n/a	0.78	n/a	n/a

Measure Name	Electric Savings - Annual kWh	Oil Savings - MMBtu per year	Propane Savings - MMBtu per year	Gas Savings - MMBtu per year
Prescriptive Air Sealing, Propane	n/a	n/a	0.71	n/a
Prescriptive Air Sealing, Gas	n/a	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_EXST	All	15	n/a	n/a	15
Prescriptive Air Sealing	CI_SBTR	All	15	n/a	n/a	15
Prescriptive Air Sealing	CI_ERII	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_EXST	All	1.00	1.00	1.00	1.00	1.00	0.28	0.07
Prescriptive Air Sealing	CI_SBTR	All	1.00	1.00	1.00	1.00	1.00	0.28	0.07
Prescriptive Air Sealing	CI_ERII	All	1.00	1.00	1.00	1.00	1.00	0.28	0.07

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.[3] For CI_ERII the coincidence factors are deemed.

Impact Factors for Calculating Net Savings:

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG[4]
Prescriptive Air Sealing	All	All	0.08	0.01	0.00	0.88

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
Prescriptive Air Sealing	All	All					$0.32	

Endnotes:

1 : Navigant. (2019). EO Model Update. 2019_Navigant_EO_Update
2 : IECC 2018 International Energy Code
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

3.8 Building Shell - Prescriptive Insulation

Measure Code	COM-BS-IN
Market	Commercial
Program Type	Retrofit
Category	Building Shell

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 Buildings (CI_EXST)	EC1b028
Prescriptive Insulation, Oil	C&I Existing Buildings (CI_EXST)	EC1b029
Prescriptive Insulation, Propane	C&I Existing Buildings (CI_EXST)	EC1b030
Prescriptive Insulation, Electric	C&I Small Business Turnkey Retrofit (CI_SBTR)	EC1c016
Prescriptive Insulation, Oil	C&I Small Business Turnkey Retrofit (CI_SBTR)	EC1c017
Prescriptive Insulation, Propane	C&I Small Business Turnkey Retrofit (CI_SBTR)	EC1c018
Prescriptive Insulation	C&I Existing Buildings (CI_EXST)	GC1b017
Prescriptive Insulation	C&I Small Business Turnkey Retrofit (CI_SBTR)	GC1c002
Prescriptive Insulation	C&I Equipment Rebates & Instant Incentives (CI_ERII)	GC1e024

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 or Basement	Electric Savings - Annual kWh	Oil Savings - MMBtu per year	Propane Savings - MMBtu per year	Gas Savings - MMBtu per year
Prescriptive Insulation, Electric	Wall	3.34	n/a	n/a	n/a
Prescriptive Insulation, Electric	Attic	1.30	n/a	n/a	n/a

Measure Name	Wall or Attic or Basement	Electric Savings - Annual kWh	Oil Savings - MMBtu per year	Propane Savings - MMBtu per year	Gas Savings - MMBtu per year
Prescriptive Insulation, Electric	Basement	8.59	n/a	n/a	n/a
Prescriptive Insulation, Oil	Wall	1.28	0.009	n/a	n/a
Prescriptive Insulation, Oil	Attic	0.50	0.004	n/a	n/a
Prescriptive Insulation, Oil	Basement	3.29	0.024	n/a	n/a
Prescriptive Insulation, Propane	Wall	1.28	n/a	0.008	n/a
Prescriptive Insulation, Propane	Attic	0.50	n/a	0.003	n/a
Prescriptive Insulation, Propane	Basement	3.29	n/a	0.021	n/a
Prescriptive Insulation, Gas	Wall	1.281	n/a	n/a	0.00828
Prescriptive Insulation, Gas	Attic	0.498	n/a	n/a	0.00322
Prescriptive Insulation, Gas	Basement	3.29	n/a	n/a	0.02127

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_EXST	All	25	n/a	n/a	25

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Prescriptive Insulation	CI_SBTR	All	25	n/a	n/a	25
Prescriptive Insulation	CI_ERII	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_EXST	All	1.00	1.00	1.00	1.00	1.00	0.28	0.07
Prescriptive Insulation	CI_SBTR	All	1.00	1.00	1.00	1.00	1.00	0.28	0.07
Prescriptive Insulation	CI_ERII	All	1.00	1.00	1.00	1.00	1.00	0	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] For CI_ERII the coincidence factors are deemed.

Impact Factors for Calculating Net Savings:

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG[4 5]
Prescriptive Insulation	CI_EXST	All	0.18	0.00	0.05	0.88
Prescriptive Insulation, Gas	CI_EXST	All	0.18	0.00	0.05	1.04
Prescriptive Insulation	CI_SBTR	All	0.18	0.00	0.05	0.88
Prescriptive Insulation, Gas	CI_SBTR	All	0.18	0.00	0.05	1.04
Prescriptive Insulation, Gas	CI_ERII	All	0.18	0.00	0.05	1.04

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
Prescriptive Air Sealing	All	All					$0.32	

Endnotes:

1 : Navigant Consulting, Inc. (2020). Energy Optimization Model Updates. 2019_Navigant_EO_Update
2 : IECC 2018 International Energy Code
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
5 : NMR Group, Inc. (2024). C&I Omnibus Gas NTG. 2024_NMR_C&I_Omnibus_Study
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

3.9 Compressed Air - Prescriptive Compressed Air

Measure Code	COM-CA-PCA
Market	Commercial
Program Type	Lost Opportunity, Retrofit
Category	Compressed Air

Measure Description:

Air Nozzle: Covers the installation of engineered air nozzles which provide effective air nozzle action while reducing compressed air system air flow.

Refrigerated Air Dryers: 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.

High Efficiency Air Compressor: 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

Zero Loss Condensate Drains: 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
Prescriptive - Compressed Air	C&I Existing Buildings (CI_EXST)	EC1b018

Algorithms for Calculating Primary Energy Impact:

Air Nozzle:

ΔkW = Delta_kWh / hr
ΔkWh = (FLOW_base - FLOW_eng) x kW_SCFM x USE x 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)

Refrigerated Air Dryer:

ΔkWh = (CFMDRYER) x (Save) x (HRS)
ΔkW = (CFMDRYER) x (Save)

Where:
CFMDRYER = 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.

High Efficiency Air Compressor:
ΔkWh = (HPCOMPRESSOR) x (Save) x (Hours)
ΔkW = (HPCOMPRESSOR) x (Save)

Where:
$HP_{COMPRESSOR}$ = Nominal rated horsepower of high efficiency air compressor.
Save = Air compressor kW reduction per HP: 0.189.[2]
Hours = Annual operating hours of the air compressor.

Low Pressure Drop Filter:
ΔkWh = [(HPcomp) x (0.7457) / eff] x [((Existing P) - (Adjusted P)) / (2x100)] x (Hours)
ΔkW = [(HPcomp) x (0.7457) / eff] x [((Existing P) - (Adjusted P)) / (2x100)]

Where:
ΔkWh = Energy savings
ΔkW = Demand savings
HPCOMP = 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%
20	93.0%
25	93.6%

HP	Efficiency
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)

Zero Loss Condensate Drain:
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[3]
Hours = Annual operating hours of the zero-loss condensate drain

Rolled Up Savings in BC Model (PA Specific):

Measure Name	Core Initiative	BCR Measure ID	kWh Savings	kW Savings
Prescriptive - Compressed Air	C&I Existing Buildings (CI_EXST)	EC1b018	19,135	4.94

Baseline Efficiency:

Air Nozzle	The baseline is a standard nozzle on a compressed air system.
Refrigerated Air Dryer	The baseline efficiency case is a non-cycling refrigerated air dryer.
High Efficiency Air Compressor	The baseline efficiency case is a typical load/unload compressor.
Low Pressure Drop Filter	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.
Zero Loss Condensate Drain	The baseline efficiency case is installation of a standard condensate drain on a compressor system.

High Efficiency:

Air Nozzle	The high efficient case is the same air compressor with an engineered nozzle.
Refrigerated Air Dryer	The high efficiency case is a cycling refrigerated dryer or a refrigerated dryer equipped with a VFD.
High Efficiency Air Compressor	The high efficient 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.
Low Pressure Drop Filter	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.
Zero Loss Condensate Drain	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.[4]

Measure Name	PA	EUL	OYF	RUL	AML
Air Nozzle	All	13	n/a	n/a	13
Refrigerated Air Dryer	All	15	n/a	n/a	15
High Efficiency Air Compressors	All	15	n/a	n/a	15
Low Pressure Drop Filter	All	5	n/a	n/a	5
Zero Loss Condensate Drains	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 - Compressed Air	CI_EXST	CLC	1.00	1.25	1.00	0.95	0.80	0.70	0.64
Prescriptive - Compressed Air	CI_EXST	Eversource	1.00	1.25	1.00	0.95	0.80	0.70	0.64
Prescriptive - Compressed Air	CI_EXST	National Grid	1.00	1.00	1.00	1.00	1.00	0.70	0.64

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Prescriptive - Compressed Air	CI_EXST	Unitil	1.00	1.00	1.00	1.00	1.00	0.70	0.64

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

Realization Rates:
For CLC and Eversource realization rates are based on the Business & Construction Solutions (BS/BC) programs measurement & verification - 2006 Final Report.[4]

For National Grid and Unitil realization rates are based on an impact evaluation of 2004 compressed air prescriptive rebates.[5]

Coincidence Factors:
Coincident factors are derived from the C&I Loadshape study.[7]

Impact Factors for Calculating Net Savings:

All PAs use statewide prescriptive net-to-gross values based on study results.[7]

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Prescriptive - Compressed Air	CI_EXST	All				0.877

Non-Energy Impacts:

NEI's are based on the O&M and Non-O&M 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
Prescriptive - Compressed Air	CI_EXST	All	$0.00	$0.00	$0.006	$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 : 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
3 : Savings algorithm source: PA calculation tool, "Prescriptive_CAIR_ZLD_LPDF_Tool.xlsx" (2016)
4 : 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
5 : 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
6 : DNV (2024). C&I Impact Shape Study 2024_DNV_C&I_Impact Shape Study
7 : NMR (2024). C&I Prescriptive and Custom Electric Net-to-Gross Omnibus Study Final Report
2024_NMR_C&I_Omnibus_Study
8 : NMR Group, Inc. (2021) O&M and Non-O&M NEI Study. 2021_NMR_CIOM and NonOM NEI Study

3.10 Cooking - Induction Stove - C&I Master Metered Multifamily

Measure Code	COM-FS-ISP
Market	Commercial
Program Type	Lost Opportunity
Category	Food Service and Cooking Equipment

Measure Description:

Rebate provided for the purchase of a propane induction stove.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Induction Stove replacing Propane-C&I Metered MF	C&I Equipment Rebates & Instant Incentives (CI_ERII)	EC1e052
Induction Stove replacing Gas-C&I Metered MF	C&I Equipment Rebates & Instant Incentives (CI_ERII)	GC1e021

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 Rebates core initiative and evaluated as such.

Unit 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	Gas/Propane MMBTUs
Induction Stove	CI_ERII	-251	-0.06	2.10

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	CI_ERII	All	16	n/a	n/a	16

Other Resource Impacts:

There are no other resource impacts.

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	CI_ERII	All	1.00	1.00	1.00	1.00	1.00	0.30	0.62

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.[4]

Impact Factors for Calculating Net Savings:

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

Non-Energy Impacts:

There are no non-energy impacts.

Endnotes:

1 : Frontier Energy (2019). Residential Cooktop Performance and Energy Comparison Study.
2019_Frontier_Energy_Residential_Cooktop_Performance_and_Energy_Comparison_Study
2 : Guidehouse (2023). MA RBUECS Demand Impact Model
2023_Guidehouse_MA_RBUECS_Demand_Impact_Model
3 : Frontier Energy (2019). Residential Cooktop Performance and Energy Comparison Study.
2019_Frontier_Energy_Residential_Cooktop_Performance_and_Energy_Comparison_Study
4 : Guidehouse (2023). MA RBUECS Demand Impact Model
2023_Guidehouse_MA_RBUECS_Demand_Impact_Model

3.11 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 - Building Shell	C&I Multifamily (CI_MF)	EC1d027
Custom - Heating Systems Replacement	C&I Multifamily (CI_MF)	EC1d029
Custom - HPWH	C&I Multifamily (CI_MF)	EC1d028
Custom - HVAC	C&I Multifamily (CI_MF)	EC1d024
Custom - Motors & VFD	C&I Multifamily (CI_MF)	EC1d023
Custom - Other	C&I Multifamily (CI_MF)	EC1d026
Custom - Water Heating	C&I Multifamily (CI_MF)	EC1d025
Custom - HVAC	C&I Multifamily (CI_MF)	GC1d014
Custom - Water Heating	C&I Multifamily (CI_MF)	GC1d015
Custom - Other	C&I Multifamily (CI_MF)	GC1d021
Custom - Building Shell	C&I Multifamily (CI_MF)	GC1d022
Custom - Heating Systems Replacement	C&I Multifamily (CI_MF)	GC1d023

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 - Motors & VFD	CI_MF	All	1.00	0.86	0.86	0.86	0.86	0.55	0.46
Custom - HVAC	CI_MF	All	1.00	0.86	0.86	0.86	0.86	0.54	0.19
Custom - Water Heating	CI_MF	All	1.00	0.86	0.86	0.86	0.86	0.30	0.62
Custom - Other	CI_MF	All	1.00	0.86	0.86	0.86	0.86	0.30	0.62
Custom - Building Shell	CI_MF	All	1.00	0.86	0.86	0.86	0.86	0.54	0.19
Custom - HPWH	CI_MF	All	1.00	0.86	0.86	0.86	0.86	0.30	0.62
Custom - Heating Systems Replacement	CI_MF	All	1.00	0.86	0.86	0.86	0.86	0.00	0.58

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 multifamily impact evaluation study and are applied to custom savings.[1]

Coincidence Factors:

Summer and winter coincidence factors are estimated on a custom basis or by 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:

All PAs use statewide net-to-gross values based on study results.[3]

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
All Measures - Custom	CI_MF	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.[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
Custom - Motors & VFD, Elec	CI_MF	All			$0.018			
Custom - HVAC, Elec	CI_MF	All			$0.149			
Custom - Water Heating, Elec	CI_MF	All			$0.065			
Custom - Other, Elec	CI_MF	All			$0.065			
Custom - Building Shell, Elec	CI_MF	All			$0.149			
Custom - HPWH, Elec	CI_MF	All			$0.065			
Custom - Heating Systems Replacement	CI_MF	All	$99.74					
Custom - HVAC, Gas	CI_MF	All					($0.037)	
Custom - Water Heating, Gas	CI_MF	All					$0.35	
Custom - Other, Gas	CI_MF	All					($0.045)	
Custom - Building Shell, Gas	CI_MF	All					$0.32	

Endnotes:

1 : Navigant Consulting (2018). Multi-Family Program Impact and Net-to-Gross Evaluation 2018_Navigant_Multifamily_Program_Impact_Evaluation
2 : Guidehouse (2023). MA RBUECS Demand Impact Model 2023_Guidehouse_MA_RBUECS_Demand_Impact_Model
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
5 : NMR (2022). Residential Heat Pump NEIs Study 2022_NMR_MA_Res_HP_NEI_Final_Report

3.12 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 are screened for cost-effectiveness based on project-specific costs and impacts.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Custom - Compressed Air	C&I Small Business Turnkey Retrofit (CI_SBTR)	EC1c001
Custom - Electrification Process	C&I Small Business Turnkey Retrofit (CI_SBTR)	EC1c054
Custom - Envelope	C&I Small Business Turnkey Retrofit (CI_SBTR)	EC1c004
Custom - HVAC	C&I Small Business Turnkey Retrofit (CI_SBTR)	EC1c003
Custom - Lighting Controls	C&I Small Business Turnkey Retrofit (CI_SBTR)	EC1c012
Custom - Lighting Systems	C&I Small Business Turnkey Retrofit (CI_SBTR)	EC1c011
Custom - Motors & VFD	C&I Small Business Turnkey Retrofit (CI_SBTR)	EC1c006
Custom - Other	C&I Small Business Turnkey Retrofit (CI_SBTR)	EC1c009
Custom - Process	C&I Small Business Turnkey Retrofit (CI_SBTR)	EC1c007
Custom - Refrigeration	C&I Small Business Turnkey Retrofit (CI_SBTR)	EC1c008
Custom - Retrocomissioning	C&I Small Business Turnkey Retrofit (CI_SBTR)	EC1c005
Custom - Water Heating	C&I Small Business Turnkey Retrofit (CI_SBTR)	EC1c002
Custom - Building Shell	C&I Small Business Turnkey Retrofit (CI_SBTR)	GC1c001
Custom - Controls	C&I Small Business Turnkey Retrofit (CI_SBTR)	GC1c004
Custom - Foodservice	C&I Small Business Turnkey Retrofit (CI_SBTR)	GC1c005
Custom - Heat Recovery	C&I Small Business Turnkey Retrofit (CI_SBTR)	GC1c006
Custom - Heating	C&I Small Business Turnkey Retrofit (CI_SBTR)	GC1c007

Measure Name	Core Initiative	BCR Measure ID
Custom - Other	C&I Small Business Turnkey Retrofit (CI_SBTR)	GC1c008
Custom - Process	C&I Small Business Turnkey Retrofit (CI_SBTR)	GC1c009
Custom - Steam Trap	C&I Small Business Turnkey Retrofit (CI_SBTR)	GC1c010
Custom - Water Heating	C&I Small Business Turnkey Retrofit (CI_SBTR)	GC1c012
Retrocomissioning	C&I Small Business Turnkey Retrofit (CI_SBTR)	GC1c013
Custom - Electrification Process	C&I Small Business Turnkey Retrofit (CI_SBTR)	GC1c027

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.

Per the 2025-2027 Strategic Evaluation Plan Policy Resolution: Schools, municipal buildings, and local small businesses in equity communities have different HVAC system baselines from the industry standard practice, as these customers are more likely to repair existing equipment than replace it. These projects will be assigned a stipulated dual baseline assumption, where the first period baseline reflects the existing conditions for 2/3 the EUL of the installed measure. The second period baseline will be the ISP HVAC system. This baseline assumption applies to this subsegment of the population even if the existing equipment is older than its EUL.

Per the 2025-2027 Strategic Evaluation Plan Policy Resolution: For custom and prescriptive envelope measures occurring in existing C&I buildings, existing multifamily high-rise (MRHR) buildings, and existing C&I buildings that are redeveloped into residential multi-family dwellings, the pre-existing condition is the baseline condition. This does not apply in any ground-up new construction or additions.

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 is screened for cost-effectiveness using project specific costs and impacts.

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}
Custom Lighting Systems, Electric	CI_SBTR	ALL	1.00	0.93	n/a	0.91	1.03	custom	custom
Custom Lighting Controls, Electric	CI_SBTR	ALL	1.00	0.42	n/a	0.92	0.92	custom	custom
Custom Other, Electric	CI_SBTR	NGRID, CLC	1.00	1.05	n/a	0.94	1.17	custom	custom
Custom Other, Electric	CI_SBTR	ES, Unitil	1.00	0.95	n/a	1.27	1.42	custom	custom
All Other Custom, Gas	CI_SBTR	ES	1.00	n/a	0.86	n/a	n/a	n/a	n/a
All Other Custom, Gas	CI_SBTR	NGRID, Berkshire, Liberty, Unitil	1.00	n/a	0.78	n/a	n/a	n/a	n/a
All Other Custom, Gas	CI_SBTR	EGMA	1.00	n/a	0.92	n/a	n/a	n/a	n/a
Steam Traps	CI_SBTR	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 all PA programs include verification of equipment installations.

Realization Rates:

- All PAs use results for lighting systems from 2018 small business impact study, which included samples of both custom and prescriptive.[3] All PAs use results for lighting controls from 2012 small business direct install lighting controls study.[4] All PAs use electric non-lighting results from the 2020 small business impact study, which included samples of both custom and prescriptive.[5]
- Gas RRs: Based on re-analysis of custom gas realization rates to reflect prospective measure mix. Eversource and EGMA use PA-specific results, while other PAs use statewide average for non-steam trap measures. All PAs use statewide results for steam trap measures.[6]

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 2024 Omnibus Electric Net-to-Gross Study[7]and 2024 Omnibus Gas Net-to-Gross Study[8]

Measure Name	Core Initiative	PA	NTG 2025	NTG 2026	NTG 2027
All Custom Gas, Turnkey	CI_SBTR	All	0.95	0.95	0.95
Custom Electric Turnkey Non-Lighting	CI_SBTR	All	0.94	0.94	0.94
Custom Electric Uncontrolled Lighting, Turnkey	CI_SBTR	All	0.85	0.81	0.77
Custom Electric Controlled Lighting, Turnkey	CI_SBTR	All	0.89	0.89	0.89

Non-Energy Impacts:

Non-energy impacts are from the 2021 C&I O&M and non-O&M NEI Study[9]and the C&I Health & Safety NEI Study[9] .

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
Custom - Compressed Air, Turnkey	CI_SBTR	All			$0.018			
Custom - Water Heating, Turnkey	CI_SBTR	All			$0.065			
Custom - HVAC, Turnkey	CI_SBTR	All			$0.149			
Custom - Envelope, Turnkey	CI_SBTR	All			$0.149			
Custom - Retrocommissioning, Turnkey	CI_SBTR	All			$0.269			
Custom - Motors & VFD, Turnkey	CI_SBTR	All			$0.018			
Custom - Process, Turnkey	CI_SBTR	All			$0.098			
Custom - Refrigeration, Turnkey	CI_SBTR	All			$0.077			

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
Custom - Other, Turnkey	CI_SBTR	All			$0.065			
Custom - Lighting Systems, Turnkey	CI_SBTR	All			$0.096			
Custom - Lighting Controls, Turnkey	CI_SBTR	All			$0.130			
Custom - Building Shell, Turnkey	CI_SBTR	All					$0.322	
Custom - Controls, Turnkey	CI_SBTR	All					- $0.037	
Custom - Foodservice, Turnkey	CI_SBTR	All					$3.399	
Custom - Heat Recovery, Turnkey	CI_SBTR	All					- $0.037	
Custom - Heating, Turnkey	CI_SBTR	All					- $0.037	
Custom - Other, Turnkey	CI_SBTR	All					$0.607	
Custom - Process, Turnkey	CI_SBTR	All					-$0.045	
Custom - Steam Trap, Turnkey	CI_SBTR	All					$0.350	
Custom - Water Heating, Turnkey	CI_SBTR	All					$0.350	

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). 2018_DNVGL_ERS_SBS_Impact
4 : Cadmus (2012). Small business Direct Install Program: Pre/Post Lighting Occupancy Sensor Study CADMUS_2012_SBDI_PrePostLightingControl_Final
5 : DNV GL (2020). Impact Evaluation of PY 2017 Small Business Initiative Non-Lighting Measures. 2020_DNV_GL_Impact_Evaluation_of_PY17_Small_Business_Initiative_Non-Lighting
6 : DNV (2024). Prospective Realization Rates for PY2025 Custom Gas.

2024_DNV_Prospective_RR_PY2025_Custom_Gas
7 : NMR Group, Inc. (2024). C&I Omnibus Electric NTG Study 2024_NMR_C&I_Omnibus_Study
8 : NMR(2024). C&I Gas Omnibus Net-to-Gross Study.
9 : NMR Group Inc. (2021). C&I O&M and non-O&M NEI Study. 2021_NMR_CIOM and NonOM NEI Study
10 : DNV(2022). C&I Health & Safety NEI Study 2022_DNV_C&I_Heath_&_Safety_NEIs

3.13 Custom - Gas Leak Detection and Repairs

Measure Code	COM-CM-CMGLS
Market	Commercial
Program Type	Retrofit
Category	Custom

Measure Description:

The gas leaks repair measure captures savings through the identification and repair of gas leaks behind the customer meter. Gas leaks inspection requires a niche skillset and should be conducted by a professional familiar with state and federal gas safety regulations. There are several relevant "Operator Qualifications" outlined by Energy World Net including: LM-01 Performing Gas Leakage Surveys, LM-02 Leak Investigation (Inside Only), LM-03 Leak Investigation (Outside Only), LM-04 Classifying Leaks.

Gas leaks are identified through a survey utilizing portable infrared lasers and optical gas imaging cameras. Leak rate is quantified through the use of an optical based high flow natural gas sampling device, which pulls air from around the gas leak to measure flow rate and methane concentration. Engineering data (including direct measurements of pipe diameter, air/gas pressure) and facility gas usage can be used to corroborate and calibrate leak results from the sampler equipment. After the survey is completed, leaks are repaired through welding broken pipe or replacing broken pipe segments or fittings. Custom incentives are paid per estimated leaked Therm, reflecting energy savings achieved after leak repair, capped at cost to repair the leaks.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Gas Leaks	C&I Existing Buildings (CI_EXST)	GC1b030

Algorithms for Calculating Primary Energy Impact:

To calculate the savings based on the above methods for detection, the following equation is used:

Therms saved = Estimated rate of leakage (in CFM)*60 min/hr*annual operation (in hrs)/1,000*10.3 therms/MCF[1]

As guidance, the customer's annual gas usage should be evaluated to approximate what percentage of the gas use is associated with heating, process, etc. Should the value of 8,760 hours of annual gas use be applied, a relatively even gas use should be seen throughout the year with little monthly variance.

It is typically estimated that gas leaks are not greater than 5% of customer's annual gas usage. Pre- and post-repair gas usage analysis will be used to verify savings if the calculated savings exceed 5% of annual gas usage.

Baseline Efficiency:

The baseline efficiency is the baseline estimated rate of leakage (in CFM) identified through the gas leak quantification methods above.

High Efficiency:

The high efficiency is the estimated rate of leakage (in CFM) after the leaks are repaired.

Measure Life:

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Custom - Gas Leaks	CI_EXST	All	5[2]	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}
Custom - Gas Leaks	CI_EXST	All	1.00	n/a	0.80	n/a	n/a	n/a	n/a

In-Service Rates:

The ISR is assumed to be 100% until evaluated.

Realization Rates:

Realization rates based on evaluation of 2021-2022 custom gas projects.[3]

Coincidence Factors:

There are no associated coincidence factors as this is a non-electric measure.

Impact Factors for Calculating Net Savings:

Net-to-gross value reflects C&I Existing Building custom gas other from the 2024 C&I Omnibus NTG Study.[4]

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Custom - Gas Leaks	CI_EXST	All	n/a	n/a	n/a	0.81

Non-Energy Impacts:

There are no non-energy impacts that will be claimed with this measure in 2024. The PAs are interested in claiming benefits related to the global warming potential of leaked methane in the future.

Endnotes:

1 : The conversion rate 10.3 therms/MCF is based on average local estimated gas supply values, supported by EIA national value. Program Administrators will annually review this value to ensure continued alignment with local and national references. (https://www.eia.gov/tools/faqs/faq.php?id=45&t=8#:~:text=One%20thousand%20cubic%20feet%20(Mcf,1.037%20MMBtu%2C%20or%2010.37%20therms)

1 : DNV GL (2017). Massachusetts Commercial Industrial Baseline Framework 2017_DNVGL_MA_Baseline_Framework

2 : Data on actual gas leak repairs from a repair vendor indicates that the length of time for which a gas leak repair lasts varies by industry. Facilities with significant vibration (e.g., steel mills) have repair work that lasts around 4-6 years, and facilities with low vibration (e.g., food processing, glass manufacturing, hospitals, universities, etc) have repairs that can last beyond 10 years. The life of a repair is also dependent on factors including age of the pipe, pressure of the gas system (high or low), and the end uses (number of regulators, end uses, etc). The PAs expect a majority of facilities supported through this measure will be low vibration but have opted for a more conservative 5-year measure life given uncertainty surrounding persistence.

3 : DNV (2023). PY2021-22 Custom Gas Impact Study. Through consensus with the EEAC EM&V consultants and DNV in November 2023, it was decided the statewide custom gas realization rate was most appropriate for this measure prospectively. 2023_DNV_PY2021-22_Custom_Gas_Impact

4 : NMR(2024). C&I Omnibus Gas NTG Study.

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

3.14 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 - Comprehensive Design (Legacy)	C&I New Buildings & Major Renovations (CI_NB&MR)	EC1a001
Custom - Electrification	C&I New Buildings & Major Renovations (CI_NB&MR)	EC1a069
Pathway 1 - Custom - Zero Net Energy Design Approach	C&I New Buildings & Major Renovations (CI_NB&MR)	EC1a065
Pathway 2 - Custom - Whole Building EUI Approach	C&I New Buildings & Major Renovations (CI_NB&MR)	EC1a066
Pathway 3 - Custom - High Performance Buildings (Lighting)	C&I New Buildings & Major Renovations (CI_NB&MR)	EC1a013
Pathway 3 - Custom - High Performance Buildings (Non-Lighting)	C&I New Buildings & Major Renovations (CI_NB&MR)	EC1a002
Custom - Comprehensive Retrofit	C&I Existing Buildings (CI_EXST)	EC1b001
Custom - Compressed Air	C&I Existing Buildings (CI_EXST)	EC1b002
Custom - Electrification HVAC	C&I Existing Buildings (CI_EXST)	EC1b004
Custom - Electrification Process	C&I Existing Buildings (CI_EXST)	EC1b005
Custom - Electrification Water Heating	C&I Existing Buildings (CI_EXST)	EC1b006
Custom - Envelope	C&I Existing Buildings (CI_EXST)	EC1b007
Custom - HVAC	C&I Existing Buildings (CI_EXST)	EC1b003

Measure Name	Core Initiative	BCR Measure ID
Custom - Indoor Agriculture	C&I Existing Buildings (CI_EXST)	EC1b011
Custom - Lighting Controls	C&I Existing Buildings (CI_EXST)	EC1b010
Custom - Lighting Systems	C&I Existing Buildings (CI_EXST)	EC1b009
Custom - Motors & VFD	C&I Existing Buildings (CI_EXST)	EC1b012
Custom - Other	C&I Existing Buildings (CI_EXST)	EC1b016
Custom - Process	C&I Existing Buildings (CI_EXST)	EC1b013
Custom - Refrigeration	C&I Existing Buildings (CI_EXST)	EC1b014
Custom - Retrocomissioning	C&I Existing Buildings (CI_EXST)	EC1b008
Custom - Water Heating	C&I Existing Buildings (CI_EXST)	EC1b015
Custom - Building Shell	C&I New Buildings & Major Renovations (CI_NB&MR)	GC1a001
Custom - Comprehensive Design	C&I New Buildings & Major Renovations (CI_NB&MR)	GC1a002
Custom - Controls	C&I New Buildings & Major Renovations (CI_NB&MR)	GC1a003
Custom - Foodservice	C&I New Buildings & Major Renovations (CI_NB&MR)	GC1a004
Custom - Heat Recovery	C&I New Buildings & Major Renovations (CI_NB&MR)	GC1a005
Custom - Other	C&I New Buildings & Major Renovations (CI_NB&MR)	GC1a006
Custom - Process	C&I New Buildings & Major Renovations (CI_NB&MR)	GC1a007
Pathway 1 - Custom - Zero Net Energy Design Approach	C&I New Buildings & Major Renovations (CI_NB&MR)	GC1a008
Pathway 2 - Custom - Whole Building EUI Approach	C&I New Buildings & Major Renovations (CI_NB&MR)	GC1a009
Custom - Electrification	C&I New Buildings & Major Renovations (CI_NB&MR)	GC1a011
Custom - Building Shell	C&I Existing Buildings (CI_EXST)	GC1b003
Custom - Controls	C&I Existing Buildings (CI_EXST)	GC1b004
Custom - Foodservice	C&I Existing Buildings (CI_EXST)	GC1b005

Measure Name	Core Initiative	BCR Measure ID
Custom - Heat Recovery	C&I Existing Buildings (CI_EXST)	GC1b006
Custom - Heating	C&I Existing Buildings (CI_EXST)	GC1b007
Custom - Other	C&I Existing Buildings (CI_EXST)	GC1b008
Custom - Ozonated Laundry	C&I Existing Buildings (CI_EXST)	GC1b009
Custom - Process	C&I Existing Buildings (CI_EXST)	GC1b010
Custom - Steam Trap	C&I Existing Buildings (CI_EXST)	GC1b011
Custom - Retrocomissioning	C&I Existing Buildings (CI_EXST)	GC1b012
Custom - Water Heating	C&I Existing Buildings (CI_EXST)	GC1b013
Custom - Electrification HVAC	C&I Existing Buildings (CI_EXST)	GC1b026
Custom - Electrification Process	C&I Existing Buildings (CI_EXST)	GC1b027
Custom - Electrification Water Heating	C&I Existing Buildings (CI_EXST)	GC1b028

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.

Per the 2025-2027 Strategic Evaluation Plan Policy Resolution: Schools, municipal buildings, and local small businesses in equity communities have different HVAC system baselines from the industry standard practice, as these customers are more likely to repair existing equipment than replace it. These projects will be assigned a stipulated dual baseline assumption, where the first period baseline reflects the existing conditions for 2/3 the EUL of the installed measure. The second period baseline will be the ISP HVAC system. This baseline assumption applies to this subsegment of the population even if the existing equipment is older than its EUL.

Per the 2025-2027 Strategic Evaluation Plan Policy Resolution: For custom and prescriptive envelope measures occurring in existing C&I buildings, existing multifamily high-rise (MRHR) buildings, and existing C&I buildings that are redeveloped into residential multi-family dwellings, the pre-existing condition is the baseline condition. This does not apply in any ground-up new construction or additions.

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.[2]

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
Comprehensive Retrofit	5-25
Compressed Air	13
Compressed Air Equipment (Compressors, Dryers, ZL drains)	15
Compressed Air Equipment and Systems	15
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
Furnace, HVAC	18
Furnace, non-HVAC	18
Heat recovery, HVAC	10, 15, 20
Heat recovery, non-HVAC	10, 15, 20

Measure Type	EUL Options in Custom Screening Tool
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
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	3
Steam trap, non-HVAC	3
Transformer Replacement	20, 25
Verified savings, HVAC	10, 15

Measure Type	EUL Options in Custom Screening Tool
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	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}	$LSAF_E$	$LSAF_{NE}$
Custom Gas, Non-Steam Trap	CI_NB&MR, CI_EXST	Eversource	1	n/a	0.86	n/a	n/a	custom	custom	n/a	1.02
		EGMA	1	n/a	0.92	n/a	n/a	custom	custom	n/a	1.02
		Statewide - Unitil, Liberty, Berkshire, NGRID	1	n/a	0.78	n/a	n/a	custom	custom	n/a	1.04
Custom Gas, Steam Trap	CI_EXST	All	1	n/a	1.00	n/a	n/a	custom	custom	n/a	1.00
Custom Electric, Non-Lighting	CI_NB&MR, CI_EXST	NGRID	1	0.92	0.92	0.78	0.85	custom	custom	1.00	1.00
		Eversource (Statewide)	1	0.93	0.93	0.88	0.86	custom	custom	0.95	0.95
		CLC (Statewide)	1	0.93	0.93	0.88	0.86	custom	custom	0.95	0.95
		Unitil (Statewide)	1	0.93	0.93	0.88	0.86	custom	custom	0.95	0.95
Custom Electric, Lighting	CI_NB&MR, CI_EXST	NGRID	1	0.99	0.99	1.04	0.91	custom	custom	1.00	1.00
		Eversource	1	1.01	1.01	0.95	0.80	custom	custom	0.96	0.96
		CLC	1	0.94	0.94	1.35	1.06	custom	custom	0.86	0.86
		Unitil (Statewide)	1	1.00	1.00	1.00	0.84	custom	custom	0.98	0.98
Custom -	CI_NB&MR,	All	1	0.80	0.80	0.80	0.80	custom	custom	1.00	1.00

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}	$LSAF_E$	$LSAF_{NE}$
Electrification	CI_EXST										
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) - Gas	CI_NB&MR	All	1	n/a	1.01	n/a	n/a	custom	custom	n/a	n/a
Custom - Zero Net Energy Design Approach - Electric	CI_NB&MR	All	1	0.94	0.94	0.94	0.94	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	0.94	0.94	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

In-Service Rates:

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

Realization Rates:

- Comprehensive Design Analysis, Electric and Gas: For Legacy programs: gas RRs based on evaluation of PY2014 projects[3] ; electric RRs based on 2021 analysis.[4] 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 PY2021-PY2023 projects.[5]
- Electric Lighting: RRs based on evaluation of PY2018-PY2019 projects, updated in the evaluation of PY2019-PY2020 projects.[6]
- Gas: RRs based on 2024 recalculation of past results to reflect future program design.[7] For steam traps, RRs based on 2023 study.[8]
- Electrification: Existing buildings RR based on desk review of in-progress projects initiated between 1/1/2022 and 4/30/2023.[9] NC&MR projects assumed to go through Zero Net Energy or Whole Building EUI program, so those programs' RRs are applied.

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 Existing Buildings Gas and Electric are taken from 2024 C&I electric[10] and gas[11] omnibus NTG studies.

Net-to-gross values for the New Buildings & Major Renovations programs and Existing Buildings Custom Electric Electrification are taken from the 2021 Non-Residential New Construction Net-to-Gross Study.[12]

Net-to-gross values for Existing Buildings Custom Gas Electrification are taken from 2021 Residential Programs Net-to-Gross Research of RCD and Select Products Measures.[13]

Zero Net Energy Design Approach and Whole Building EUI Approach operate under a market transformation framework, so net-to-gross is not applied. NB&MR electrification are assumed to be processed through one of these approaches and thus NTG is not applied.

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Custom Electric - Non-Lighting	CI_NB&MR	All	58%	23%	0%	64%
	CI_EXST	All	-	-	-	82%
Custom Electric - Lighting	CI_NB&MR	All	58%	23%	0%	64%
	CI_EXST	All	-	-	-	81%
Custom Gas - Envelope	CI_NB&MR	All	58%	23%	0%	64%
	CI_EXST	All	-	-	-	89%
Custom Gas - Other	CI_NB&MR	All	58%	23%	0%	64%
	CI_EXST	All	-	-	-	81%

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Custom Electric - Electrification	CI_NB&MR	All	n/a	n/a	n/a	n/a
	CI_EXST	All	-	-	-	102%
Custom Gas - Electrification	CI_NB&MR	All	n/a	n/a	n/a	n/a
	CI_EXST	All	0%	0.10	0%	110%
Custom - Comprehensive Design (Legacy)	CI_NB&MR	All	58.3%	22.7%	0%	64.4%
Custom - Zero Net Energy Design Approach	CI_NB&MR	All	n/a	n/a	n/a	n/a
Custom - Whole Building EUI Approach	CI_NB&MR	All	n/a	n/a	n/a	n/a

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.[14] Additional NEI updates from the 2022 C&I Health & Safety NEI study.[15]

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
Comprehensive Design	CI_NB&MR	All			$0.104			
Pathway 1 - Zero Net Energy Design Approach	CI_NB&MR	All			$0.104			
Pathway 2 - Whole Building EUI Approach	CI_NB&MR	All			$0.104			
Electrification	CI_NB&MR	All	$82.99					
Comprehensive Retrofit	CI_EXST	All			$0.113			
Compressed Air	CI_EXST	All			$0.018			
HVAC	CI_EXST	All			$0.149			
Electrification HVAC	CI_EXST	All	$82.99					
Electrification Process	CI_EXST	All						
Electrification Water Heating	CI_EXST	All						

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_EXST	All			$0.149			
Lighting Systems	CI_EXST	All			$0.096			
Lighting Controls	CI_EXST	All			$0.130			
Indoor Agriculture	CI_EXST	All			$0.096			
Motors & VFD	CI_EXST	All			$0.018			
Process	CI_EXST	All			$0.098			
Refrigeration	CI_EXST	All			$0.077			
Water Heating	CI_EXST	All			$0.065			
Other	CI_EXST	All			$0.065			
Building Shell	CI_NB&MR	All					$0.322	
Comprehensive Design	CI_NB&MR	All					$0.322	
Controls	CI_NB&MR	All					($0.045)	
Foodservice	CI_NB&MR	All					$4.579	
Heat Recovery	CI_NB&MR	All					($0.037)	
Other	CI_NB&MR	All					$0.607	
Process	CI_NB&MR	All					($0.051)	
Pathway 1 - Zero Net Energy Design Approach	CI_NB&MR	All					$0.322	
Pathway 2 - Whole Building EUI Approach	CI_NB&MR	All					$0.322	
Electrification	CI_NB&MR	All	$82.99					
Building Shell	CI_EXST	All					$0.322	
Controls	CI_EXST	All					($0.037)	
Foodservice	CI_EXST	All					$4.579	
Heat Recovery	CI_EXST	All					($0.037)	

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	CI_EXST	All					($0.037)	
Other	CI_EXST	All					$0.607	
Ozonated Laundry	CI_EXST	All					$0.445	
Process	CI_EXST	All					($0.045)	
Steam Traps	CI_EXST	All					$0.350	
Retrocommissioning	CI_EXST	All					$1.619	
Water Heating	CI_EXST	All					$0.350	
Electrification HVAC	CI_EXST	All	$82.99					
Electrification Process	CI_EXST	All					($0.045)	
Electrification Water Heating	CI_EXST	All					$0.350	

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 : DNV GL (2018). Massachusetts Commercial and Industrial Impact Evaluation of 2014 Custom CDA Installations. 2018_DNVGL_P56_Custom_CDA
4 : DNV (2021). Massachusetts C&I Custom CDA Results Memo. 2021_DNV_CDA_Results-Memo
5 : DNV (2024). Impact Evaluation of PY2021/2022/2023 Custom Electric Installations. 2024_DNV_PY2021-22-23_Custom_Electric
6 : DNV (2022). Massachusetts Impact Evaluation of PY2019-2020 Custom Electric Installations. 2022_DNV_Custom_Electric_Evaluation
7 : DNV (2024). Prospective Realization Rates for PY2025 Custom Gas. 2024_DNV_Prospective_RR_PY2025_Custom_Gas
8 : DNV (2023). Massachusetts Impact Evaluation of PY2021/PY2022 Custom Gas Installations. 2023_DNV_PY2021-22_Custom_Gas_Impact
9 : DNV (2023). Custom Electrification Realization Rate Memo. 2023_DNV_MA22C07-E-CELECTRIF_final memo
10 : NMR (2024). C&I Prescriptive and Custom Electric Net-to-Gross Omnibus Study Final Report 2024_NMR_C&I_Omnibus_Study

11 : NMR (2024). C&I Gas Prospective Net-to-Gross Omnibus Study.
12 : NMR Group. Inc. (2021). Non Residential New Construction NTG Report. 2021_NMR_Non_Residential_New_Construction_NTG_Report
13 : Guidehouse (2021). Residential Programs Net-to-Gross Research of RCD and Select Products Measures. 2021_Guidehouse_MA_Res_NTG_Final_Report
14 : NMR Group, Inc. (2021). Non O&M and non-O&M NEI study. 2021_NMR_CIOM and NonOM NEI Study
15 : DNV(2022). C&I Health & Safety NEI Study. 2022_DNV_C&I_Heath_&_Safety_NEIs

3.15 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
Battery Storage Daily Dispatch	C&I ConnectedSolutions (CI_CS)	EC1f002
Battery Storage Targeted Dispatch	C&I ConnectedSolutions (CI_CS)	EC1f003
Technology-Neutral Daily Dispatch, Summer	C&I ConnectedSolutions (CI_CS)	EC1f004
Technology-Neutral Targeted Dispatch, Summer	C&I ConnectedSolutions (CI_CS)	EC1f005

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 of 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	C&I Connected Solutions (CI_CS)	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.[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 of 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_CS	National Grid	1.00	0.84	1.00	0.84	1.00	1.00	0.00
Interruptible Load	CI_CS	Unitil	1.00	0.77	1.00	0.77	1.00	1.00	0.00
Interruptible Load	CI_CS	Eversource	1.00	0.73	1.00	0.73	1.00	1.00	0.00
Interruptible Load	CI_CS	CLC	1.00	0.82	1.00	0.82	1.00	1.00	0.00
Battery Storage	CI_CS	All	1.00	1.00	1.00	1.00	1.00	0.00	0.00

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Daily Dispatch, charge (consumption) Summer									
Battery Storage Targeted Dispatch, discharge (savings) Summer	CI_CS	All	1.00	1.00	1.00	1.00	1.00	1.00	0.00
Battery Storage Targeted Dispatch, charge (consumption) Summer	CI_CS	All	1.00	1.00	1.00	1.00	1.00	0.00	0.00
Battery Storage Daily Dispatch, discharge (savings) Summer	CI_CS	All	1.00	1.00	1.00	1.00	1.00	0.00	0.00
Technology-Neutral Daily Dispatch	CI_CS	Eversource	1.00	0.71	1.00	0.71	1.00	1.00	1.00
Technology-Neutral Daily (Curtailment)	CI_CS	National Grid	1.00	1.17	1.00	1.17	1.00	1.00	1.00
Technology-Neutral Targeted Dispatch	CI_CS	Eversource	1.00	0.74	1.00	0.74	1.00	1.00	1.00
Custom	CI_CS	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_CS	All	0.00	0.00	0.00	1.00

Non-Energy Impacts:

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

Endnotes:

1 : DNV (2024). C&I 2023 Summer ADR Evaluation 2024_DNV_C&I_2023 Summer ADR Evaluation
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 : DNV (2024). C&I 2023 Summer ADR Evaluation 2024_DNV_C&I_2023 Summer ADR Evaluation

3.16 Food Service - Dishwasher

Measure Code	COM-FS-DW
Market	Commercial
Program Type	Lost Opportunity, New Construction, Time of Sale
Category	Food Service and Cooking Equipment

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Midstream - Dishwashers	C&I Equipment Rebates & Instant Incentives (CI_ERII)	EC1e036

Algorithms for Calculating Primary Energy Impact:

Unit savings are deemed based on a study:[1] [2]

Energy Savings for Commercial Dishwashers:

Measure Name	kW[3]	kWh	MMBtu
Midstream - Dishwashers	0.26	1,347	33

Baseline Efficiency:

The baseline efficiency case is ENERGY STAR Commercial Dishwashers Version 2.0.[4]

High Efficiency:

The high efficiency case is Tier 2.[5]

Measure Life:

The measure life for dishwashers is 13 years.[6]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Midstream - Dishwashers	CI_ERII	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}
Midstream - Dishwashers	CI_ERII	All	1.00	1.00	1.00	1.00	1.00	0.80	0.82

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 based on the C&I Loadshape Study.[7]

Impact Factors for Calculating Net Savings:

All PAs use Statewide prescriptive net-to-gross results.[8]

Measure	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Midstream - Dishwashers	CI_ERII	All	25.0%	0.2%	8.5%	87.7%

Non-Energy Impacts:

Non-energy impacts are based on study results.[9]

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
Dishwashers	CI_ERII	ALL	$0.00	$0.00	$0.01	$0.00	$0.00	$0.00

Endnotes:

1 : NMR Group, Inc. (2023). Appliance Standards Energy Savings Report. 2023_NMR_MA23X12-B-ASGS_Appliance Standards Gross Savings Report_FINAL_2023
2 : DNV. (2022). Massachusetts Commercial Food Service Equipment ISP Recommendation. 2022_DNV_MA21C03-B-ISPREP - Kitchen Equipment ISP FINAL MEMO
3 : DNV. (2024). C&I Impact Shape Study. 2024_DNV_C&I_Impact Shape Study
4 : NMR Group, Inc. (2023). Appliance Standards Energy Savings Report. 2023_NMR_MA23X12-B-ASGS_Appliance Standards Gross Savings Report_FINAL_2023
5 : DNV. (2022). Massachusetts Commercial Food Service Equipment ISP Recommendation. 2022_DNV_MA21C03-B-ISPREP - Kitchen Equipment ISP FINAL MEMO
6 : NMR Group, Inc. (2023). Appliance Standards Energy Savings Report. 2023_NMR_MA23X12-B-ASGS_Appliance Standards Gross Savings Report_FINAL_2023
8 : NMR (2024). C&I Prescriptive and Custom Electric Net-to-Gross Omnibus Study Final Report 2024_NMR_C&I_Omnibus_Study
9 : DNV. (2022). C&I Health and Safety Non-Energy Impacts. 2022_DNV_C&I_Heath_&_Safety_NEIs

3.17 Food Service - Electric Kitchen Equipment

Measure Code	COM-FS-EKE
Market	Commercial
Program Type	Lost Opportunity, New Construction, Time of Sale
Category	Food Service and Cooking Equipment

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Midstream - Kitchen Equipment	C&I Equipment Rebates & Instant Incentives (CI_ERII)	EC1e035

Algorithms for Calculating Primary Energy Impact:

Equipment Type	kWh	kW[1]	Therms
Electric Conveyor Broiler <22"	7,144	1.37	1,145
Electric Conveyor Broiler 22-28"	6,403	1.22	1,933
Electric Conveyor Broiler >28"	23,849	4.58	3,161
Commercial Conveyor Toaster	2,340	0.36	n/a
Commercial Fryer - Tier 2	1,585	0.53	n/a
Commercial Electric Griddle	3,965	0.90	n/a
Full Size Convection Oven Tier 2	1,111	0.41	n/a
Combination Convection Oven Tier 2 - Mode and Steam Mode	8,190	1.90	n/a
Steam Cooker Tier 2	2,800	1.00	n/a
Electric Deck Oven	7,519	1.55	n/a
Electric Hand Wrapper	1,565	0.18	n/a

Sources:

Energy Savings for Conveyor Broiler[2]
Energy Savings for Commercial Conveyor Toaster[3]
Energy Savings for Commercial Fryer[4]
Energy Savings for Commercial Electric Griddle[5]
Energy Savings for Commercial Ovens[6]
Energy Savings for Electric Steam Cooker[7]
Energy Savings for Electric Deck Oven[8]
Electric Hand Wrapper

Baseline Efficiency:

Conveyor Broiler:

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"

Conveyor Toaster:

Since commercial 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.

Electric Fryer:

The baseline efficiency case is ENERGY STAR for Commercial Fryers, Version 2.0.

Electric Griddle:

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.

Electric Ovens:

The baseline efficiency case for electric ovens is a MA-ISP Blended Used/ ENERGY STAR Ovens V2.2.[9]

Electric Steam Cooker:

The Baseline Efficiency case is ENERGY STAR Commercial Steam Cooker Version 1.2.[10]

Electric Deck Oven:

40% Efficiency & 1.9 kW idle energy rate.[11]

Electric Hand Wrapper:

The baseline is a Commercial Electric Hand-wrap Machine Always On

High Efficiency:

Conveyor Broiler:

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.

Conveyor Toaster:

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.

Electric Fryer:

The high efficiency case for a Tier 2 $\geq$ 86% cooking efficiency, $\leq$ 0.75 kW idle rate.

Electric Griddle:

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.

Electric Oven:

High efficiency case is Tier 2.

Electric Steam Cooker:

High efficiency case is Tier 2.

Electric Deck Oven:

Food Service Technology Center (FSTC) pre-approved list https://caenergywise.com/rebates/

Electric Hand Wrapper:

On-demand Hand-wrap Machine with Mechanical or Optical Control System

Measure Life:

The measure life for kitchen equipment is 12 years.[12]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Midstream - Kitchen Equipment	CI_ERII	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}
Midstream - Kitchen Equipment	CI_ERII	All	1.00	1.00	1.00	n/a	1.00	1.00	0.80	0.82

In-Service Rate:

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

Realization Rate:

Realizations rates are set to 100% for deemed measures.

Coincidence Factors:

Coincidence factors are estimated using the demand allocation methodology described in the Impact Shape Brief.[13]

Impact Factors for Calculating Net Savings:

All PAs use Statewide prescriptive net-to-gross results.[14]

Measure	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Midstream - Kitchen Equipment	CI_ERII	All	25.0%	0.2%	8.5%	87.7%

Non-Energy Impacts:

Non-energy impacts are based on study results.[15]

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 - Kitchen Equipment	CI_ERII	All	$0.00	$0.00	$0.01	$0.00	$0.00	$0.00

Endnotes:

1 : DNV. (2024). C&I Impact Shape Study. 2024_DNV_C&I_Impact Shape Study

2 : SoCalGas Work Paper WPSCGNRCC171226A Commercial Conveyor Broilers, Revision 0,

December 27, 2017. 2017_SoCalGas_Commercial Conveyor Broilers
3 : Energy Solutions (2023). Conveyor Toaster Impacts Analysis
conveyor_toaster_commercial_lab_testing_data_2020
4 : DNV. (2022). Massachusetts Commercial Food Service Equipment ISP Recommendation.
2022_DNV_MA21C03-B-ISPREP - Kitchen Equipment ISP FINAL MEMO
5 :
https://www.energystar.gov/partner_resources/energy_star_training_center/commercial_food_serviceAugust 27, 2021 ENERGY STAR Calculator - New Baselines and Efficiencies 082721
6 : DNV. (2022). Massachusetts Commercial Food Service Equipment ISP Recommendation.
2022_DNV_MA21C03-B-ISPREP - Kitchen Equipment ISP FINAL MEMO
7 : DNV. (2022). Massachusetts Commercial Food Service Equipment ISP Recommendation.
2022_DNV_MA21C03-B-ISPREP - Kitchen Equipment ISP FINAL MEMO
8 : DNV. (2022). Massachusetts Commercial Food Service Equipment ISP Recommendation.
2022_DNV_MA21C03-B-ISPREP - Kitchen Equipment ISP FINAL MEMO
9 : DNV. (2022). Massachusetts Commercial Food Service Equipment ISP Recommendation.
2022_DNV_MA21C03-B-ISPREP - Kitchen Equipment ISP FINAL MEMO
10 : DNV. (2022). Massachusetts Commercial Food Service Equipment ISP Recommendation.
2022_DNV_MA21C03-B-ISPREP - Kitchen Equipment ISP FINAL MEMO
11 : California eTRM. (2020). https://www.caetrm.com/measure/SWFS016/01/ California eTRM. (2020). https://www.caetrm.com/measure/SWFS016/01/
12 :
https://www.energystar.gov/partner_resources/energy_star_training_center/commercial_food_service August 27, 2021 ENERGY STAR Calculator - New Baselines and Efficiencies 082721
13 : DNV. (2024). C&I Impact Shape Study. 2024_DNV_C&I_Impact Shape Study
14 : NMR (2024). C&I Prescriptive and Custom Electric Net-to-Gross Omnibus Study Final Report
2024_NMR_C&I_Omnibus_Study
15 : DNV. (2022). C&I Health and Safety Non-Energy Impacts.
2022_DNV_C&I_Heath_&_Safety_NEIs

3.18 Food Service - Food Storage (unrefrigerated)

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
Midstream - Food Storage (unrefrigerated)	C&I Equipment Rebates & Instant Incentives (CI_ERII)	EC1e038

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[2]	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

Equipment Type	kW[2]	kWh
3/4 Size - Tier 2	0.28	1,215
1/2 Size - Tier 2	0.15	657

Weighted Averages for BC Model:

Measure Name	BCR ID	kW	kWh
Midstream - Food Storage (unrefrigerated)	EC1e038	0.21	1,085

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%).[3]

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.[4]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Midstream - Food Storage (unrefrigerated)	CI_ ERII	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}
Midstream - Food Storage (unrefrigerated)	CI_ERII	ALL	1.00	1.00	1.00	1.00	1.00	0..80	0.82

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 estimated using the demand allocation methodology described in the Impact Shape Brief.[5]

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
Midstream - Food Storage (unrefrigerated)	CI_ERII	All	25.0%	0.2%	8.5%	87.7%

Non-Energy Impacts:

Non-energy impacts are 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
Midstream - Food Storage (unrefrigerated)	CI_ERII	ALL	$0.00	$0.00	$0.01	$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 : DNV. (2024). C&I Impact Shape Study. 2024_DNV_C&I_Impact Shape Study
3 : Appliance standards document signed 3/26/21 starting on page 27 references what the product must meet. MA appliance standards (003)
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 : DNV. (2024). C&I Impact Shape Study. 2024_DNV_C&I_Impact Shape Study
6 : NMR Group, Inc. (2024). C&I Prescriptive and Custom Electric Net-to-Gross Omnibus Study Final Report. 2024_NMR_C&I_Omnibus_Study

3.19 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
Midstream - Ice Machines	C&I Equipment Rebates & Instant Incentives (CI_ERII)	EC1e037

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] :

Measure Name	kW[2]	kWh
Midstream - Ice Machines	0.33	1,703

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.[3]

Measure Life:

The measure life for a new ice making machine is assumed to be 8 years.[4]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Midstream - Ice Machines	CI_ERII	All	8	n/a	n/a	8

Other Resource Impacts:

There are water savings associated with this measure[5] :

Dishwasher Type	Annual water savings (gal/unit)
Midstream - Ice Machines	3,322

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 Machines	CI_ERII	All	1.00	1.00	1.00	1.00	1.00	0.80	0.82

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 estimated using the demand allocation methodology described in the Impact Shape Brief.[6]

Impact Factors for Calculating Net Savings:

All PAs use Statewide prescriptive net-to-gross results.[7]

Measure	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Midstream - Ice Machines	CI_ERII	All	25.0%	0.2%	8.5%	87.7%

Non-Energy Impacts:

Non-energy impacts are based on study results.[8]

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
Midstream - Ice Machines	CI_ERII	ALL	$0.00	$0.00	$0.01	$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 : DNV. (2024). C&I Impact Shape Study. 2024_DNV_C&I_Impact Shape Study
3 : https://www.energystar.gov/partner_resources/energy_star_training_center/commercial_food_service June 29, 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 : 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 : DNV. (2024). C&I Impact Shape Study. 2024_DNV_C&I_Impact Shape Study

3.20 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 Cooktops displacing Electric Resistance	C&I Equipment Rebates & Instant Incentives (CI_ERII)	EC1e044
Induction Cooktop	C&I Equipment Rebates & Instant Incentives (CI_ERII)	GC1e016

Algorithms for Calculating Primary Energy Impact:

Unit kWh savings are deemed.[1]

Measure Name	Core Initiative	kWh	kW[2]	MMBtu
Midstream - Induction Cooktop Displacing Electric Resistance	CI_ERII	2,488	0.48	n/a
Induction Cooktop	CI_ERII	-6,522	-1.49	48.9

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
Induction Cooktop	CI_ERII	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}
Induction Cooktop	CI_ERII	All	1.00	1.00	1.00	1.00	1.00	0.80	0.82

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 research assumptions.

Coincidence Factors:

Summer and winter coincidence factors are estimated using the demand allocation methodology described in the Impact Shape Brief.[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_ERII	All	25.0%	0.2%	8.5%	87.7%[5]
Induction Cooktop	CI_ERII	All	37.0%	3%	19%	84%[6]

Non-Energy Impacts:

The non-energy impacts are below.[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
Midstream - Induction Cooktop Displacing Electric Resistance	CI_ERII	All			$0.01			
Induction Cooktop	CI_ERII	All					$4.58	

Endnotes:

1 : Frontier Energy. (2019). Residential Cooktop Performance and Energy Comparison Study. 2019_Frontier_Energy_Residential_Cooktop_Performance_and_Energy_Comparison_Study
2 : DNV. (2024). C&I Impact Shape Study. 2024_DNV_C&I_Impact Shape Study
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 : DNV. (2024). C&I Impact Shape Study. 2024_DNV_C&I_Impact Shape Study
5 : NMR Group, Inc. (2024). C&I Prescriptive and Custom Electric Net-to-Gross Omnibus Study. 2024_NMR_C&I_Omnibus_Study
6 : NMR Group, Inc. (2021). C&I Prescriptive and Custom NTG Omnibus Study. 2021_NMR_C&I_Omnibus_NTG
7 : DNV. (2022). C&I Health and Safety Non Energy Impacts. 2022_DNV_C&I_Heath_&_Safety_NEIs
8 : NMR Group, Inc. (2021). O&M and non-O&M NEI Study. 2021_NMR_CIOM and NonOM NEI Study

3.21 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	C&I Small Business Turnkey Retrofit (CI_SBTR)	GC1c024
Boiler Reset Control	C&I Equipment Rebates & Instant Incentives (CI_ERII)	GC1e023

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] [2]

Measure Name	ΔMMBtu
Boiler Reset Control	37.3

Annual Electric Energy Savings

ΔkWh=N/A
ΔkW=N/A

Annual Fossil Fuel Energy Savings

$\Delta MMBtu = units \times kBtu/h_{in} \ 1{,}000 \times EFLH_{heating} \times ESF$
$\Delta MMBtu = 1 \times k533 \ Btu/h_{in} \ 1{,}000 \times 1400 \ hrs \times 5\% = 37.3$

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%[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.[6]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Boiler Reset Control	CI_ERII, CI_SBTR	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_ERII, CI_SBTR	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.[7]

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Boiler Reset Control	CI_SBTR	All				0.91
Boiler Reset Control (Turnkey)	CI_SBTR	All				1.02

Non-Energy Impacts:

NEIs are based on study results.[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
Boiler Reset Control	CI_ERII, CI_SBTR	All					$ 0.622	

Endnotes:

1 : Cadeo (2021). Non-Residential TRM Review Study. MA22C01-B_TRM Review_FINAL_31OCT2022
2 : GDS Associates, Inc. (2009). Natural Gas Energy Efficiency Potential in Massachusetts. Study assumes 5% savings factor. GDS_2009_Natural_Gas_Energy_Efficiency_Potential_in_MA
3 : Weighted boiler input capacity based on Eversource program data.
4 : KEMA (2012), Prescriptive Gas Program Final Evaluation Report. Prepared for Massachusetts Energy Efficiency Program Administrators; page 1-2. 2012_KEMA_Prescriptive_Gas_Impact
5 : GDS Associates, Inc. (2009). Natural Gas Energy Efficiency Potential in Massachusetts. Study assumes 5% savings factor. GDS_2009_Natural_Gas_Energy_Efficiency_Potential_in_MA
6 : ACEEE (2006). Emerging Technologies Report: Advanced Boiler Controls. ACEEE_2006_Emerging_Technologies_Report_Advanced_Boiler_Controls
7 : NMR (2024). C&I Gas Prospective Net-to-Gross Omnibus Study.
8 : DNV (2022). C&I Health and Safety Non-Energy Impacts (MA21X19-B-CIHSNEI) 2022_DNV_C&I_Heath_&_Safety_NEIs

3.22 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 Buildings (CI_EXST)	GC1b016
Building Management System	C&I Small Business Turnkey Retrofit (CI_SBTR)	GC1c014

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:

The measure life is 15 years.[2]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Building Management System	CI_EXST	All	15	n/a	n/a	15
Building Management System	CI_SBTR	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}
Building Management System	CI_EXST	All	1.00	1.00	1.00	1.00	1.00	custom	custom
Building Management System	CI_SBTR	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 2024 C&I NTG evaluation[3] .

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Building Management System	CI_EXST	All	37.0%	0.0%	3.0%	87.8%
Building Management System	CI_SBTR	All	28.5%	0.0%	0.0%	95.1%

Non-Energy Impacts:

Impact factors from the C&I Health & Safety 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
Building Management System	CI_EXST	All					$1.62	
Building Management System	CI_SBTR	All					$1.62	

Endnotes:

1 : Descriptions of the EMS savings calculation tools are included in the TRM Library "C&I Spreadsheet Tools" folder.

2 : DNV (2024). MA C&I BMS Increase Proposal Review Final Memo 2024_DNV_MA CI BMS Increase Proposal Review Final Memo
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
3 : NMR Group, Inc. (2024). C&I Omnibus Net-to-Gross (NTG) Study 2024_NMR_C&I_Omnibus_Study
4 : 2022_DNV_C&I_Heath_&_Safety_NEIs

3.23 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	C&I Small Business Turnkey Retrofit (CI_SBTR)	EC1c020
Wi-Fi Thermostat	C&I Small Business Turnkey Retrofit (CI_SBTR)	GC1c016
Wi-Fi Thermostat	C&I Equipment Rebates & Instant Incentives (CI_ERII)	EC1e011
Wi-Fi Thermostat	C&I Equipment Rebates & Instant Incentives (CI_ERII)	GC1e009
Wi-Fi Thermostat	C&I Multifamily (CI_MF)	EC1d016
Wi-Fi Thermostat	C&I Multifamily (CI_MF)	GC1d010

Algorithms for Calculating Primary Energy Impact:

For CI_SBTR and CI_ERII fossil fuel unit savings are deemed based on a residential study.[1] For multifamily unit savings are deemed based on study results. [2] Demand savings are derived from the demand impact model which is developed as part of the Residential Baseline Study.[3]

Measure Name	Core Initiative	ΔkWh	ΔkW	Fuel Oil Δ MMBtu	Propane Δ MMBtu	Gas Δ MMBtu
Wi-Fi Thermostat, AC Only	CI_MF	22	0.02	n/a	n/a	n/a
Wi-Fi Thermostat, Oil	CI_MF	22	0.02	1.1	n/a	n/a
Wi-Fi Thermostat, Propane	CI_MF	22	0.02	n/a	2.0	n/a
Wi-Fi Thermostat, Gas	CI_MF	22	0.02	n/a	n/a	1.61
Wi-Fi Thermostat, Elec	CI_ERII CI_SBTR	836	1.34			

Measure Name	Core Initiative	ΔkWh	ΔkW	Fuel Oil Δ MMBtu	Propane Δ MMBtu	Gas Δ MMBtu
Wi-Fi Thermostat, Oil	CI_ERII CI_SBTR	18	0.02	2.78		
Wi-Fi Thermostat, Other	CI_ERII CI_SBTR	18	0.02		2.78	
Wi-Fi Thermostat, Gas	CI_ERII CI_SBTR	18	0.02	n/a	n/a	2.79

Weighted averages for electric BC model

Measure Name	BCR ID	ΔkWh	ΔkW	Δ Oil MMBTUs	Δ Propane MMBTUs
Wi-Fi Thermostat, (Multifamily)	EC1d016	26.4	0.03	0.55	0.2
Wi-Fi Thermostat	EC1c020				
Wi-Fi Thermostat	EC1e011				

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	CI_SBTR CI_MF CI_ERII	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	CI_SBTR	All	1.00	1.00	1.00	1.00	1.00	0.28	0.07

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Wi-Fi Thermostat	CI_MF	All	1.00	1.00	1.00	1.00	1.00	0.54	0
Wi-Fi Thermostat	CI_ERII	All	1.00	1.00	1.00	1.00	1.00	0.33	0.43
Wi-Fi Thermostat, gas	CI_SBTR	All	1.00	1.00	1.00	1.00	1.00	0	0
Wi-Fi Thermostat, gas	CI_MF	All	1.00	1.00	1.00	1.00	1.00	0.54	0
Wi-Fi Thermostat, gas	CI_ERII	All	1.00	1.00	1.00	1.00	1.00	0	0

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.[5]

Impact Factors for Calculating Net Savings:

Net to gross factors are based on evaluation results.[6] [7]

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Wi-Fi Thermostat	CI_SBTR	All	0.04	0	0	0.96
Wi-Fi Thermostat	CI_MF	All	0.14	0	0	0.86
Wi-Fi Thermostat	CI_ERII	All	0.12	0	0	0.88
Wi-Fi Thermostat, gas	CI_SBTR	All	0.29	0	0	1.02
Wi-Fi Thermostat, gas	CI_MF	All	0.14	0	0	0.86
Wi-Fi Thermostat, gas	CI_ERII	All	0.17	0.002	0.05	0.88

Non-Energy Impacts:

C&I values from 2021 C&I NEI study.[8] 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	CI_SBTR	All			$ 0.18			
Wi-Fi Thermostat	CI_MF	All	$14.35					

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	CI_ERII	All						

Endnotes:

1 : Navigant Consulting (2021). Thermostat Impact Evaluation 2021_Guidehouse_Thermostat_Impact_Study
2 : Guidehouse (2024). Massachusetts Income-Eligible and Residential Coordinated Delivery Multifamily Impact Evaluation 2024_Guidehouse_MF_Impact_Report
3 : Guidehouse (2023). MA RBUECS Demand Impact Model 2023_Guidehouse_MA_RBUECS_Demand_Impact_Model
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 (2023). MA RBUECS Demand Impact Model 2023_Guidehouse_MA_RBUECS_Demand_Impact_Model
6 : NMR (2024). C&I Prescriptive and Custom Electric Net-to-Gross Omnibus Study Final Report 2024_NMR_C&I_Omnibus_Study
7 : Guidehouse (2021). Residential Programs Net-to-Gross Research of RCD and Select Products Measures Workbook 2021_Guidehouse_MA_Res_NTG_Final_Results_Workbook
8 : NMR Group Inc (2021). O&M and Non-O&M NEI Study. 2021_NMR_CIOM and NonOM NEI Study

3.24 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 Weatherization	C&I Small Business Turnkey Retrofit (CI_SBTR)	EC1c021
Duct Insulation	C&I Existing Buildings (CI_EXST)	GC1b021
Duct Insulation	C&I Small Business Turnkey Retrofit (CI_SBTR)	GC1c018
Duct Insulation	C&I Equipment Rebates & Instant Incentives (CI_ERII)	GC1e028

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_EXST, CI_ERII, CI_SBTR	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_EXST, CI_ERII, CI_SBTR	1.00	n/a	1.00	n/a	n/a	n/a	n/a
Duct Insulation, Electric	CI_SBTR	1.00	1.00	n/a	1.00	1.00	0.28	0.07
Duct Insulation, Oil	CI_SBTR	1.00	n/a	1.00	n/a	n/a	n/a	n/a
Duct Insulation, Propane	CI_SBTR	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 a weighted value of the cooling and heating load shapes from the C&I Impact Shape Study.[3] The weight was 30% cooling and 70% heating.

Impact Factors for Calculating Net Savings:

Impact factors are from the 2024 C&I NTG evaluations.[4] [5]

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Duct Insulation, Gas	CI_EXST, CI_ERII	All				0.88
Duct Insulation, Gas (Turnkey)	CI_SBTR	All				1.02
Duct Insulation, Electric (Turnkey)	CI_SBTR	All				0.964
Duct Insulation, Oil (Turnkey)	CI_SBTR	All				0.964

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Duct Insulation, Propane (Turnkey)	CI_SBTR	All				0.964

Non-Energy Impacts:

Non-energy impact factors come from the 2021 C&I NEI evaluation.[6] NEIs for Turnkey Electric, Oil and Propane measures are referencing 2022 C&I Health and Safety 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
Duct Insulation, Gas	CI_EXST, CI_ERII	All					$ 0.593	
Duct Insulation, Gas (Turnkey)	CI_SBTR	All					$ 0.593	
Duct Insulation, Electric (Turnkey)	CI_SBTR	All			0.095			
Duct Insulation, Oil (Turnkey)	CI_SBTR	All			0.095			
Duct Insulation, Propane (Turnkey)	CI_SBTR	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 : DNV (2024). C&I Impact Shape Study. 2024_DNV_C&I_Impact Shape Study
4 : NMR (2024). C&I Gas Prospective Net-to-Gross Omnibus Study.
5 : NMR (2024). C&I Prescriptive and Custom Electric Net-to-Gross Omnibus Study Final Report. 2024_NMR_C&I_Omnibus_Study
6 : NMR (2021). O&M and Non-O&M NEI Study. 2021_NMR_CIOM and NonOM NEI Study
7 : 2022 C&I Health and Safety Non-Energy Impacts (MA21X19-B-CIHSNEI)
2022_DNV_C&I_Heath_&_Safety_NEIs

3.25 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	C&I Multifamily (CI_MF)	EC1d009
Duct Insulation	C&I Multifamily (CI_MF)	GC1d004

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	CI_MF	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, Elec	CI_MF	All	1.00	0.86	0.86	0.86	0.86	0.54	0.19
Duct Insulation, Gas	CI_MF	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 programs include verification of equipment installations.

Realization Rates:

Realization rates are based on evaluation results and are applied to the vendor estimated savings.[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_MF	All	0.14	0.0	0.0	0.86
Duct Insulation, Elec (Residential End Use)	CI_MF	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 (2023). MA RBUECS Demand Impact Model 2023_Guidehouse_MA_RBUECS_Demand_Impact_Model
5 : Guidehouse (2021). Residential Programs Net-to-Gross Research of RCD and Select Products. 2021_Guidehouse_MA_Res_NTG_Final_Report

3.26 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	C&I Small Business Turnkey Retrofit (CI_SBTR)	GC1c017

Algorithms for Calculating Primary Energy Impact:

Unit savings are deemed based on study results:
$\Delta MMBtu = MMBtu \times Units$

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_SBTR	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_SBTR	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 (Turnkey)	CI_SBTR	All				1.02

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_SBTR	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 : NMR (2024). C&I Gas Prospective Net-to-Gross Omnibus Study.
4 : NMR (2021). O&M and Non-O&M NEI Study. 2021_NMR_CIOM and NonOM NEI Study

3.27 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	C&I Multifamily (CI_MF)	EC1d008
Duct Sealing	C&I Multifamily (CI_MF)	GC1d003

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_MF	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, Elec	CI_MF	All	1.00	0.86	0.86	0.86	0.86	0.54	0.19
Duct Sealing, Gas	CI_MF	All	1.00	0.86	0.86	0.86	0.86	n/a	n/a

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 and are applied to the vendor estimated savings.[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_MF	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 Unit	Annual $ per kWh	One-time $ per KWh	Annual $ per Therm	One-time $ per Therm
Duct Sealing	CI_MF	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 (2023). MA RBUECS Demand Impact Model
2023_Guidehouse_MA_RBUECS_Demand_Impact_Model
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

3.28 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 Buildings (CI_EXST)	EC1b017
Energy Management System	C&I Small Business Turnkey Retrofit (CI_SBTR)	EC1c010

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 15 years.[2]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Energy Management System	CI_EXST, CI_SBTR	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}
Energy Management System	CI_EXST	All	1.00	1.00	1.00	1.00	1.00	custom	custom
Energy Management System	CI_SBTR	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 2024 C&I NTG evaluation[3] .

Measure Name	Core Initiative	PA	NTG
Energy Management System	CI_EXST	All	81.9%
Energy Management System	CI_SBTR	All	94.0%

Non-Energy Impacts:

Impact factors from C&I Health & Safety 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
Energy Management System	CI_EXST	All			$0.239			
Energy Management System	CI_SBTR	All			$0.239			

Endnotes:

1 : Descriptions of the EMS savings calculation tools are included in the TRM Library "C&I Spreadsheet Tools" folder.

2 : DNV (2024). MA C&I BMS Increase Proposal Review Final Memo 2024_DNV_MA CI BMS Increase Proposal Review Final Memo
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
3 : NMR Group, Inc. (2024). C&I Omnibus Net-to-Gross (NTG) Study 2024_NMR_C&I_Omnibus_Study
4 : 2022_DNV_C&I_Heath_&_Safety_NEIs

3.29 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	C&I Multifamily (CI_MF)	EC1d020
Custom - Heat Pumps displacing Oil	C&I Multifamily (CI_MF)	EC1d021
Custom - Heat Pumps displacing Propane	C&I Multifamily (CI_MF)	EC1d022
Moderate Income Qualified - Custom - Heat Pumps displacing Electric Heat	C&I Multifamily (CI_MF)	EC1d039
Moderate Income Qualified - Custom - Heat Pumps displacing Oil	C&I Multifamily (CI_MF)	EC1d040
Moderate Income Qualified - Custom - Heat Pumps displacing Propane	C&I Multifamily (CI_MF)	EC1d041
Custom - Heat Pumps displacing Gas	C&I Multifamily (CI_MF)	GC1d016
Moderate Income Qualified - Custom - Heat Pumps displacing Gas	C&I Multifamily (CI_MF)	GC1d026

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	CI_MF	All	1.00	1.00	1.00	1.00	1.00	0.00	0.58
Custom - Heat Pumps displacing Oil	CI_MF	All	1.00	1.00	1.00	1.00	1.00	0.54	0.19
Custom - Heat Pumps displacing Propane	CI_MF	All	1.00	1.00	1.00	1.00	1.00	0.54	0.19
Moderate Income Qualified - Custom - Heat Pumps displacing Electric Heat	CI_MF	All	1.00	1.00	1.00	1.00	1.00	0.00	0.58
Moderate Income Qualified - Custom - Heat Pumps displacing Oil	CI_MF	All	1.00	1.00	1.00	1.00	1.00	0.54	0.19
Moderate Income Qualified - Custom - Heat Pumps displacing Propane	CI_MF	All	1.00	1.00	1.00	1.00	1.00	0.54	0.19
Custom - Heat Pumps displacing Gas	CI_MF	All	1.00	1.00	1.00	1.00	1.00	0.00	0.58
Moderate Income Qualified - Custom - Heat Pumps displacing Gas	CI_MF	All	1.00	1.00	1.00	1.00	1.00	0.00	0.58

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 based on an evaluation study.[2]

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Custom - Heat Pumps	CI_MF	All	0.14	0.00	0.00	0.86
Moderate Income Custom - Heat Pumps	CI_MF	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.[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	CI_MF	All	$392.92					
Moderate Income Custom - Heat Pumps	CI_MF	All	$392.92					

Endnotes:

1 : Guidehouse (2023). MA RBUECS Demand Impact Model
2023_Guidehouse_MA_RBUECS_Demand_Impact_Model
2 : Guidehouse (2021). Residential Programs Net-to-Gross Research of RCD and Select Products
2021_Guidehouse_MA_Res_NTG_Final_Report
3 : NMR Group, Inc. (2023). Residential Heat Pump NEIs Study. 2022_NMR_MA21X21-E-RHPNEI_Residential Heat Pump NEIs Study Final Report_2023

3.30 HVAC - Heat Pump 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
ASHP displacing Gas - Partial	C&I Small Business Turnkey Retrofit (CI_SBTR)	GC1c028
ASHP displacing Gas - Full	C&I Small Business Turnkey Retrofit (CI_SBTR)	GC1c029
VRF displacing Gas - Partial	C&I Small Business Turnkey Retrofit (CI_SBTR)	GC1c030
VRF displacing Gas - Full	C&I Small Business Turnkey Retrofit (CI_SBTR)	GC1c031
ASHP displacing Gas - Partial	C&I Equipment Rebates & Instant Incentives (CI_ERII)	GC1e010
ASHP displacing Gas - Full	C&I Equipment Rebates & Instant Incentives (CI_ERII)	GC1e011
VRF displacing Gas - Partial	C&I Equipment Rebates & Instant Incentives (CI_ERII)	GC1e012
VRF displacing Gas - Full	C&I Equipment Rebates & Instant Incentives (CI_ERII)	GC1e013
GSHP displacing Gas	C&I Equipment Rebates & Instant Incentives (CI_ERII)	GC1e014

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. **Please note that these electric penalties include the midstream incremental EE savings, as the PAs will no longer be offering these equipment types through midstream.**

Measure	Core Initiative	PA	Annual kWh/ton[3]	Annual kW/ton[2]	Annual MMBtu/ton
ASHP Displacing Gas - Partial	CI_ERII CI_SBTR	All	-942	-2.7	9.2
ASHP Displacing Gas - Full	CI_ERII CI_SBTR	All	-1,624	-4.5	14.0

Measure	Core Initiative	PA	Annual kWh/ton[3]	Annual kW/ton[2]	Annual MMBtu/ton
VRF Displacing Gas - Partial	CI_ERII CI_SBTR	All	-664	-2.0	9.3
VRF Displacing Gas - Full	CI_ERII CI_SBTR	All	-1,261	-3.6	14.5
GSHP Displacing Gas	CI_ERII	All	-1,718	-4.5	26.0

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 an installer survey fielded as part of the 2024 C&I Energy Optimization Model Update study (V2.1). 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 was 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 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[4] .

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
VRF Displacing Gas	CI_ERII CI_SBTR	All	17	n/a	n/a	17
ASHP Displacing Gas	CI_ERII CI_SBTR	All	17	n/a	n/a	17
GSHP Displacing Gas	CI_ERII	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 Displacing Gas	CI_ERII CI_SBTR	All	1.00	1.00	1.00	1.00	1.00	-0.079	0.035
ASHP Displacing Gas	CI_ERII CI_SBTR	All	1.00	1.00	1.00	1.00	1.00	-0.079	0.035
GSHP Displacing Gas	CI_ERII	All	1.00	1.00	1.00	1.00	1.00	-0.079	0.035

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.[5]

Impact Factors for Calculating Net Savings:

Measure Name	Core Initiative	PA	NTG [6]
VRF Displacing Gas	CI_ ERII	All	0.878
VRF Displacing Gas	CI_SBTR	All	1.02
ASHP Displacing Gas	CI_ ERII	All	0.878
ASHP Displacing Gas	CI_SBTR	All	1.02
GSHP Displacing Gas	CI_ ERII	All	0.878
GSHP Displacing Gas	CI_SBTR	All	1.02

Non-Energy Impacts:

NEIs are based on study results.[7]

Measure Name	Core Initiative	PA	Total $/ton NEI value
ASHP Displacing Gas - Partial	CI_ERII CI_SBTR	All	$82.99

Measure Name	Core Initiative	PA	Total $/ton NEI value
ASHP Displacing Gas - Full	CI_ERII CI_SBTR	All	$158.12
VRF Displacing Gas - Partial	CI_ERII CI_SBTR	All	$82.99
VRF Displacing Gas - Full	CI_ERII CI_SBTR	All	$158.12
GSHP Displacing Gas	CI_ERII	All	$158.12

Endnotes:

1 : Cadeo (2024). Energy Optimization Model Update (V2.1) 2024_DNV_EO_Model_v2.1_Update
2 : The 2024 C&I Energy Optimization Model Update study calculated HP impacts for both downstream and midstream. The PAs will no longer be offering ASHPs, GSHPs, or VRF HPs through midstream, so these electric penalties reflect the sum of the downstream penalty and midstream incremental EE savings.
3 : Navigant Consulting (2019). Massachusetts Energy Optimization Model for Residential and Small Commercial Applications. MA19C04-E-EO - MA Energy Optimization Model_19APR2021
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 : DNV(2024). C&I Impact Shape Study. 2024_DNV_C&I_Impact Shape Study
6 : 2024_NMR_C&I_Omnibus_Study
7 : NMR (2024) C&I Heat Pump NEI Results Memo 2024_NMR_C&I_HP_NEI_Memo

3.31 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 Equipment Rebates & Instant Incentives (CI_ERII)	EC1e041

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 by CBECS building type. **Please note that these savings will be claimed downstream moving forward (i.e. integrated into downstream ASHP and VRF numbers), which will be reflected in future eTRM versions.**

Measure	Electric Savings (kWh/ton)
Midstream - ASHP	127
Midstream - VRF	188

Baseline Efficiency:

Baseline efficiencies are equal to code for VRFs, while ISP is used in place of code for ASHPs. 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_ERII	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_ERII	All	1.00	1.00	1.00	1.00	1.00	0.07	0.1

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 derived from the C&I Loadshape study.[3]

Impact Factors for Calculating Net Savings:

The net-to-gross ratio for Midstream Heat Pump Systems is based on the HVAC Upstream study which developed statewide net-to-gross results.[4]

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Midstream - Heat Pump Systems	CI_ERII	All	45.0%	0.0%	0.0%	55.0%

Non-Energy Impacts:

Non-energy impacts are based on the C&I Health & Safety NEI study results.[5]

Measure Name	Core Initiative	PA	Annual $ per kWh
Midstream - Heat Pump Systems	CI_ERII	All	0.095

Endnotes:

1 : Cadeo (2024). Energy Optimization Model Version 2.1 2023_Cadeo_MA22C10_Energy Optimization Model Update

8 : Since IECC 2015 does not provide EER requirements for air-cooled heat pumps < 65 kBtu/h, assume the following conversion from SEER to EER: EER≈SEER/1.1.
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 : DNV (2024). C&I Impact Shape Study 2024_DNV_C&I_Impact Shape Study
4 : NMR Group Inc. (2021). C&I Upstream HVAC Net-to-Gross Study.
2021_NMR_C&I_HVAC_NTG
5 : NMR (2021). C&I OM & NonOM NEI Study 2021_NMR_CIOM and NonOM NEI Study

3.32 HVAC - Heat Recovery Ventilator

Measure Code	COM-HVAC-HRV
Market	Commercial
Program Type	Retrofit
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	C&I Multifamily (CI_MF)	GC1d011

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. kW savings are derived from the Guidehouse Demand Impact Model.[2]

Measure Name	ΔMMBtu/Unit	ΔkWh/Unit	ΔkW/Unit
Heat Recovery Ventilator	8.6	-171	-0.10

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.[3]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Heat Recovery Ventilator	CI_MF	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	CI_MF	All	1.00	1.00	1.00	1.00	1.00	0.54	0.19

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:

All PAs use statewide net-to-gross values based on study results.[5]

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Heat Recovery Ventilator	C&I Multifamily (CI_MF)	All	0.14	0.0	0.0	0.86

Non-Energy Impacts:

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

Endnotes:

1 : TRM Study Update 2021_Guidehouse_TRM_Final_Report
2 : Guidehouse (2023). MA RBUECS Demand Impact Model.
2023_Guidehouse_MA_RBUECS_Demand_Impact_Model
3 : GDS Associates, Inc. (2009). Natural Gas Energy Efficiency Potential in Massachusetts.
GDS_2009_Natural_Gas_Energy_Efficiency_Potential_in_MA
4 : Guidehouse (2023). MA RBUECS Demand Impact Model
2023_Guidehouse_MA_RBUECS_Demand_Impact_Model
5 : Guidehouse (2021). Residential Programs Net-to-Gross Research of RCD and Select Products
2021_Guidehouse_MA_Res_NTG_Final_Report

3.33 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
Prescriptive - High Efficiency Chiller	C&I Existing Buildings (CI_EXST)	EC1b038

Algorithms for Calculating Primary Energy Impact:

Updates to algorithms, baseline efficiency, and high-efficiency edits are suggestions from the C&I Comprehensive TRM Review.[1] 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/EERbase - 12/EERee) * Hours
kW = Tons * (12/EERbase - 12/EERee)

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 document, energy efficiency must be met via compliance with the International Energy Conservation Code (IECC) 2015. There were no updates impacting chillers in IECC 2018.

The table below details the specific efficiency requirements by equipment type and capacity.

Chiller - Minimum Efficiency Requirements[2] are a blended baseline for New Construction and Replace on Failure.[3]

Equipment Type	Size Category (Tons)	Units	Path A		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
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

Equipment Type	Size Category (Tons)	Units	Path A		Path B	
			Full Load	IPLV	Full Load	IPLV
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[4] .

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_ERII	All	1.00	1.00	1.00	1.00	1.00	0.59	0.05
Chillers – FL used	CI_NB&MR CI ERII	All	1.00	2.63	2.63	1.00	1.00	0.59	0.05

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[5] . Realization rates assume PA use of the prescriptive algorithms detailed above.

Coincidence Factors:

Coincidence factors are derived from the C&I Loadshape study.[6]

Impact Factors for Calculating Net Savings:

All PAs use Statewide net-to-gross results[7] . Net savings factors for CI_NB&MR initiative are based on 2021 NRNC Study (paths 3&4)8 . Net savings factors for CI_ERII initiative are based on 2024 Omnibus NTG Study (prescriptive).

Measure Name	Core Initiative	PA	NTG
High Efficiency Chiller - IPLV	CI_NB&MR	All	64.4%
High Efficiency Chiller - FL	CI_NB&MR	All	64.4%
High Efficiency Chiller - IPLV	CI_ERII	All	87.7%
High Efficiency Chiller - FL	CI_ERII	All	87.7%

Non-Energy Impacts:

NEIs from the C&I health and safety NEI study[9] .

Measure Name	Core Initiative	PA	Annual $ per kWh
High Efficiency Chiller - IPLV	CI_NB&MR, CI_ERII	All	$0.001
High Efficiency Chiller - FL	CI_NB&MR, CI_ERII	All	$0.001

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
5 : 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
6 : 2024_DNV_C&I_Impact Shape Study
7 : NMR Group, Inc. (2024). C&I Omnibus Net-to-Gross (NTG) Study
2024_NMR_C&I_Omnibus_Study
8 : NMR Group, Inc. (2021). Non Residential New Construction NTG Report.
2021_NMR_Non_Residential_New_Construction_NTG_Report
9 : 2021_NMR_CIOM and NonOM NEI Study

3.34 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
Midstream - Hotel Occupancy Sensor	C&I Equipment Rebates & Instant Incentives (CI_ERII)	EC1e053

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 78^{o} 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_ERII	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_ERII	National Grid	1.00	1.00	n/a	1.00	1.00	0.30	0.70
HVAC - Hotel Occupancy Sensors	CI_ERII	Eversource CLC	1.00	1.01	n/a	1.09	1.57	0.82	0.05
HVAC - Hotel Occupancy Sensors	CI_ERII	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	NTG
HVAC - Hotel Occupancy Sensors	CI_ERII	All	87.7%

Non-Energy Impacts:

NEI values based on study results.[9] [10]

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_ERII	All			$0.239			

Endnotes:

1 : Mass Save (2010). Energy Analysis: Hotel Guest Occupancy Sensors. Prepared for National Grid and Eversource (NSTAR). NGRID_and_NSTAR_EnergyAnalysis_Hotel_Guest_Occupancy_Sensors
2 : Mass Save (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. (2024). C&I Prescriptive and Custom NTG Omnibus Study 2024_NMR_C&I_Omnibus_Study
9 : 2022_DNV_C&I_Heath_&_Safety_NEIs
10 : 2021_NMR_CIOM and NonOM NEI Study

3.35 HVAC - Other HVAC

Measure Code	COM-HVAC-OTHER
Market	Commercial
Program Type	Replace on Burnout
Category	Heating Ventilation and Air Conditioning

Measure Description:

HVAC - Other HVAC includes Dual Enthalpy Economizer Controls (DEEC), Circulator Pumps, and Midstream VRF.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Midstream - HVAC Equipment (non-heat pumps)	C&I Equipment Rebates & Instant Incentives (CI_ERII)	EC1e043

Algorithms for Calculating Primary Energy Impact:

Savings for Dual Enthalpy Economizer Controls (DEEC) below.

ΔkWh = (kBtu/h)(1 Ton/12 kBtu / h)(SAVEkWh)
ΔkWh = (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)

Savings for the Midstream - Circulator Pump depend on application and pump size as described in table below.[3]

Size	Type	kW	kWh
<= 1 HP	Hydronic Heating	ΔkW = 0.245 * HPrated + 0.02	ΔkWh = 1,325 * HPrated+ 111

Size	Type	kW	kWh
<= 1 HP	Service Hot Water	ΔkW = 0.245 * HPrated+ 0.02	ΔkWh = 2,780 * HPrated+ 233
> 1 HP	Hydronic Heating	ΔkW = 0.265	ΔkWh = 1,436
> 1 HP	Service Hot Water	ΔkW = 0.265	ΔkWh = 3,013

Savings for the Midstream - PEI-Rated Clean Water Pump are based on the prescriptive algorithms 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:

Dual Enthalpy Economizer Controls (DEEC):

The baseline efficiency case for this measure assumes the relevant HVAC equipment is operating with a fixed dry-bulb economizer.

Circulator Pump:

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:

Dual Enthalpy Economizer Controls (DEEC):

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.

Circulator Pump:

The high efficiency case is a pump with an ECM.

Measure Life:

The measure life is 10 years.[4]

Impact Factors for Calculating Adjusted Gross Savings:

Measure	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Other HVAC	CI_ERII	National Grid	1.00	1.00	n/a	1.00	1.00	0.59	0.05
Other HVAC	CI_ERII	Eversource (NSTAR)	1.00	1.01	n/a	1.09	1.57	0.59	0.05
Other HVAC	CI_ERII	CLC	1.00	1.01	n/a	1.09	1.57	0.59	0.05
Other HVAC	CI_ERII	Unitil	1.00	1.00	n/a	1.00	1.00	0.59	0.05

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.[5]
- Unitil realization rates same as Unitary AC.

Coincidence Factors:

Coincidence factors are derived from the C&I Loadshape study.[5]

Impact Factors for Calculating Net Savings:

Statewide net impact factors are based on the Upstream HVAC Net-to-Gross study[6]

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Other HVAC	CI_ERII	All	0.45	0.00	0.00	0.55

Non-Energy Impacts:

Non-energy impacts are based on the C&I Health & Safety NEI study results.[7]

Measure Name	Core Initiative	PA	Annual $ per kWh
Other HVAC	CI_ERII	All	0.095

Endnotes:

1 : Patel (2001). Energy Analysis Dual Enthalpy Controls
Patel_2001_Energy_Analysis_Dual_Enthalpy_Controls
2 : Patel (2001). Energy Analysis Dual Enthalpy Controls
Patel_2001_Energy_Analysis_Dual_Enthalpy_Controls
3 : The Cadmus Group(2017).Circulator Pump Technical Memo
Cadmus_2017_Circulator_Pump_Technical_Memo
4 : ERS (2005). Measure Life Study ERS_2005_Measure_Life_Study
5 : KEMA(2011). CI Unitary HVAC Load Shape Project
KEMA_2011_CIUnitaryHVACLoadShapeProject
6 : 2021_NMR_C&I_HVAC_NTG
7 : 2022_DNV_C&I_Heath_&_Safety_NEIs

3.36 HVAC - Packaged Terminal Heat Pump

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
Packaged Terminal Heat Pump (PTHP)	C&I Equipment Rebates & Instant Incentives (CI_ERII)	EC1e042

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)
Packaged Terminal Heat Pump (PTHP)	CI_ERII	All	1,123

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
Packaged Terminal Hat Pump (PTHP)	CI_ERII	All	12	0.95e	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}
Packaged Terminal Heat Pump (PTHP)	CI_ERII	All	1.00	1.00	n/a	1.00	1.00	0.07	0.10

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 are derived from the C&I Loadshape study.[3]

Impact Factors for Calculating Net Savings:

From the HVAC Upstream study which developed statewide net-to-gross results.[4]

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Packaged Terminal Heat Pump (PTHP)	CI_ERII	All	45.0%	0.0%	0.0%	55.0%

Non-Energy Impacts:

Non-energy impacts are based on study results.[5]

Measure Name	Core Initiative	PA	Annual $ per kWh
Packaged Terminal Heat Pump (PTHP)	CI_ERII	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
8 : Since IECC 2015 does not provide EER requirements for air-cooled heat pumps < 65 kBtu/h, assume the following conversion from SEER to EER: EER≈SEER/1.1.
1 : Cadeo (2024). Energy Optimization Model Update Version 2.1. 2024_DNV_EO_Model_v2.1_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 : 2024_DNV_C&I_Impact Shape Study
4 : NMR Group Inc. (2021). C&I Upstream HVAC Net-to-Gross Study. 2021_NMR_C&I_HVAC_NTG
5 : NMR (2021). C&I O&M and Non-O&M NEI Study. 2021_NMR_CIOM and NonOM NEI Study

3.37 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 Weatherization	C&I Small Business Turnkey Retrofit (CI_SBTR)	EC1c022
Pipe Wrap Steam	C&I Existing Buildings (CI_EXST)	GC1b025
Pipe Wrap Steam	C&I Small Business Turnkey Retrofit (CI_SBTR)	GC1c023

Algorithms for Calculating Primary Energy Impact:

Unit savings are deemed based on PA calculations.[1] [2]

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.[3]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Pipe Wrap	CI_EXST, CI_SBTR	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, Gas	CI_EXST, CI_SBTR	All	1.00	n/a	1.00	n/a	n/a	n/a	n/a
Pipe Wrap, Electric	CI_EXST, CI_SBTR	All	1.00	1.00	n/a	1.00	1.00	0.28	0.07
Pipe Wrap, Oil	CI_EXST, CI_SBTR	All	1.00	n/a	1.00	n/a	n/a	n/a	n/a
Pipe Wrap, Propane	CI_EXST, CI_SBTR	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:
Summer and winter coincidence factors are from the C&I Impact Shape Study.[4]

Impact Factors for Calculating Net Savings:

Values are based on evaluation studies.[5] [6]

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Pipe Weatherization, Electric	CI_EXST	All				0.877
Pipe Weatherization, Oil	CI_EXST	All				0.877
Pipe Weatherization, Propane	CI_EXST	All				0.877
Pipe Weatherization, Electric (Turnkey)	CI_SBTR	All				0.964
Pipe Weatherization, Oil (Turnkey)	CI_SBTR	All				0.964
Pipe Weatherization, Propane (Turnkey)	CI_SBTR	All				0.964
Pipe Wrap Steam, Gas	CI_EXST	All				0.878
Pipe Wrap Steam, Gas (Turnkey)	CI_SBTR	All				1.024

Non-Energy Impacts:

Pipe Wrap, Gas NEIs are from the 2021 Study.[7] Pipe Wrap Oil and Propane NEIs are updated based on the C&I H&S 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
Pipe Weatherization, Electric	CI_EXST	All			$0.095			
Pipe Weatherization, Oil	CI_EXST	All			$0.095			
Pipe Weatherization, Propane	CI_EXST	All			$0.095			
Pipe Weatherization, Electric (Turnkey)	CI_SBTR	All			$0.095			
Pipe Weatherization, Oil (Turnkey)	CI_SBTR	All			$0.095			
Pipe Weatherization, Propane (Turnkey)	CI_SBTR	All			$0.095			
Pipe Wrap Steam, Gas	CI_EXST	All					$0.622	
Pipe Wrap Steam, Gas (Turnkey)	CI_SBTR	All					$0.622	

Endnotes:

1 : National Grid Staff Calculations (2010). Pipe insulation for SBS DI measures 2010 Workbook. NGrid_Pipe_insulation_for_SBS_DImeasures_2010
2 : This methodology was validated in a subsequent study: DNV (2024). Pipe Insulation Savings Calculator Review. 2024_DNV_Pipe_Insulation_Savings_Calculator_Review
3 : GDS Associates, Inc (2009). Natural Gas Energy Efficiency Potential in Massachusetts. GDS_2009_Natural_Gas_Energy_Efficiency_Potential_in_MA
4 : DNV (2024). C&I Impact Shape Study. 2024_DNV_C&I_Impact Shape Study
5 : NMR (2024). C&I Prescriptive and Custom Electric Net-to-Gross Omnibus Study Final Report 2024_NMR_C&I_Omnibus_Study
6 : NMR (2024). C&I Gas Prospective Net-to-Gross Omnibus Study.
7 : NMR Group Inc (2021). O&M and Non-O&M NEI Study. 2021_NMR_CIOM and NonOM NEI Study
8 : DNV (2022). C&I Health and Safety Non-Energy Impacts (MA21X19-B-CIHSNEI) 2022_DNV_C&I_Heath_&_Safety_NEIs

3.38 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)	C&I Multifamily (CI_MF)	GC1d006

Algorithms for Calculating Primary Energy Impact:

Unit savings are deemed per linear foot of pipe insulation based on study results.[1]

Measure Name	Δ MMBtu
Pipe Wrap (Heating), Gas	0.03

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	CI_MF	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	CI_MF	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	CI_MF	All	0.14	0.0	0.0	0.86

Non-Energy Impacts:

There are no non-energy impacts for this measure.

Endnotes:

1 : Guidehouse (2024). Massachusetts Income-Eligible and Residential Coordinated Delivery Multifamily Impact Evaluation 2024_Guidehouse_MF_Impact_Report
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

3.39 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	C&I Small Business Turnkey Retrofit (CI_SBTR)	EC1c019
Programmable Thermostat	C&I Equipment Rebates & Instant Incentives (CI_ERII)	EC1e010
Programmable Thermostat	C&I Small Business Turnkey Retrofit (CI_SBTR)	GC1c015
Programmable Thermostat	C&I Equipment Rebates & Instant Incentives (CI_ERII)	GC1e008

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

Measure Name	SAVEkWh (kWh/SqFt)[1]	SAVEkW (kW/SqFt)
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	ΔkWh	ΔkW	Fuel Oil ΔMMBtu	Propane ΔMMBtu	Gas ΔMMBtu
Programmable Thermostat, Gas			2.1		
Programmable Thermostat, Oil				2.1	
Programmable Thermostat, Other					2.1

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_SBTR	All	15	n/a	n/a	15
Programmable Thermostat	CI_ERII	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_SBTR	All	1.00	1.00	1.00	1.00	1.00	0.28	0.07
Programmable Thermostat	CI_ERII	All	1.00	1.00	1.00	1.00	1.00	0.33	0.43

In-Service Rates:

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

Realization Rates:

CI_SBTR RRs set to 100% based on no evaluations.
CI_SBTR RRs come from the Small Business Impact Evaluation[4]

Coincidence Factors:

Coincidence factors come from the DNV MA Impact Shapes study.[4]

Impact Factors for Calculating Net Savings:

Values from 2024 C&I NTGs studies.[5] [6]

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Programmable Thermostat	CI_SBTR	All	0.04	0	0	0.96
Programmable Thermostat	CI_ERII	All	0.12	0	0.09	0.88
Programmable Thermostat, Gas	CI_SBTR	All	0.05	0.02	0.05	1.02
Programmable Thermostat, Gas	CI_ERII	All	0.17	0.002	0.05	0.88

Non-Energy Impacts:

Non-energy impacts are from the C&I Health & Safety 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
Programmable Thermostat	CI_SBTR	All			$ 0.18			
Programmable Thermostat	CI_ERII	All						
Programmable Thermostat, Gas	CI_SBTR	All					$2.03	
Programmable Thermostat, Gas	CI_ERII	All						

Endnotes:

1 : All deemed savings values based on Massachusetts common assumptions.
2 : Energy & Resource Solutions (2005). Measure Life Study. ERS_2005_Measure_Life_Study
3 : DNV GL (2020). Impact Evaluation of PY 2017 Small Business Initiative Non-Lighting Measures.
4 : DNV (2024). C&I Impact Shape Study 2024_DNV_C&I_Impact Shape Study
5 : NMR (2024). C&I Prescriptive and Custom Electric Net-to-Gross Omnibus Study Final Report 2024_NMR_C&I_Omnibus_Study
6 : NMR (2024). C&I Gas Prospective Net-to-Gross Omnibus Study.
7 : NMR Group Inc (2021). O&M and Non-O&M NEI Study. 2021_NMR_CIOM and NonOM NEI Study

3.40 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	C&I Multifamily (CI_MF)	EC1d015
Programmable Thermostat	C&I Multifamily (CI_MF)	GC1d009

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	ΔMMBtu
Programmable Thermostat, Electric Resistance, No AC	475	0.23	n/a
Programmable Thermostat, Electric Resistance, With AC	499	0.24	n/a
Programmable Thermostat, AC Only	24	0.02	n/a
Programmable Thermostat, Heat Pump	250	0.12	n/a
Programmable Thermostat, Oil	24	0.02	0.9
Programmable Thermostat, Gas	24	0.02	1.3

Weighted averages for BC model

Measure Name	BCR ID	ΔkWh	ΔkW	Δ Oil MMBTUs	Δ Propane MMBTUs	Δ Gas MMBtus
Programmable Thermostat	EC1d015	509	0.25	0.5	n/a	n/a
Programmable Thermostat, Gas	GC1d009	24	0.02	n/a	n/a	1.3

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	CI_MF	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_MF	All	1.00	1.00	1.00	1.00	1.00	0.00	0.58
Programmable Thermostat, gas	CI_MF	All	1.00	1.00	1.00	1.00	1.00	0.54	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	CI_MF	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	CI_MF	All	$14.35					

Endnotes:

1 : Guidehouse (2024). Massachusetts Income-Eligible and Residential Coordinated Delivery Multifamily Impact Evaluation 2024_Guidehouse_MF_Impact_Report
2 : Guidehouse (2023). MA RBUECS Demand Impact Model 2023_Guidehouse_MA_RBUECS_Demand_Impact_Model
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 (2023). Baseline Demand Impact Model 2023_Guidehouse_MA_RBUECS_Demand_Impact_Model
6 : Guidehouse (2021). Residential Programs Net-to-Gross Research of RCD and Select Products. 2021_Guidehouse_MA_Res_NTG_Final_Report

3.41 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 Equipment Rebates & Instant Incentives (CI_ERII)	EC1e055

Algorithms for Calculating Primary Energy Impact:

For units with cooling capacities less than 65 kBtu/h:
ΔkWh = (kBtu/h) (1/SEERbase – 1/ SEEREe) (EFLHcool)
ΔkW = (kBtu/h) (1/EERbase – 1/ EERee)

For units with cooling capacities equal to or greater than 65 kBtu/h and EER available:
ΔkWh = (kBtu/h) (1/EERbase – 1/ EERee) (EFLHcool)
ΔkW = (kBtu/h) (1/EERbase – 1/ EERee)

For units with cooling capacities equal to or greater than 65 kBtu/h and IEER available:

ΔkWh = (kBtu/h) (1/IEERbase – 1/ IEERee) (EFLHcool)
ΔkW = (kBtu/h) (1/EERbase – 1/ EERee)

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 2020.

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 13.4 SEER2	AHRI 210/240
			Single Package	14.0 SEER 13.4 SEER2	
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 13.85 IEER	AHRI 340/360
		All other	Split System and Single Package	11.0 EER 13.65 IEER	
	≥ 135,000 Btu/h and < 240,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	11.0 EER 13.3 IEER	

Equipment Type	Size Category	Heating Section Type	Subcategory Or Rating Condition	Minimum Efficiency	Test Procedure
		All other	Split System and Single Package	10.8 EER 13.1 IEER	
	≥ 240,000 Btu/h and < 760,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	10.0 EER 12.4 IEER	
		All other	Split System and Single Package	9.8 EER 12.2 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	
	≥ 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	< 65,000 Btu/h	All	Split System and Single Package	12.1 EER 12.3 IEER	AHRI 210/240

Equipment Type	Size Category	Heating Section Type	Subcategory Or Rating Condition	Minimum Efficiency	Test Procedure
cooled	≥ 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, water cooled	≥ 135,000 Btu/h			13.5 EER 14.0 IEER	
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_ERII	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_ERII	CLC	1.00	1.00	1.00	0.74	0.00	0.59	0.05
Unitary AC	CI_ERII	National Grid	1.00	1.00	1.00	1.00	1.00	0.59	0.05
Unitary AC	CI_ERII	Eversource	1.00	1.00	1.00	0.74	0.00	0.59	0.05
Unitary AC	CI_ERII	Unitil	1.00	1.00	1.00	1.00	1.00	0.59	0.05

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:

Coincidence factors are derived from the C&I Loadshape study.[3]

Impact Factors for Calculating Net Savings:

NTG values were developed as part of an upstream HVAC NTG study in 2021 in Massachusetts.[4]

Measure	Initiative	PA	FR	SO_P	SO_{NP}	NTG
HVAC - Upstream - Unitary Air Conditioner - 2022	CI_ERII	All	0.45	0.00	0.00	0.55
HVAC - Upstream - Unitary Air Conditioner - 2023	CI_ERII	All	0.45	0.00	0.00	0.55
HVAC - Upstream - Unitary Air Conditioner - 2024	CI_ERII	All	0.45	0.00	0.00	0.55

Non-Energy Impacts:

Non-energy impact (NEI) values are from the O&M and Non-O&M NEI study[5]

Measure Name	Core Initiative	PA	Annual $ per kWh	Annual $ per Therm
HVAC - Unitary Air Conditioner	CI_ERII	All	$0.095	

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 : 2024 DNV C&I Impact Shape Study 2024_DNV_C&I_Impact Shape Study
4 : NMR Group, Inc. (2021). C&I Upstream HVAC & Gas Water Heating NTG Study
2021_NMR_C&I_HVAC_NTG
5 : NMR Group Inc (2021). O&M and Non-O&M NEI Study (MA20X10-B-CIOMNEI).
2021_NMR_CIOM and NonOM NEI Study

3.42 HVAC - VRF, GSHP, ASHP 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
VRF displacing Electric Resistance - Partial	C&I Small Business Turnkey Retrofit (CI_SBTR)	EC1c039
VRF displacing Electric Resistance - Full	C&I Small Business Turnkey Retrofit (CI_SBTR)	EC1c041
ASHP displacing Electric Resistance - Partial	C&I Small Business Turnkey Retrofit (CI_SBTR)	EC1c038
ASHP displacing Electric Resistance - Full	C&I Small Business Turnkey Retrofit (CI_SBTR)	EC1c040
VRF displacing Electric Resistance - Partial	C&I Equipment Rebates & Instant Incentives (CI_ERII)	EC1e015
VRF displacing Electric Resistance - Full	C&I Equipment Rebates & Instant Incentives (CI_ERII)	EC1e017
ASHP displacing Electric Resistance - Partial	C&I Equipment Rebates & Instant Incentives (CI_ERII)	EC1e014
ASHP displacing Electric Resistance - Full	C&I Equipment Rebates & Instant Incentives (CI_ERII)	EC1e016
GSHP displacing Electric Resistance	C&I Equipment Rebates & Instant Incentives (CI_ERII)	EC1e018

Algorithms for Calculating Primary Energy Impact:

Unit savings are deemed based on a model[1] (v2.1) developed to estimate the savings associated with the displacement of existing heating (and cooling) systems. **Please note that these electric savings include the midstream incremental EE savings, as the PAs will no longer be offering these equipment types through midstream.**

Measure	Core Initiative	Annual kWh/ton[3]	Annual kW/ton[2]
VRFHP displacing electric resistance - partial	CI_ERII, CI_SBTR	2,025	2.2
VRFHP displacing electric resistance - full	CI_ERII, CI_SBTR	2,723	3.0
GSHP displacing electric resistance - full	CI_ERII, CI_SBTR	4,119	4.5
ASHP displacing electric resistance - partial	CI_ERII, CI_SBTR	1,808	1.9
ASHP displacing electric resistance - full	CI_ERII, CI_SBTR	2,503	2.7

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 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.[4]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
VRFHP displacing electric resistance - partial	CI_ERII, CI_SBTR	All	17	n/a	n/a	17
VRFHP displacing electric resistance - full	CI_ERII, CI_SBTR	All	17	n/a	n/a	17
GSHP displacing electric resistance - full	CI_ERII, CI_SBTR	All	25	n/a	n/a	25
ASHP displacing electric resistance - partial	CI_ERII, CI_SBTR	All	17	n/a	n/a	17
ASHP displacing electric resistance - full	CI_ERII, CI_SBTR	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}
VRFHP displacing electric resistance - partial	CI_ERII, CI_SBTR	All	1.00	1.00	1.00	1.00	1.00	0.07	0.1
VRFHP displacing electric resistance - full	CI_ERII, CI_SBTR	All	1.00	1.00	1.00	1.00	1.00	0.07	0.1
GSHP displacing electric resistance - full	CI_ERII, CI_SBTR	All	1.00	1.00	1.00	1.00	1.00	0.07	0.1
ASHP displacing electric resistance - partial	CI_ERII, CI_SBTR	All	1.00	1.00	1.00	1.00	1.00	0.07	0.1
ASHP displacing electric resistance - full	CI_ERII, CI_SBTR	All	1.00	1.00	1.00	1.00	1.00	0.07	0.1

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 derived from the C&I Loadshape study.[5]

Impact Factors for Calculating Net Savings:

Measure Name	Core Initiative	PA	NTG[6]
VRFHP displacing electric resistance - partial	CI_ERII	All	0.877
VRFHP displacing electric resistance - partial	CI_SBTR	All	0.964
VRFHP displacing electric resistance - full	CI_ERII	All	0.877
VRFHP displacing electric resistance - full	CI_SBTR	All	0.964
GSHP displacing electric resistance - full	CI_ERII	All	0.877
GSHP displacing electric resistance - full	CI_SBTR	All	0.964
ASHP displacing electric resistance - partial	CI_ERII	All	0.877

Measure Name	Core Initiative	PA	NTG[6]
ASHP displacing electric resistance - partial	CI_SBTR	All	0.964
ASHP displacing electric resistance - full	CI_ERII	All	0.877
ASHP displacing electric resistance - full	CI_SBTR	All	0.964

Non-Energy Impacts:

Non-energy impacts are based on the C&I Health & Safety NEI study results[7]

Measure Name	PA	Total $/ton NEI value
VRFHP displacing electric resistance - partial	All	$183.56
VRFHP displacing electric resistance - full	All	$183.56
GSHP displacing electric resistance - full	All	$183.56
ASHP displacing electric resistance - partial	All	$183.56
ASHP displacing electric resistance - full	All	$183.56

Endnotes:

1 : Cadeo (2024). Energy Optimization Model Version 2.1. 2024_DNV_EO_Model_v2.1_Update
2 : DNV (2024). C&I Impact Shape Study 2024_DNV_C&I_Impact Shape Study
3 : The 2024 C&I Energy Optimization Update study calculated HP impacts for both downstream and midstream measures. The PAs will no longer be offering ASHPs, GSHPs, or VRF HPs through midstream, so these electric savings reflect the sum of the downstream savings and the midstream incremental EE savings.
4 : Navigant Consulting (2018). Baseline Study Saturation Result
2018_Navigant_Baseline_Loadshape_Comprehensive_Report
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 : NMR Group, Inc. (2024). C&I Omnibus NTG Study. 2024_NMR_C&I_Omnibus_Study
7 : NMR (2024) C&I Heat Pump NEI Results Memo 2024_NMR_C&I_HP_NEI_Memo

3.43 HVAC - VRF, GSHP, ASHP 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
ASHP displacing Oil - Partial	C&I Small Business Turnkey Retrofit (CI_SBTR)	EC1c042
ASHP displacing Propane - Partial	C&I Small Business Turnkey Retrofit (CI_SBTR)	EC1c043
VRF displacing Oil - Partial	C&I Small Business Turnkey Retrofit (CI_SBTR)	EC1c044
VRF displacing Propane - Partial	C&I Small Business Turnkey Retrofit (CI_SBTR)	EC1c045
ASHP displacing Oil - Full	C&I Small Business Turnkey Retrofit (CI_SBTR)	EC1c046
ASHP displacing Propane - Full	C&I Small Business Turnkey Retrofit (CI_SBTR)	EC1c047
VRF displacing Oil - Full	C&I Small Business Turnkey Retrofit (CI_SBTR)	EC1c048
VRF displacing Propane - Full	C&I Small Business Turnkey Retrofit (CI_SBTR)	EC1c049
ASHP displacing Oil - Partial	C&I Equipment Rebates & Instant Incentives (CI_ERII)	EC1e019
ASHP displacing Propane - Partial	C&I Equipment Rebates & Instant Incentives (CI_ERII)	EC1e020
VRF displacing Oil - Partial	C&I Equipment Rebates & Instant Incentives (CI_ERII)	EC1e021
VRF displacing Propane - Partial	C&I Equipment Rebates & Instant Incentives (CI_ERII)	EC1e022
ASHP displacing Oil - Full	C&I Equipment Rebates & Instant Incentives (CI_ERII)	EC1e023
ASHP displacing Propane - Full	C&I Equipment Rebates & Instant Incentives (CI_ERII)	EC1e024
VRF displacing Oil - Full	C&I Equipment Rebates & Instant Incentives (CI_ERII)	EC1e025
VRF displacing Propane - Full	C&I Equipment Rebates & Instant Incentives (CI_ERII)	EC1e026
GSHP displacing Oil	C&I Equipment Rebates & Instant Incentives (CI_ERII)	EC1e027
GSHP displacing Propane	C&I Equipment Rebates & Instant Incentives (CI_ERII)	EC1e028

Algorithms for Calculating Primary Energy Impact:

Unit savings are deemed based on a model[1] (v2.1) developed to estimate the savings associated with the displacement of existing heating (and cooling) systems. **Please note that these electric penalties include the midstream incremental EE savings, as the PAs will no longer be offering these equipment types through midstream.**

Measure	Core Initiative	PA	Annual kWh/ton[3]	Annual kW/ton[2]	Annual MMBtu/ton
VRF displacing Oil - Partial	CI_ERII, CI_SBTR	All	-645	-2.0	9.2
VRF displacing Propane - Partial	CI_ERII, CI_SBTR	All	-645	-2.0	9.2
VRF displacing Oil - Full	CI_ERII, CI_SBTR	All	-1,170	-3.3	14.3
VRF displacing Propane - Full	CI_ERII, CI_SBTR	All	-1,170	-3.3	14.3
GSHP displacing Oil - Full	CI_ERII, CI_SBTR	All	-1,719	-4.5	26.6
GSHP displacing Propane - Full	CI_ERII, CI_SBTR	All	-1,719	-4.5	24.5
ASHP displacing Oil - Partial	CI_ERII, CI_SBTR	All	-1,143	-3.2	11.2
ASHP displacing Propane - Partial	CI_ERII, CI_SBTR	All	-999	-2.8	10.7
ASHP displacing Oil - Full	CI_ERII, CI_SBTR	All	-2,013	-5.5	17.3
ASHP displacing Propane - Full	CI_ERII, CI_SBTR	All	-1,886	-5.1	17

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 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.[4]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
VRF displacing Oil - Partial	CI_ERII, CI_SBTR	All	17	n/a	n/a	17
VRF displacing Propane - Partial	CI_ERII, CI_SBTR	All	17	n/a	n/a	17
VRF displacing Oil - Full	CI_ERII, CI_SBTR	All	17	n/a	n/a	17
VRF displacing Propane - Full	CI_ERII, CI_SBTR	All	17	n/a	n/a	17
GSHP displacing Oil - Full	CI_ERII, CI_SBTR	All	25	n/a	n/a	25
GSHP displacing Propane - Full	CI_ERII, CI_SBTR	All	25	n/a	n/a	25
ASHP displacing Oil - Partial	CI_ERII, CI_SBTR	All	17	n/a	n/a	17
ASHP displacing Propane - Partial	CI_ERII, CI_SBTR	All	17	n/a	n/a	17
ASHP displacing Oil - Full	CI_ERII, CI_SBTR	All	17	n/a	n/a	17
ASHP displacing Propane - Full	CI_ERII, CI_SBTR	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}
VRF displacing Oil - Partial	CI_ERII, CI_SBTR	All	1.00	1.00	1.00	1.00	1.00	-0.079	0.035
VRF displacing Propane - Partial	CI_ERII, CI_SBTR	All	1.00	1.00	1.00	1.00	1.00	-0.079	0.035
VRF displacing Oil - Full	CI_ERII, CI_SBTR	All	1.00	1.00	1.00	1.00	1.00	-0.079	0.035
VRF displacing Propane - Full	CI_ERII, CI_SBTR	All	1.00	1.00	1.00	1.00	1.00	-0.079	0.035
GSHP displacing Oil - Full	CI_ERII, CI_SBTR	All	1.00	1.00	1.00	1.00	1.00	-0.079	0.035
GSHP displacing Propane - Full	CI_ERII, CI_SBTR	All	1.00	1.00	1.00	1.00	1.00	-0.079	0.035

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
ASHP displacing Oil - Partial	CI_ERII, CI_SBTR	All	1.00	1.00	1.00	1.00	1.00	-0.079	0.035
ASHP displacing Propane - Partial	CI_ERII, CI_SBTR	All	1.00	1.00	1.00	1.00	1.00	-0.079	0.035
ASHP displacing Oil - Full	CI_ERII, CI_SBTR	All	1.00	1.00	1.00	1.00	1.00	-0.079	0.035
ASHP displacing Propane - Full	CI_ERII, CI_SBTR	All	1.00	1.00	1.00	1.00	1.00	-0.079	0.035

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 derived from the C&I Loadshape study[5] and reflect a blend of heating and cooling.

Impact Factors for Calculating Net Savings:

Measure Name	Core Initiative	PA	NTG [6]
VRF displacing Oil - Partial	CI_ERII	All	0.877
VRF displacing Oil - Partial	CI_SBTR	All	0.964
VRF displacing Propane - Partial	CI_ERII	All	0.877
VRF displacing Propane - Partial	CI_SBTR	All	0.964
VRF displacing Oil - Full	CI_ERII	All	0.877
VRF displacing Oil - Full	CI_SBTR	All	0.964
VRF displacing Propane - Full	CI_ERII	All	0.877
VRF displacing Propane - Full	CI_SBTR	All	0.964
GSHP displacing Oil - Full	CI_ERII	All	0.877
GSHP displacing Oil - Full	CI_SBTR	All	0.964
GSHP displacing Propane - Full	CI_ERII	All	0.877
GSHP displacing Propane - Full	CI_SBTR	All	0.964

Measure Name	Core Initiative	PA	NTG [6]
ASHP displacing Oil - Partial	CI_ERII	All	0.877
ASHP displacing Oil - Partial	CI_SBTR	All	0.964
ASHP displacing Propane - Partial	CI_ERII	All	0.877
ASHP displacing Propane - Partial	CI_SBTR	All	0.964
ASHP displacing Oil - Full	CI_ERII	All	0.877
ASHP displacing Oil - Full	CI_SBTR	All	0.964
ASHP displacing Propane - Full	CI_ERII	All	0.877
ASHP displacing Propane - Full	CI_SBTR	All	0.964

Non-Energy Impacts:

NEIs are based on study results.[7]

Measure Name	Core Initiative	PA	Total $/ton NEI value
VRF displacing Oil - Partial	CI_ERII, CI_SBTR	All	$82.99
VRF displacing Propane - Partial	CI_ERII, CI_SBTR	All	$82.99
VRF displacing Oil - Full	CI_ERII, CI_SBTR	All	$158.11
VRF displacing Propane - Full	CI_ERII, CI_SBTR	All	$158.11
GSHP displacing Oil - Full	CI_ERII, CI_SBTR	All	$158.11
GSHP displacing Propane - Full	CI_ERII, CI_SBTR	All	$158.11
ASHP displacing Oil - Partial	CI_ERII, CI_SBTR	All	$82.99
ASHP displacing Propane - Partial	CI_ERII, CI_SBTR	All	$82.99
ASHP displacing Oil - Full	CI_ERII, CI_SBTR	All	$158.11
ASHP displacing Propane - Full	CI_ERII, CI_SBTR	All	$158.11

Endnotes:

1 : Cadeo (2024). Energy Optimization Model Version 2.1 2024_DNV_EO_Model_v2.1_Update
2 : DNV (2024). C&I Impact Shape Study 2024_DNV_C&I_Impact Shape Study
3 : The 2024 C&I Energy Optimization Model Update study calculated HP impacts for both downstream and midstream. The PAs will no longer be offering ASHPs, GSHPs, or VRF HPs through midstream, so these electric penalties reflect the sum of the downstream penalty and midstream incremental EE

savings.

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 : DNV (2024). C&I Impact Shape Study 2024_DNV_C&I_Impact Shape Study
6 : NMR Group Inc. (2024). C&I Omnibus Net-to-Gross Study. 2024_NMR_C&I_Omnibus_Study
7 : DNV (2022). C&I Health & Safety NEIs 2022_DNV_C&I_Heath_&_Safety_NEIs

3.44 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	C&I Small Business Turnkey Retrofit (CI_SBTR)	EC1c023
Faucet Aerator	C&I Small Business Turnkey Retrofit (CI_SBTR)	GC1c019
Faucet Aerator	C&I Equipment Rebates & Instant Incentives (CI_ERII)	EC1e003
Faucet Aerator	C&I Equipment Rebates & Instant Incentives (CI_ERII)	GC1e002

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

Weighted averages for BC model

Measure Name	BCR ID	ΔkWh	ΔkW	Δ Oil MMBtu	Δ Propane MMBtu
Faucet Aerator (Turnkey)	EC1c023	281.9	0.06	0.20	0.14
Faucet Aerator	EC1e003	281.9	0.06	0.20	0.14

Baseline Efficiency:

The baseline efficiency case is a 2.2 GPM faucet.[4] [5]

High Efficiency:

The high efficiency case is a faucet with 1.5 GPM or less aerator installed.[6] [7]

Measure Life:

The measure life is 3 years.[8]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Faucet Aerator	CI_ERII, CI_SBTR	All	10	n/a	n/a	3

Other Resource Impacts:

There are deemed water savings of 5,460 gallons/unit.[9]

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	CI_ERII, CI_SBTR	All	1.00	1.00	1.00	1.00	1.00	0.54	0.56

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 from the 2024 C&I Impact Shape Study.[10]

Impact Factors for Calculating Net Savings:

Net to gross factors are based on evaluation results.[11] [12] [13]

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Faucet Aerator, Gas	CI_ERII	All				0.84
Faucet Aerator, Gas (Turnkey)	CI_SBTR	All				0.82
Faucet Aerator, Electric/Oil/Propane (Turnkey)	CI_SBTR	All				0.964
Faucet Aerator, Electric/Oil/Propane	CI_ERII	All				0.877

Non-Energy Impacts:

Non-energy impacts identified for this measure are as below.[14]

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_ERII	All					$ 0.357	
Faucet Aerator, Gas (Turnkey)	CI_SBTR	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 : Cadeo (2022). Non-Residential Technical Reference Manual Review. MA22C01-B-TRM Review_FINAL_31Oct2022
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 : 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 faucets and aerators to be 2.2 GPM or less. As it has been nearly 30 years since that regulation took effect it is reasonable to assume that an average market baseline would be lower than 2.2 GPM; however, newer market data is not available to support a change at this time.
6 : GDS Associates, Inc (2009). Natural Gas Energy Efficiency Potential in Massachusetts, Table B-2a GDS_2009_Natural_Gas_Energy_Efficiency_Potential_in_MA
7 : 2022 TRM Review confirmed that implementation programs use multiple high efficiency flow rates in field including 1.5 GPM, 1.0 GPM, and 0.5 GPM
8 : DNV GL (2021). Prescriptive Measures NRNC and ISP Results. 2021_DNV_Prescriptive Measures NRNC and ISP Results
9 : Federal Energy Management Program (2011). Energy Cost Calculator for Faucets and Showerheads.
10 : DNV (2024). C&I Impact Shape Study. 2024_DNV_C&I_Impact Shape Study
11 : Tetra Tech (2021). C&I Prescriptive and Custom Net-to-Gross Omnibus Study. 2021_TetraTech_CI_PrescrCustom_NTG_Omnibus
12 : NMR (2024). C&I Prescriptive and Custom Electric Net-to-Gross Omnibus Study Final Report. 2024_NMR_C&I_Omnibus_Study
13 : NMR (2024). C&I Gas Prospective Net-to-Gross Omnibus Study.
14 : NMR Group Inc (2021). O&M and Non-O&M NEI Study. 2021_NMR_CIOM and NonOM NEI Study

3.45 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	C&I Multifamily (CI_MF)	EC1d011
Faucet Aerator	C&I Multifamily (CI_MF)	GC1d007

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	Core Initiative	ΔkWh	ΔkW	Δ MMBtu
Faucet Aerator, Electric	CI_MF	50	0.01	
Faucet Aerator, Oil	CI_MF			0.3
Faucet Aerator, Propane	CI_MF			0.3
Faucet Aerator, Gas	CI_MF			0.3

Weighted averages for BC model

Measure Name	BCR ID	ΔkWh	ΔkW	Δ Oil MMBTUs	Δ Propane MMBTUs
Faucet Aerator	EC1d011	41	0.01	0.04	0.02

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_MF	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_MF	All	1.00	1.00	1.00	1.00	1.00	0.30	0.62
Faucet Aerator, Gas	CI_MF	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.[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
Faucet Aerator	CI_MF	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	CI_MF	All	0.58	0.00	0.00	0.00	0.00	0.00

Endnotes:

1 : Guidehouse (2024). Massachusetts Income-Eligible and Residential Coordinated Delivery Multifamily Impact Evaluation 2024_Guidehouse_MF_Impact_Report
2 : Guidehouse (2023). MA RBUECS Demand Impact Model
2023_Guidehouse_MA_RBUECS_Demand_Impact_Model
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 (2023). MA RBUECS Demand Impact Model
2023_Guidehouse_MA_RBUECS_Demand_Impact_Model
6 : Guidehouse (2021). Residential Programs Net-to-Gross Research of RCD and Select Products.
2021_Guidehouse_MA_Res_NTG_Final_Report

3.46 Hot Water - Heat Pump Water Heater

Measure Code	COM-WH-HPWH
Market	Commercial
Program Type	Retrofit
Category	Water Heating

Measure Description:

Midstream heat pump water heater displacing electric, oil, or propane.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Heat Pump Water Heater displacing Electric Resistance	C&I Small Business Turnkey Retrofit (CI_SBTR)	EC1c050
Heat Pump Water Heater displacing Oil	C&I Small Business Turnkey Retrofit (CI_SBTR)	EC1c051
Heat Pump Water Heater displacing Propane	C&I Small Business Turnkey Retrofit (CI_SBTR)	EC1c052
Heat Pump Water Heater displacing Gas	C&I Small Business Turnkey Retrofit (CI_SBTR)	GC1c032
Midstream - Heat Pump Water Heater displacing Electric Resistance	C&I Equipment Rebates & Instant Incentives (CI_ERII)	EC1e045
Midstream - Heat Pump Water Heater displacing Oil	C&I Equipment Rebates & Instant Incentives (CI_ERII)	EC1e046
Midstream - Heat Pump Water Heater displacing Propane	C&I Equipment Rebates & Instant Incentives (CI_ERII)	EC1e047
Heat Pump Water Heater displacing Gas	C&I Equipment Rebates & Instant Incentives (CI_ERII)	GC1e020

Algorithms for Calculating Primary Energy Impact:

Annual Electric Energy Savings

$\Delta kWh = units \times GPD \times 365 \times 8.33 \times \Delta Tmain$ 3,412 × ($FeDHW\ UEFbaseline$ − 1 $UEFee \times Fderate$) + $\Delta kWhcooling - \Delta kWhheating$

$\Delta kWhcooling = units \times GPD \times 365 \times 8.33 \times \Delta Tmain$ 3,412 × 1 $UEFee \times FLoc \times FCool\ SEER$/3.412

$\Delta kWhheating = units \times GPD \times 365 \times 8.33 \times \Delta Tmain$ 3,412 × 1 $UEFee \times FLoc \times FElecHeat \times FHeat\ HSPF$/3.412

Peak Coincident Demand Savings
$\Delta kW = units \times (\Delta kW/unit)$

MMBtu savings

ΔMMBtu=(GPD × D days/year × 8.33 lb/gal × ΔT × (1/COPb - 1/COPh) ÷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
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

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)
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
5***0-80 Gal Commercial Heat Pump Water Heater, Gas Storage WH Replacement***															
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

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)
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

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)
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
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

Equipment Type	**Baseline** (from 2018 IECC)	**Measure Eligibility / Qualifications**
		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

High Efficiency:

The high efficiency case is an electric heat pump water heater with UEF >= 3.3 (for HPWHs <= 80 gallons) and COP >=3.6 (for HPWHs >80 and <=120 gallons).

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
Heat Pump Water Heater	CI_ERII, CI_SBTR	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}
Heat Pump Water Heater	CI_ERII	All	1.00	1.00	1.00	1.00	1.00	0.54	0.56

In-Service Rates:

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

Realization Rates:

Realization rates assumed to be 1.0.

Coincidence Factors:

Coincidence factors are derived from the C&I Loadshape study.[1]

Impact Factors for Calculating Net Savings:

Net savings impact factors from the C&I HVAC & Water Heater NTG study (storage water heater).[2]

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Heat Pump Water Heater	CI_ERII, CI_SBTR	All	0.71	0.00	0.09	0.29

Non-Energy Impacts:

NEIs are based on study results.[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
Heat Pump Water Heater displacing Electric Resistance	CI_ERII, CI_SBTR	All			$0.095			
Heat Pump Water Heater displacing Oil	CI_ERII, CI_SBTR	All			$0.095			
Heat Pump Water Heater displacing Propane	CI_ERII, CI_SBTR	All			$0.095			
Heat Pump Water Heater displacing Gas	CI_SBTR	All					$0.35	

Endnotes:

1 : DNV (2024). C&I Impact Shape Study. 2024_DNV_C&I_Impact Shape Study
2 : NMR Group, Inc. (2021). C&I Upstream HVAC & Gas Water Heating NTG Study 2021_NMR_C&I_HVAC_NTG
3 : NMR Group Inc (2021). O&M and Non-O&M NEI Study. 2021_NMR_CIOM and NonOM NEI Study

3.47 Hot Water - High Speed Clothes Washer

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	C&I Equipment Rebates & Instant Incentives (CI_ERII)	GC1e019

Algorithms for Calculating Primary Energy Impact:

Savings values are tied to pound of capacity.[1]

Measure Name	ΔMMBtu/lb
High Speed Clothes Washer	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	CI_ERII	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_ERII	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 2024 C&I Prescriptive & Custom Omnibus NTG study[4] .

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
High Speed Clothes Washer	CI_ERII	All	0.1222	0.003	0.045	0.926

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 : 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. 2019_DNV GL_Impact_Eval_C&I_Water_Heaters
4 : NMR (2024). C&I Gas Prospective Net-to-Gross Omnibus Study. 2024_NMR_C&I_Omnibus_Study

3.48 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	C&I Small Business Turnkey Retrofit (CI_SBTR)	EC1c024
Low-Flow Showerhead	C&I Small Business Turnkey Retrofit (CI_SBTR)	GC1c020
Low-Flow Showerhead	C&I Equipment Rebates & Instant Incentives (CI_ERII)	EC1e004
Low-Flow Showerhead with TSV	C&I Equipment Rebates & Instant Incentives (CI_ERII)	EC1e005
Low-Flow Showerhead	C&I Equipment Rebates & Instant Incentives (CI_ERII)	GC1e003
Low-Flow Showerhead with TSV	C&I Equipment Rebates & Instant Incentives (CI_ERII)	GC1e004

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

Weighted averages for BC model

Measure Name	BCR ID	ΔkWh	ΔkW	Δ Oil MMBtu	Δ Propane MMBtu
Low-Flow Showerhead	EC1e004	416	0.07	0.32	0.21
Low-Flow Showerhead with TSV	EC1e005	416	0.07	0.32	0.21
Low-Flow Showerhead (Turnkey)	EC1c024	416	0.07	0.32	0.21

Baseline Efficiency:

The baseline efficiency case is a 2.5 GPM showerhead.[3]

High Efficiency:

The high efficiency case is a 1.5 GPM showerhead.[4]

Measure Life:

The measure life is 7 years.[5]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Low-Flow Showerhead	CI_ERII, CI_SBTR	All	10	n/a	n/a	7

Other Resource Impacts:

It is assumed that 7,300 gallons/unit are saved.[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}
Low-Flow Showerhead, Electric	CI_ERII, CI_SBTR	All	1.00	1.00	n/a	1.00	1.00	0.54	0.56
Low-Flow Showerhead, Gas	CI_ERII, CI_SBTR	All	1.00	n/a	1.00	n/a	n/a	n/a	n/a
Low-Flow Showerhead, Oil	CI_ERII, CI_SBTR	All	1.00	n/a	1.00	n/a	n/a	n/a	n/a
Low-Flow Showerhead, Propane	CI_ERII, CI_SBTR	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 from the 2024 C&I Impact Shape Study.[7]

Impact Factors for Calculating Net Savings:

Net-to-Gross values are based on evaluation results.[8] [9] [10]

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Low-Flow Showerhead, Electric/Oil/Propane	CI_ERII	All				0.877
Low-Flow Showerhead with TSV, Electric/Oil/Propane	CI_ERII	All				0.877
Low-Flow Showerhead, Electric/Oil/Propane (Turnkey)	CI_SBTR	All				0.964
Low-Flow Showerhead, Gas	CI_ERII	All				0.84
Low-Flow Showerhead with TSV, Gas	CI_ERII	All				0.84
Low-Flow Showerhead, Gas (Turnkey)	CI_SBTR	All				0.82

Non-Energy Impacts:

C&I values from 2021 C&I 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
Low-Flow Showerhead, Electric	CI_ERII, CI_SBTR	All				$ 0.004		
Low-Flow Showerhead, Gas	CI_ERII, CI_SBTR	All					$ 0.36	
Low-Flow Showerhead, Oil	CI_ERII, CI_SBTR	All				$ 0.004		
Low-Flow Showerhead, Propane	CI_ERII, CI_SBTR	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 : Cadeo (2022). Non-Residential Technical Reference Manual Review MA22C01-B_TRM Review_FINAL_31OCT2022
3 : 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.
4 : 2022 TRM Review confirmed that implementation programs use multiple high efficiency flow rates in field including 1.6 GPM and 1.5 GPM.
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 : DNV (2024). C&I Impact Shape Study. 2024_DNV_C&I_Impact Shape Study
8 : NMR Group, Inc (2021). C&I Prescriptive and Custom Net-to-Gross Omnibus Study. 2021_NMR_C&I_Omnibus_NTG
9 : NMR (2024). C&I Prescriptive and Custom Electric Net-to-Gross Omnibus Study Final Report 2024_NMR_C&I_Omnibus_Study
10 : NMR (2024). C&I Gas Prospective Net-to-Gross Omnibus Study.
11 : NMR Group Inc (2021). O&M and Non-O&M NEI Study. 2021_NMR_CIOM and NonOM NEI Study

3.49 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	C&I Multifamily (CI_MF)	EC1d012
Low-Flow Showerhead	C&I Multifamily (CI_MF)	GC1d008

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	ΔkWh	ΔkW	Δ MMBtu
Low-Flow Showerhead, Electric	182	0.05	
Low-Flow Showerhead, Gas			1.0
Low-Flow Showerhead, Oil			1.1
Low-Flow Showerhead, Other			1.0

Weighted averages for BC model

Measure Name	BCR ID	ΔkWh	ΔkW	Δ Oil MMBTUs	Δ Propane MMBTUs
Low-Flow Showerhead	EC1d012	147	0.04	0.13	0.08

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_MF	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	CI_MF	All	1.00	1.00	1.00	n/a	n/a	0.30	0.62
Low-Flow Showerhead, Gas	CI_MF	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	CI_MF	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	CI_MF	All	0.58	0.00	0.00	0.00	0.00	0.00

Endnotes:

1 : Guidehouse (2024). Massachusetts Income-Eligible and Residential Coordinated Delivery Multifamily Impact Evaluation 2024_Guidehouse_MF_Impact_Report
2 : Guidehouse (2023). MA RBUECS Demand Impact Model 2023_Guidehouse_MA_RBUECS_Demand_Impact_Model
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 (2023). MA RBUECS Demand Impact Model 2023_Guidehouse_MA_RBUECS_Demand_Impact_Model
6 : Guidehouse (2021). Residential Programs Net-to-Gross Research of RCD and Select Products. 2021_Guidehouse_MA_Res_NTG_Final_Report

3.50 Hot Water - Low-Flow Showerhead w/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	C&I Multifamily (CI_MF)	EC1d013
Low-Flow Showerhead with TSV	C&I Multifamily (CI_MF)	GC1d012

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	ΔMMBtu
Low-Flow Showerhead with TSV, Electric	237	0.06	
Low-Flow Showerhead with TSV, Oil			1.4
Low-Flow Showerhead with TSV, Other			1.3
Low-Flow Showerhead with TSV, Gas			1.3

Weighted averages for BC model

Measure Name	BCR ID	ΔkWh	ΔkW	Δ Oil MMBTUs	Δ Propane MMBTUs
Low-Flow Showerhead with TSV	EC1d013	192	0.05	0.17	0.1

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_MF	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_MF	All	1.00	1.00	1.00	n/a	n/a	0.30	0.62
Low-Flow Showerhead with TSV, Gas	CI_MF	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% 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_MF	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_MF	All	$0.58					

Endnotes:

1 : Guidehouse (2024). Massachusetts Income-Eligible and Residential Coordinated Delivery Multifamily Impact Evaluation 2024_Guidehouse_MF_Impact_Report
2 : Guidehouse (2023). MA RBUECS Demand Impact Model 2023_Guidehouse_MA_RBUECS_Demand_Impact_Model
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 (2023). MA RBUECS Demand Impact Model 2023_Guidehouse_MA_RBUECS_Demand_Impact_Model
6 : Guidehouse (2021). Residential Programs Net-to-Gross Research of RCD and Select Products. 2021_Guidehouse_MA_Res_NTG_Final_Report

3.51 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	C&I Equipment Rebates & Instant Incentives (CI_ERII)	EC1e008
Pipe Wrap (Water Heating)	C&I Existing Buildings (CI_EXST)	GC1b025
Pipe Wrap (Water Heating) (Turnkey)	C&I Small Business Turnkey Retrofit (CI_SBTR)	GC1c022

Algorithms for Calculating Primary Energy Impact:

Unit savings are deemed based on PA calculations.[1] [2]

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

Weighted averages for BC model:

Measure Name	BCR ID	ΔkWh	ΔkW	Δ Oil MMBtu	Δ Propane MMBtu
Pipe Wrap	EC1e008	162	0.01	0.25	0.17

Baseline Efficiency:

The baseline efficiency case is uninsulated 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.[3]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Pipe Wrap	CI_EXST, CI_ERII, CI_SBTR	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_EXST, CI_ERII, CI_SBTR	All	1.00	n/a	1.00	n/a	n/a	n/a	n/a
Pipe Wrap, Electric	CI_EXST, CI_ERII, CI_SBTR	All	1.00	1.00	n/a	1.00	1.00	0.54	0.56
Pipe Wrap, Oil	CI_EXST, CI_ERII, CI_SBTR	All	1.00	n/a	1.00	n/a	n/a	n/a	n/a
Pipe Wrap, Propane	CI_EXST, CI_ERII, CI_SBTR	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 from the C&I Impact Shape Study.[4]

Impact Factors for Calculating Net Savings:

Values are based on an evaluation study.[5] [6]

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Pipe Wrap, Electric/Oil/Propane	CI_EXST, CI_ERII	All				0.877
Pipe Wrap, Electric/Oil/Propane (Turnkey)	CI_SBTR	All				0.964

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Pipe Wrap (Water Heating), Gas	CI_EXST, CI_ERII	All				0.926
Pipe Wrap (Water Heating), Gas (Turnkey)	CI_SBTR	All				0.816

Non-Energy Impacts:

C&I values from 2021 C&I NEI Study.[7] NEIs for Turnkey Electric, Oil and Propane measures are referencing 2022 C&I Health and Safety 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
Pipe Wrap (Water Heating), Gas	CI_EXST, CI_ERII, CI_SBTR	All					$0.080	
Pipe Wrap, Electric/Oil/Propane	CI_EXST, CI_ERII, CI_SBTR	All						

Endnotes:

1 : National Grid Staff Calculation (2010). Pipe insulation for SBS DI measures 2010 Excel Workbook. NGrid_Pipe_insulation_for_SBS_DImeasures_2010
2 : This methodology was validated in a subsequent study: DNV (2024). Pipe Insulation Savings Calculator Review. 2024_DNV_Pipe_Insulation_Savings_Calculator_Review
3 : GDS Associates, Inc (2009). Natural Gas Energy Efficiency Potential in Massachusetts GDS_2009_Natural_Gas_Energy_Efficiency_Potential_in_MA
4 : DNV (2024). C&I Impact Shape Study. 2024_DNV_C&I_Impact Shape Study
5 : NMR (2024). C&I Gas Prospective Net-to-Gross Omnibus Study.
6 : NMR (2024). C&I Prescriptive and Custom Electric Net-to-Gross Omnibus Study Final Report. 2024_NMR_C&I_Omnibus_Study
7 : NMR Group Inc (2021). O&M and Non-O&M NEI Study. 2021_NMR_CIOM and NonOM NEI Study
8 : DNV (2022). C&I Health and Safety Non-Energy Impacts (MA21X19-B-CIHSNEI). 2022_DNV_C&I_Heath_&_Safety_NEIs

3.52 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)	C&I Multifamily (CI_MF)	EC1d010
Pipe Wrap (Water Heating)	C&I Multifamily (CI_MF)	GC1d005

Algorithms for Calculating Primary Energy Impact:

Unit savings are deemed per linear foot of pipe insulation 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 Pipe Wrap (Water Heating):

Measure Name	Core Initiative	ΔkWh	ΔkW	ΔMMBtu
Pipe Wrap (Water Heating), Electric	CI_MF	9	0.01	
Pipe Wrap (Water Heating), Oil	CI_MF			0.07
Pipe Wrap (Water Heating), Propane	CI_MF			0.06
Pipe Wrap (Water Heating), Gas	CI_MF			0.06

Weighted averages for BC model

Measure Name	BCR ID	ΔkWh	ΔkW	Δ Oil MMBTUs	Δ Propane MMBTUs
Pipe Wrap (Water Heating)	EC1d010	7.3	0.01	0.01	0.00

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)	CI_MF	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	CI_MF	All	1.00	1.00	1.00	1.00	1.00	0.30	0.62
Pipe Wrap (Water Heating), Gas	CI_MF	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)	CI_MF	All	0.14	0.0	0.0	0.86

Non-Energy Impacts:

There are no non energy benefits identified for this measure.

Endnotes:

1 : Guidehouse (2024). Massachusetts Income-Eligible and Residential Coordinated Delivery Multifamily Impact Evaluation 2024_Guidehouse_MF_Impact_Report
2 : Guidehouse (2023). MA RBUECS Demand Impact Model
2023_Guidehouse_MA_RBUECS_Demand_Impact_Model
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 (2023). MA RBUECS Demand Impact Model
2023_Guidehouse_MA_RBUECS_Demand_Impact_Model
5 : Guidehouse (2021). Residential Programs Net-to-Gross Research of RCD and Select Products.
2021_Guidehouse_MA_Res_NTG_Final_Report

3.53 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	C&I Small Business Turnkey Retrofit (CI_SBTR)	EC1c026
Pre-Rinse Spray Valve	C&I Small Business Turnkey Retrofit (CI_SBTR)	GC1c021
Pre-Rinse Spray Valve	C&I Equipment Rebates & Instant Incentives (CI_ERII)	EC1e007
Pre-Rinse Spray Valve	C&I Equipment Rebates & Instant Incentives (CI_ERII)	GC1e001

Algorithms for Calculating Primary Energy Impact:

Unit savings are deemed and based on the following calculations and deemed inputs. 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		1,300	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[1]
GPM_{ee} = Flow rate of high efficiency installed PRSV, default 1.1 GPM[2]
Eff_{gas} = Water heater efficiency (natural gas), default 80% E_t[3]
Eff_{elec} = Water heater efficiency (electric), default 98% E_t[4]
T_{PRSV} = Average end-use temperature (°F), default 108°F[5]
T_{main} = Supply water temperature in water main (°F), default 55.7°F[6]
Hrs = Annual operating hours of PRSV, default 333 hrs[7]
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

Weighted averages for BC model

Measure Name	BCR ID	ΔkWh	ΔkW	Δ Oil MMBtu	Δ Propane MMBtu
Pre-Rinse Spray Valve	EC1e007	949	0	0.68	0.68
Pre-Rinse Spray Valve (Turnkey)	EC1c026	949	0	0.68	0.68

Baseline Efficiency:

The baseline efficiency case is 1.6 GPM spray valve.[1]

High Efficiency:

The high efficiency case is a low flow pre-rinse spray valve with an average flow rate of 1.1 GPM.[2]

Measure Life:

The measure life is 3 years.[8]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Pre-Rinse Spray Valve	CI_ERII, CI_SBTR	All	8	n/a	n/a	3

Other Resource Impacts:

There are water savings of 9,990 gallons per unit.[9]

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_ERII, CI_SBTR	All	1.00	n/a	1.00	n/a	n/a	n/a	n/a
Pre-Rinse Spray Valve, Electric	CI_ERII, CI_SBTR	All	1.00	1.00	n/a	1.00	1.00	0.54	0.56
Pre-Rinse Spray Valve, Oil	CI_ERII, CI_SBTR	All	1.00	n/a	1.00	n/a	n/a	n/a	n/a
Pre-Rinse Spray Valve, Propane	CI_ERII, CI_SBTR	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 from the 2024 C&I Impact Shape Study.[10]

Impact Factors for Calculating Net Savings:

Values from evaluation studies.[11] [12]

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Pre-Rinse Spray Valve, Gas (Turnkey)	CI_SBTR	All				0.82
Pre-Rinse Spray Valve, Gas	CI_ERII	All				0.93
Pre-Rinse Spray Valve, Electric/Oil/Propane (Turnkey)	CI_SBTR	All				0.964
Pre-Rinse Spray Valve, Electric/Oil/Propane	CI_ERII	All				0.877

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_ERII, CI_SBTR	All					$ 0.36	

Endnotes:

1 : Federal Standard – PRSV manufactured on or after January 1, 2006, and before January 28, 2019, shall have a flow rate of not more than 1.6 gallons per minute: https://www.epa.gov/watersense/pre-rinse-spray-valves
2 : Based on program maximum flowrate.
3 : 2022-05 Final Determination Technical Support Document Energy Conservation Program for Consumer Products and Certain Commercial and Industrial Equipment: Commercial Prerinse Spray Valves. Page 7-8. https://downloads.regulations.gov/EERE-2019-BT-STD-0034-0020/content.pdf
4 : 2022-05 Final Determination Technical Support Document Energy Conservation Program for Consumer Products and Certain Commercial and Industrial Equipment: Commercial Prerinse Spray Valves. Page 7-8. https://downloads.regulations.gov/EERE-2019-BT-STD-0034-0020/content.pdf
5 : 2022-05 Final Determination Technical Support Document Energy Conservation Program for Consumer Products and Certain Commercial and Industrial Equipment: Commercial Prerinse Spray Valves. Page 7-7 (based on 5 field studies) https://downloads.regulations.gov/EERE-2019-BT-STD-0034-0020/content.pdf
6 : 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 Based on Burch, J., and C. Christensen. Towards Development of an Algorithm for Mains Water Temperature. 2007. Proceedings of the 2007 ASES Annual Conference: Cleveland, OH.
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 7.2.3 Weighted Average Annual CPSV Operating Time (Weighted Average Operating Time Across Building Types) https://downloads.regulations.gov/EERE-2019-BT-STD0034-0020/content.pdf
2 : Per program administrator internal analysis.
8 : DNV GL (2021). Prescriptive Measures NRNC and ISP Results. 2021_DNV_Prescriptive Measures NRNC and ISP Results
9 : 2022-05 Final Determination Technical Support Document Energy Conservation Program for Consumer Products and Certain Commercial and Industrial Equipment: Commercial Prerinse Spray Valves. Page 7-7 (based on 5 field studies) https://downloads.regulations.gov/EERE-2019- BT-STD-0034-0020/content.pdf
10 : DNV (2024). C&I Impact Shape Study. 2024_DNV_C&I_Impact Shape Study
11 : NMR (2024). C&I Prescriptive and Custom Electric Net-to-Gross Omnibus Study Final Report. 2024_NMR_C&I_Omnibus_Study
12 : NMR (2024). C&I Gas Prospective Net-to-Gross Omnibus Study.
13 : NMR Group Inc (2021). O&M and Non-O&M NEI Study 2021_NMR_CIOM and NonOM NEI Study

3.54 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	C&I Small Business Turnkey Retrofit (CI_SBTR)	EC1c025
Thermostatic Shut-Off Valve	C&I Equipment Rebates & Instant Incentives (CI_ERII)	EC1e006
Thermostatic Shut-off Valve	C&I Equipment Rebates & Instant Incentives (CI_ERII)	GC1e005

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	
Standalone TSV, Gas			0.33
Standalone TSV, Oil			0.33
Standalone TSV, Propane			0.33

Weighted average for BC model:

Measure Name	BCR ID	ΔkWh	ΔkW	Δ Oil MMBtu	Δ Propane MMBtu
Thermostatic Shut-Off Valve	EC1e006	55.9	0.01	0.04	0.03
Thermostatic Shut-Off Valve (Turnkey)	EC1c025	55.9	0.01	0.04	0.03

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 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_ERII, CI_SBTR	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_ERII, CI_SBTR	All	1.00	1.00	n/a	1.00	1.00	0.54	0.56
Standalone TSV, Gas	CI_ERII	All	1.00	n/a	1.00	n/a	n/a	n/a	n/a
Standalone TSV, Oil	CI_ERII, CI_SBTR	All	1.00	n/a	1.00	n/a	n/a	n/a	n/a
Standalone TSV, Propane	CI_ERII, CI_SBTR	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 from the 2024 C&I Impact Shape Study.[5]

Impact Factors for Calculating Net Savings:

Net to gross values based on evaluated numbers.[6] [7]

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Standalone TSV, Electric/Oil/Propane	CI_ERII	All				0.877
Standalone TSV, Electric/Oil/Propane (Turnkey)	CI_SBTR	All				0.964
Standalone TSV, Gas	CI_ERII	All				0.84

Non-Energy Impacts:

C&I values are 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
Standalone TSV, Gas	CI_ERII	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 Gas Networks; 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 : DNV (2024). C&I Impact Shape Study. 2024_DNV_C&I_Impact Shape Study
6 : Tetra Tech (2021). C&I Prescriptive and Custom Net-to-Gross Omnibus Study.
2021_TetraTech_CI_PrescrCustom_NTG_Omnibus
7 : NMR (2024). C&I Prescriptive and Custom Electric Net-to-Gross Omnibus Study Final Report.
2024_NMR_C&I_Omnibus_Study
8 : NMR Group Inc (2021). O&M and Non-O&M NEI Study. 2021_NMR_CIOM and NonOM NEI Study

3.55 Hot Water - Steam Trap

Measure Code	COM-HVAC-ST
Market	Commercial
Program Type	Retrofit
Category	Water Heating

Measure Description:

Repair or replace malfunctioning low-pressure steam traps.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Steam Trap	C&I Existing Buildings (CI_EXST)	GC1b014
Steam Trap	C&I Small Business Turnkey Retrofit (CI_SBTR)	GC1c011
Steam Trap	C&I Equipment Rebates & Instant Incentives (CI_ERII)	GC1e022

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_EXST, CI_ERII, CI_SBTR	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_EXST, CI_ERII, CI_SBTR	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 2024 C&I NTG study[3] and Steam Traps and Boiler Efficiency Research – Phase II.[4]

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Steam Trap	CI_EXST, CI_ERII	All				1.00
Steam Trap	CI_SBTR	All				1.02

Non-Energy Impacts:

NEIs are from 2021 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
Steam Trap	CI_ERII, CI_SBTR	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 : NMR (2024). C&I Gas Prospective Net-to-Gross Omnibus Study.
4 : DNV (2022). Steam Traps and Boiler Efficiency Research – Phase II. 2022_DNV_Stram Trap and Boiler Efficiency
5 : NMR (2021). O&M and Non-O&M NEI Study 2021_NMR_CIOM and NonOM NEI Study

3.56 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	C&I Multifamily (CI_MF)	EC1d014
Thermostatic Shut-off Valve	C&I Multifamily (CI_MF)	GC1d013

Algorithms for Calculating Primary Energy Impact:

Unit kWh and MMBtus savings are deemed based on study results.[1] kW savings are calculated using the demand impact model.[2]

Measure Name	ΔkWh	ΔkW	Δ MMBtu
Thermostatic Shut-off Valve, Electric	76	0.02	
Thermostatic Shut-off Valve, Gas			0.42
Thermostatic Shut-off Valve, Oil			0.4
Thermostatic Shut-off Valve, Other			0.4

Weighted averages for BC model

Measure Name	BCR ID	ΔkWh	ΔkW	Δ Oil MMBTUs	Δ Propane MMBTUs
Thermostatic Shut-off Valve	EC1d014	62	0.02	0.05	0.03

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_MF	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	CI_MF	All	1.00	1.00	1.00	1.00	1.00	0.30	0.62
Thermostatic Shut-off Valve, Gas	CI_MF	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	CI_MF	All	0.14	0.0	0.0	0.86

Non-Energy Impacts:

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

Endnotes:

1 : Guidehouse (2024). Massachusetts Income-Eligible and Residential Coordinated Delivery Multifamily Impact Evaluation 2024_Guidehouse_MF_Impact_Report
2 : Guidehouse (2023). MA RBUECS Demand Impact Model 2023_Guidehouse_MA_RBUECS_Demand_Impact_Model
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 (2023). MA RBUECS Demand Impact Model 2023_Guidehouse_MA_RBUECS_Demand_Impact_Model
6 : Guidehouse (2021). Residential Programs Net-to-Gross Research of RCD and Select Products. 2021_Guidehouse_MA_Res_NTG_Final_Report

3.57 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	C&I Multifamily (CI_MF)	EC1d030
LED Fixture, Linear Indoor Common Area	C&I Multifamily (CI_MF)	EC1d031
LED Fixture, Outdoor Common Area	C&I Existing Building Retrofit (CI_MF)	EC1d032

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".

3.58 Lighting - C&I Metered Multi-Family Occupancy Sensors

Measure Code	COM-L-OS
Market	Commercial
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
Lighting Occupancy Sensor, Common Area	C&I Multifamily (CI_MF)	EC1d018

Algorithms for Calculating Primary Energy Impact:

Although this measure is reported within the C&I sector in order to follow Department directives regarding sector cross-subsidization, it is delivered as part of the Residential Turnkey Solutions core initiative and evaluated as such. Therefore, please refer to the residential TRM entry for the savings calculations for this measure: "Lighting - Occupancy Sensors".

3.59 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 - Interior	C&I Existing Buildings (CI_EXST)	EC1b021
Lighting Controls - Exterior	C&I Existing Buildings (CI_EXST)	EC1b022
Lighting Controls - Interior	C&I Small Business Turnkey Retrofit (CI_SBTR)	EC1c034
Lighting Controls - Exterior	C&I Small Business Turnkey Retrofit (CI_SBTR)	EC2a035

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 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.

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_ESXT, CI_SBTR	All	9	n/a	n/a	9

Other Resource Impacts:

There are fossil fuel heating penalties associated with lighting controls.[4] Please see the Lighting - Systems section of the TRM for penalties associated with midstream lighting controls.

Measure Name	Core Initiative	PA	MMBtu/kWh
Lighting Controls	CI_EXST, CI_SBTR	All	-0.000691

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	CI_SBTR	All	1.00	0.42	0.42	0.92	0.92	0.32	0.22
Lighting Controls – Exterior	CI_SBTR	All	1.00	0.42	0.42	0.92	0.92	0.32	0.22
Lighting Controls – Interior	CI_EXST	All	1.00	1.03	1.03	0.94	0.94	0.32	0.22
Lighting Controls – Exterior	CI_EXST	All	1.00	0.72	0.72	0.94	0.94	0.32	0.22

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.[5]
- Small C&I Existing Building Retrofit: RRs from statewide Pre/Post Occupancy Sensor study.[6]

Coincidence Factors:

Coincidence Factors are from the C&I Load Shape Study.[7]

Impact Factors for Calculating Net Savings:

Net-to-gross values are deemed based on study results.[8]

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Lighting Controls (All)	CI_EXST	All				0.909
Lighting Controls (All)	CI_SBTR	All				0.964

Non-Energy Impacts:

NEIs are based on 2021 NEI study.[9] and the 2022 Health & Safety NEI study.[10]

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_EXST, CI_SBTR	All			$0.130			

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 : DNV KEMA (2013). Impact Evaluation of 2010 Prescriptive Lighting Installations. DNV_KEMA_2013_Prescriptive_Ltg_Impact_Eval_PY2010
6 : The Cadmus Group (2012). Final Report, Small Business Direct Install Program: Pre/Post Occupancy Sensor Study. CADMUS_2012_SBDI_PrePostLightingControl_Final
7 : DNV (2024). C&I Impact Shape Study 2024_DNV_C&I_Impact Shape Study
8 : NMR (2024). C&I Prescriptive and Custom Electric Net-to-Gross Omnibus Study Final Report. 2024_NMR_C&I_Omnibus_Study
9 : NMR (2021). O&M and Non-O&M NEI Study. 2021_NMR_CIOM and NonOM NEI Study
10 : NMR (2022). C&I Health and Safety Non-Energy Impacts. 2022_DNV_C&I_Heath_&_Safety_NEIs

3.60 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 Existing Buildings (CI_EXST)	EC1b019
Lighting Systems - Exterior	C&I Existing Buildings (CI_EXST)	EC1b020
Lighting Systems - Interior	C&I Small Business Turnkey Retrofit (CI_SBTR)	EC1c032
Lighting Systems - Exterior	C&I Small Business Turnkey Retrofit (CI_SBTR)	EC1c033
Midstream - LED Linear Lamp (TLED) with Controls	C&I Equipment Rebates & Instant Incentives (CI_ERII)	EC1e048
Midstream - LED Linear Fixture with Controls	C&I Equipment Rebates & Instant Incentives (CI_ERII)	EC1e049
Midstream - High Bay / Low Bay with Controls	C&I Equipment Rebates & Instant Incentives (CI_ERII)	EC1e050
Midstream - LED Exterior with Controls	C&I Equipment Rebates & Instant Incentives (CI_ERII)	EC1e051

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, $Count_i = Count_j$).
$Watts_i$ = 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 (i.e., C&I Equipment Rebates & Instant Incentives) measures will calculate gross energy savings in the 2025-2027 term using annual hours of operation defined for the building type where the installation occurred. 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

Building Type	Hours of Use
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
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 retrofit installations, the high efficiency case is project-specific and is determined using actual fixture counts for the project and the Mass Save Wattage Tables.

Measure Life:

Measure lives are deemed based on study results for 2022.[6] AMLs for 2025-2027 are estimated based off of historical trajectory for planning purposes. AMLs for C&I Existing Buildings reflect fixtures with controls where only the controlled portion of the savings are claimed.

Application	Core Initiative	PA	2025	2026	2027
Lighting Systems Interior	CI_EXST	All	9	9	9
Lighting Systems Exterior	CI_EXST	All	9	9	9
Lighting System Interior	CI_SBTR	All	4	3	2
Lighting Systems Exterior	CI_SBTR	All	3	2	1
LED Linear Lamp (TLED) with Controls	CI_ERII	All	10	10	10
LED Linear Fixture with Controls	CI_ERII	All	10	10	10
High / Bay / Low Bay with Controls	CI_ERII	All	10	10	10
LED Exterior with Controls	CI_ERII	All	10	10	10

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_EXST	All	-0.000691

Measure Name	Core Initiative	PA	MMBtu/kWh
Lighting Systems Exterior	CI_EXST	All	n/a
Lighting Systems Interior	CI_SBTR	All	-0.00090
Lighting Systems Exterior	CI_SBTR	All	n/a
LED Linear Lamp (TLED) with Controls	CI_ERII	All	-0.000162
LED Linear Fixture with Controls	CI_ERII	All	-0.000162
High Bay / Low Bay with Controls	CI_ERII	All	-0.000329
LED Exterior with Controls	CI_ERII	All	n/a

Heating penalties for downstream, interior lighting systems (non-turnkey) are from the 12-month data logging study.[7] Penalties for interior, small business turnkey are from the 2018 small business lighting impact evaluation[8] . Penalties for midstream 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_EXST	All	1.00	1.03	1.03	0.94	0.94	0.32	0.22
Lighting Systems Exterior	CI_EXST	All	1.00	0.72	0.72	0.94	0.94	0.32	0.22
Lighting Systems Interior	CI_SBTR	All	1.00	0.93	0.93	0.91	1.03	0.88	0.71
Lighting Systems Exterior	CI_SBTR	All	1.00	0.93	0.93	0.91	1.03	0.32	0.86
LED Linear Fixture with Controls	CI_ERII	All	1.00	0.94	0.94	1.06	0.91	0.32	0.22
High Bay / Low Bay with Controls	CI_ERII	All	1.00	0.91	0.91	1.02	0.88	0.32	0.22
LED Linear Lamp (TLED) with Controls	CI_ERII	All	1.00	0.88	0.88	0.99	0.85	0.32	0.22
LED Exterior with Controls	CI_ERII	All	1.00	0.92	0.92	0.92	0.92	0.32	0.22

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 Midstream: 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.[13]
- 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.[14]
- 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.[15]

Coincidence Factors:

All coincidence factors are from the C&I Load Shape Impact Study.[16]

Impact Factors for Calculating Net Savings:

Net-to-gross values are based on study results.[17]

Measure Name	Core Initiative	PA	2025 NTG	2026 NTG	2027 NTG
Lighting Systems Interior	CI_EXST	All	0.909	0.909	0.909
Lighting Systems Exterior	CI_EXST	All	0.909	0.909	0.909
Lighting System Interior	CI_SBTR	All	0.924	0.884	0.844
Lighting System Exterior	CI_SBTR	All	0.924	0.884	0.844

Midstream Net-to-Gross for 2025-2027

Midstream lighting NTG are based on study results.[18]

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
LED Linear Lamp (TLED) with Controls	CI_ERII	All				0.909
LED Linear Fixture with Controls	CI_ERII	All				0.909
High Bay / Low Bay with Controls	CI_ERII	All				0.909
LED Exterior with Controls	CI_ERII	All				0.909

Non-Energy Impacts:

Non-energy benefits come from the 2021 NEI study.[19] Lighting controls come from the 2021 NEI study as well as the 2022 C&I Health & Safety NEI study.[22]

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_EXST	All			$0.130			
Lighting Systems Exterior	CI_EXST	All			$0.130			
Lighting Systems Interior	CI_SBTR	All			$0.048			
Lighting Systems Exterior	CI_SBTR	All			$0.048			
Lighting Midstream – LED Linear w/ Controls	CI_ERII	All			$0.116			
Lighting Midstream - High/Low Bay w/Controls	CI_ERII	All			$0.116			
Lighting Midstream - LED Linear Lamp (TLED) with Controls	CI_ERII	All			$0.116			
Lighting Midstream - LED Exterior with Controls	CI_ERII	All			$0.116			

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 GL (2021). Impact Evaluation of PY2019 Massachusetts C&I Upstream Lighting Initiative. 2021_DNV_Upstream_Lighting_Impact_Report
14 : DNV KEMA (2013). Impact Evaluation of 2010 Prescriptive Lighting Installations. DNV_KEMA_2013_Prescriptive_Ltg_Impact_Eval_PY2010
15 : DNV GL (2018). Impact Evaluation of PY2016 Massachusetts Commercial & Industrial Small Business Initiative: Phase I (Lighting). 2018_DNVGL_ERS_SBS_Impact
16 : DNV (2024). C&I Impact Shape Study 2024_DNV_C&I_Impact Shape Study
17 : NMR (2024). C&I Prescriptive and Custom Electric Net-to-Gross Omnibus Study. 2024_NMR_C&I_Omnibus_Study
18 : NMR (2024). C&I Prescriptive and Custom Electric Net-to-Gross Omnibus Study. The EEAC and the PAs negotiated to use the value for controlled lighting from this study for midstream, and to conduct an evaluation once there are enough participants in the redesigned program. 2024_NMR_C&I_Omnibus_Study
19 : NMR Group Inc (2021). O&M and Non-O&M NEI Study. 2021_NMR_CIOM and NonOM NEI Study
20 : NMR (2022). C&I Health and Safety Non-Energy Impacts. 2022_DNV_C&I_Heath_&_Safety_NEIs

3.61 Motor - Prescriptive Motors & VFD

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 Existing Buildings (CI_EXST)	EC1b023

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] [2] :

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/	3,721	396	657	2,015	2,040	3,561	941	903

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
High School								
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
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

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
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
Prescriptive - Motors & VFD	CI_EXST	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_EXST	All	1.00	0.94	n/a	1.00	1.00	0.55	0.46

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.

Coincidence Factors:

Coincident factors are derived from the C&I Loadshape study.[5]

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
VFD with Motor	CI_EXST	All				0.877

Non-Energy Impacts:

Non-energy benefits come from the C&I O&M Non-O&M NEI Study[8]and the C&I Health & Safety NEI Study.[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
VFD with motor	CI_EXST	All	$0.00	$0.00	$0.003	$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/HP estimates derived from Cadmus (2014). Variable Speed Drive Loadshape Project. Prepared for the NEEP Regional Evaluation, Measurement & Verification Forum. 2014_Cadmus_Variable_Speed_Drive_Loadshape_Project

2 : 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 (2024). C&I Impact Shape Study 2024_DNV_C&I_Impact Shape Study

6 : NMR Group, Inc. (2021). Prescriptive and Custom NTG 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
9 : DNV(2022). C&I Health & Safety NEI Study 2022_DNV_C&I_Heath_&_Safety_NEIs

3.62 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	C&I Small Business Turnkey Retrofit (CI_SBTR)	EC1c031

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)									
University/ College	3641	449	745	2316	2344	3220	1067	1023	3061

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
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
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})									

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	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	CI_SBTR	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}
Prescriptive - Motors & VFD	CI_SBTR	Eversource / Unitil	1.00	0.946	n/a	1.265	1.415	1.00	1.00
Prescriptive - Motors & VFD	CI_SBTR	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:

Coincidence factors are derived from the C&I Loadshape study.[5]

Impact Factors for Calculating Net Savings:

All PAs use statewide prescriptive net-to-gross results for non-residential end use measures.[6]

Measure Name	Core Initiative	PA	NTG
Prescriptive - Motors & VFD	CI_SBTR	All	0.94

Non-Energy Impacts:

Non-energy benefits come from the 2021 NEI study.[7]

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
Prescriptive - Motors & VFD	CI_SBTR	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
6 : NMR Group, Inc. (2024). C&I Omnibus Net-to-Gross (NTG) Study 2024_NMR_C&I_Omnibus_Study
7 : NMR Group Inc (2021). O&M and Non-O&M NEI Study. 2021_NMR_CIOM and NonOM NEI Study

3.63 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 Equipment Rebates & Instant Incentives (CI_ERII)	EC1e029
Electric Leaf blower	C&I Equipment Rebates & Instant Incentives (CI_ERII)	EC1e030
Electric Trimmer	C&I Equipment Rebates & Instant Incentives (CI_ERII)	EC1e031
Electric Chainsaw	C&I Equipment Rebates & Instant Incentives (CI_ERII)	EC1e032
Electric Forklift	C&I Equipment Rebates & Instant Incentives (CI_ERII)	EC1e033

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_ERII	-218	-0.23
Electric Leaf blower	CI_ERII	-0.78	0.00
Electric Trimmer	CI_ERII	-0.71	0.00
Electric Chainsaw	CI_ERII	-1.02	0.00
Electric Forklift	CI_ERII	-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_ERII	All	7	n/a	n/a	7
Electric Leaf blower	CI_ERII	All	2	n/a	n/a	2
Electric Trimmer	CI_ERII	All	2	n/a	n/a	2
Electric Chainsaw	CI_ERII	All	2	n/a	n/a	2
Electric Forklift	CI_ERII	All	8	n/a	n/a	8

Other Resource Impacts:

Measure Name	Core Initiative	PA	Gasoline (MMBTUs)[4]	Propane (MMBTUs)
Electric Lawnmower	CI_ERII	All	2.5	
Electric Leaf blower	CI_ERII	All	1.4	
Electric Trimmer	CI_ERII	All	1.4	
Electric Chainsaw	CI_ERII	All	1.4	
Electric Forklift	CI_ERII	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_ERII	All	1.00	1.00	1.00	1.00	1.00	0.55	0.00
Electric Leaf blower	CI_ERII	All	1.00	1.00	1.00	1.00	1.00	0.55	0.00
Electric Trimmer	CI_ERII	All	1.00	1.00	1.00	1.00	1.00	0.55	0.00
Electric Chainsaw	CI_ERII	All	1.00	1.00	1.00	1.00	1.00	0.55	0.00
Electric Forklift	CI_ERII	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 2024 Omnibus NTG study[6]

Measure Name	Core Initiative	PA	NTG
Electric Lawnmower	CI_ERII	All	0.877
Electric Leaf blower	CI_ERII	All	0.877
Electric Trimmer	CI_ERII	All	0.877
Electric Chainsaw	CI_ERII	All	0.877
Electric Forklift	CI_ERII	All	0.877

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
6 : (2024) NMR C&I Omnibus Net-to-Gross (NTG) Study 2024_NMR_C&I_Omnibus_Study

3.64 Other - Standards Adoption

Measure Code	COM-CM-CSA
Market	Commercial
Program Type	Lost Opportunity, New Construction
Category	Other

Measure Description:

Standards Advocacy work focuses on engaging with stakeholders to advocate for higher appliance standards. This Advocacy is on both the state and federal level.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Standards Adoption	C&I Equipment Rebates & Instant Incentives (CI_ERII)	EC1e054
Standards Adoption	C&I Equipment Rebates & Instant Incentives (CI_ERII)	GC1e029

Algorithms for Calculating Primary Energy Impact:

2025-2027 savings are based on Program Administrator activity in advocating for the passage of appliance standards passed in the 2021 Climate Act, and are based on study results.[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

Savings (kWh)			
Electric PA	**2025**	**2026**	**2027**
CLC	119,794	118,280	116,786
Eversource	863,320	852,413	841,644
National Grid	721,870	712,750	703,745
Unitil	19,825	19,574	19,327

Savings (MMBtu)			
Gas PA	**2025**	**2026**	**2027**
Berkshire	0.03	0.03	0.03
EGMA	0.19	0.19	0.19
Eversource	0.18	0.18	0.18
Liberty	0.03	0.03	0.03
National Grid	0.55	0.55	0.55
Unitil	0.01	0.01	0.01

Baseline Efficiency:

The baseline level of efficiency will also be determined on a case-by-case basis. The baseline level of efficiency would correspond to the appliance standard that would have been in place without the intervention of the Program Administrators.

High Efficiency:

The high efficiency case would be the appliance standard that was advocated for by the Program Administrators.

Measure Life:

Measure lives for Standards Adoption are based on evaluation results.[3]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Standards Adoption, Electric	CI_ERII	All	6	n/a	n/a	6
Standards Adoption, Gas	CI_ERII	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}
Standards Adoption	CI_ERII	All	1.00	1.00	1.00	1.00	1.00	0.80	0.82

In-Service Rates:

All PAs use 100% in service rate.

Realization Rates:
All PAs use 100% realization rates.

Coincidence Factors:
Coincidence Factors are based on study results.[4]

Impact Factors for Calculating Net Savings:

The attribution factor is based on study results.[5]

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Standards Adoption	CI_ERII	All	n/a	n/a	n/a	0.20

Non-Energy Impacts:

NEI values can be found in Appendix B. [6]

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 (2023). Appliance Standards Gross Savings. 2023_NMR_MA23X12-B-ASGS_Appliance Standards Gross Savings Report_FINAL_2023
4 : DNV (2024). C&I Impact Shape Study 2024_DNV_C&I_Impact Shape Study
5 : NMR (2023). Standard Promulgation and Attribution 2023_NMR_MA22X01-B-SPA_Standards Promulgation Attribution Report FINAL_19may23
6 : NMR Group Inc. (2021). C&I O&M and non-O&M NEI Study. 2021_NMR_CIOM and NonOM NEI Study

3.65 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, Tier 1	C&I Multifamily (CI_MF)	EC1d017
Smart Strip, Tier 1	C&I Equipment Rebates & Instant Incentives (CI_ERII)	EC1e001
Smart Strip, Tier 2	C&I Equipment Rebates & Instant Incentives (CI_ERII)	EC1e002
Smart Strip, Tier 1	C&I Multifamily (CI_MF)	GC1d017

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, Tier 1	CI_MF CI_ERII	105	0.01
Smart Strip, Tier 2	CI_ERII	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 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, Tier 1	CI_MF	All	0.73	0.92	0.92	0.92	1.00	1.00
Smart Strip, Tier 1	CI_ERII	All	0.83	0.92	0.92	0.92	1.00	1.00
Smart Strip, Tier 2	CI_ERII	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:

For CI_ERII the PAs use statewide prescriptive net-to-gross values based on the 2024 C&I Omnibus NTG Study. [7] For CI_MF the PAs the Residential Products NTG Report.[8]

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Smart Strip, Tier 1	CI_MF	All				0.92
Smart Strip, Tier 1/Tier 2	CI_ERII	All				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 (2023). MA RBUECS Demand Impact Model
2023_Guidehouse_MA_RBUECS_Demand_Impact_Model

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 (2024). C&I Prescriptive and Custom Electric Net-to-Gross Omnibus Study Final Report
2024_NMR_C&I_Omnibus_Study
8 : NMR Group, Inc. (2021). Residential Products NTG Report.
2021_NMR_Res_Products_NTG_Report

3.66 Refrigeration - Prescriptive Refrigeration

Measure Code	COM-R-PR
Market	Commercial
Program Type	Lost Opportunity, Retrofit
Category	Refrigeration

Measure Description:

Evaporator Fan Control- 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.

ECM Evaporator Fan Motors for Walk In Coolers- Installation of various sizes of electronically commutated motors (ECMs) in walk-in coolers and freezers to replace existing evaporator fan motors.

Cooler Night Cover- 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.

Case Motor Replacement- 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.

Door Heater Controls- 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.

Electronic Defrost Control- A control mechanism to skip defrost cycles when defrost is unnecessary.

Novelty Cooler Shutoff- 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.

The assumptions and algorithms for the measures above are specific to NRM products.

Lab Grade Cold Storage
Refrigerated Chef Base

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Prescriptive - Refrigeration	C&I Small Business Turnkey Retrofit (CI_SBTR)	EC1c027

Algorithms for Calculating Primary Energy Impact:

Evaporator Fan Control

$\Delta kWh = \Delta kWh_{Fan} + \Delta kWh_{Heat} + \Delta kWh_{Control}$
$\Delta kWh_{Fan} = kW_{Fan} * 8760 * \%OFF$
$\Delta kWh_{Heat} = \Delta kWh_{Fan} * 0.28 * Eff_{RS}$
$\Delta kWh_{Control} = [kW_{CP} * Hours_{CP} + kW_{Fan} * 8760 * (1-\%OFF)] * 5\%$
$\Delta kW = \Delta kWh / 8760$

Where :

ΔkWhFan= Energy savings due to evaporator being shut off
ΔkWhHeat= Energy savings due to reduced heat from the evaporator fans
ΔkWhControl = Energy savings due to the electronic controls on compressor and evaporator
kWFan = 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
%OFF = Percent of annual hours that the evaporator is turned off: 46%[2]
0.28 = Conversion of kW to tons: 3,413 Btuh/kW divided by 12,000 Btuh/ton.
EffRS = Efficiency of typical refrigeration system: 1.6 kW/ton[3]
kWCP = Total power demand of compressor motor and condenser fan calculated from equipment nameplate data and estimated 0.85 power factor[4] : Amps x Voltage x PF x √Phase
$Hours_{CP}$ = Equivalent annual full load hours of compressor operation: 4,072 hours[5]
5% = Reduced run-time of compressor and evaporator due to electronic temperature controls[6]
ΔkW = Average demand savings
8,760 = Hours per Year

ECM Evaporator Fan Motors for Walk-In Coolers

$\Delta kWh = \Delta kWh_{Fan} + \Delta kWh_{Heat}$
$\Delta kWh_{Fan} = kW_{Fan} * LRF * Hours$
$\Delta kWh_{Heat} = \Delta kWh_{Fan} * 0.28 * Eff_{RS}$
$\Delta kW = \Delta kWh / 8760$

Where:

ΔkWhFan = Energy savings due to increased efficiency of evaporator fan motor
ΔkWhHeat = Energy savings due to reduced heat from the evaporator fans
kWFan = Power demand of evaporator fan calculated from equipment nameplate data and estimated 0.55 power factor/adjustment[7] : Amps x Voltage x PF x √Phase
LRF = Load reduction factor for motor replacement (65%)[8]
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[9]
ΔkW = Average demand savings
8,760 = Hours per year

Cooler Night Cover

ΔkWh = (Width) x (Save) x (Hours)
ΔkW = (Width) x (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[10]
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

Case Motor Replacement

$\Delta kWh = \Delta kWh_{Motor} + \Delta kWh_{Heat}$
$\Delta kWh_{Motor} = kW_{Motor} \times LRF \times Hours$
$\Delta kWh_{Heat} = \Delta kWh_{Motor} \times 0.28 \times Eff_{rs}$
$\Delta kW = \Delta kWh/8760$

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.[11]
Hours = Average runtime of case motors (8,500 hours)[12]
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)[13]
ΔkW = Average demand savings
8,760 = Hours per year

Door Heater Controls

$\Delta kWh = kW_{DH} * \%OFF * 8760$
$\Delta kW = kW_{DH} * \%OFF$

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)[14]

Electronic Defrost Control

$\Delta kWh_{Defrost} = kW_{Defrost} \times Hours \times DRF$
$\Delta kWh_{Heat} = \Delta kWh_{Defrost} \times 0.28 \times Eff_{RS}$
$\Delta kWh = \Delta kWh_{Defrost} + \Delta kWh_{Heat}$
$\Delta kW = \Delta kWh/8760$

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%)[15]
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)[16]
ΔkW = Average demand savings
8,760 = Hours per year

Novelty Cooler Shutoff

$\Delta kWh = kW_{NC} * DC_{AVG} * Hours_{OFF}$
$\Delta kW = 0$

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[17]
$Hours_{OFF}$ = 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%[18]

Freezer/Cooler LEDs

Updates to deemed savings, algorithms, baseline efficiency, and/or high-efficiency edits are suggestions from the C&I Comprehensive TRM Review.[1]

$\Delta kWh = \Delta kWh_{LED} + \Delta kWh_{HeatFreezer}$
$\Delta kWh = \Delta kWh_{LED} + \Delta kWh_{HeatRefrigerator}$
$\Delta kWh_{HeatFreezer} = \Delta kWh_{LED} \times 0.28 \times Eff_{Freezer}$
$\Delta kWh_{HeatRefrigerator} = \Delta kWh_{LED} \times 0.28 \times EffRefrigerator$
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]
EffRefrigerator = Efficiency of typical refrigeration system: 1.05 kW/ton[3]

Baseline Efficiency:

Measure Name	Baseline Efficiency
Evaporator Fan Control	The baseline efficiency case assumes evaporator fans that run 8,760 annual hours with no temperature control.
ECM Evaporator Fan Motors for Walk-In Coolers	The baseline efficiency case is an existing evaporator fan motor.
Cooler Night Cover	The baseline efficiency case is the annual operation of open-display cooler cases.
Case Motor Replacement	The baseline efficiency case is the existing case motor.
Door Heater Controls	The baseline efficiency case is a cooler or freezer door heater that operates 8,760 hours per year without any controls.
Electronic Defrost Control	The baseline efficiency case is an evaporator fan electric defrost system that uses a time clock mechanism to initiate defrost.

Measure Name	Baseline Efficiency
Novelty Cooler Shutoff	The baseline efficiency case is the novelty coolers operating 8,760 hours per year.
Freezer/Cooler LEDs	The baseline efficiency case is the existing lighting fixtures in the cooler or freezer cases.

High Efficiency:

Measure Name	High Efficiency
Evaporator Fan Control	The high efficiency case is the use of an energy management system to control evaporator fan and compressor operation based on temperature.
ECM Evaporator Fan Motors for Walk In Coolers	The high efficiency case is the replacement of existing evaporator fan motors with ECMs.
Cooler Night Cover	The high efficiency case is the use of night covers to protect the exposed area of display cooler cases during unoccupied hours.
Case Motor Replacement	The high efficiency case is the replacement of the existing case motor with an ECM.
Door Heater Controls	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.[19]
Electronic Defrost Control	The high efficiency case is an evaporator fan defrost system with electric defrost controls.
Novelty Cooler Shutoff	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.
Freezer/Cooler LEDs	The high efficiency case is the installation of LED lighting fixtures on the cooler or freezer cases, replacing the existing lighting fixtures.

Measure Life:

This measure has been determined to be an add on single baseline measure for retrofit installations.[20] [21]

Measure Name	PA	EUL	OYF	RUL	AML
Evaporator Fan Control	All	10	1	n/a	10
ECM Evaporator Fan Motors for Walk In Coolers	All	9	1	n/a	9

Measure Name	PA	EUL	OYF	RUL	AML
Cooler Night Cover	All	10	1	n/a	10
Case Motor Replacement	All	15	1	n/a	15
Door Heater Controls	All	10	1	n/a	10
Electronic Defrost Control	All	10	1	n/a	10
Novelty Cooler Shutoff	All	10	1	n/a	10
Freezer/Cooler LEDs	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}
Prescriptive - Refrigeration	CI_SBTR	CLC, NGRID	1.00	1.05	1.00	0.94	1.17	0.68	0.72
Prescriptive - Refrigeration	CI_SBTR	Eversource, Unitil	1.00	0.95	1.00	1.27	1.42	0.68	0.72

In-Service Rates:

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

Realization Rates:

Realization rates based on small business non-lighting impact evaluation of PY2017 projects[22] .

Coincidence Factors:

Coincident factors are derived from the C&I Loadshape study[28] .

Impact Factors for Calculating Net Savings:

All PAs use statewide prescriptive net-to-gross values based on study results.[29]

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Prescriptive - Refrigeration	CI_SBTR	All				0.964

Non-Energy Impacts:

NEIs are based on the O&M and Non-O&M NEI Study[25]

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
Prescriptive - Compressed Air	CI_EXST	All	$0.00	$0.00	$0.001	$0.00	$0.00	$0.00

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 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
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 : This value is an estimate by NRM based on hundreds of downloads of hours of use data from the electronic controller.
5 : Conservative value based on 15 years of NRM field observations and experience.
6 : 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
7 : Conservative value based on 15 years of NRM field observations and experience.
8 : 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
9 : 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
10 : 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_Refrigerated_Display_Case
11 : Load factor is an estimate by NRM based on several pre- and post-meter readings of installations
12 : Conservative value based on 15 years of NRM field observations and experience.
13 : 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
14 : 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
15 : 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.
16 : 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
17 : Conservative value based on 15 years of NRM field observations and experience.
18 : 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
19 : California eTRM. (2020). https://www.caetrm.com/measure/SWFS016/01/
19 : 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
20 : 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
21 : Energy & Resource Solutions (2005). Measure Life Study. ERS_2005_Measure_Life_Study
22 : DNV GL. (2019). Impact Evaluation of PY 2017 Small Business Initiative Non-lighting measures. Final Report MA19C03-E-SBIMPCT 03202020
23 : DNV(2024). C&I Impact Shape Study. 2024_DNV_C&I_Impact Shape Study
24 : NMR(2024). C&I Electric Omnibus NTG Study. 2024_NMR_C&I_Omnibus_Study
25 : NMR(2021). C&I O&M and Non-O&M NEI Study. 2021_NMR_CIOM and NonOM NEI Study

3.67 Refrigeration - Refrigeration/ Freezer

Measure Code	COM-R-RFR
Market	Commercial
Program Type	Early Replacement, Lost Opportunity, New Construction
Category	Food Service and Cooking Equipment, Refrigeration

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Midstream - Refrigeration	C&I Equipment Rebates & Instant Incentives (CI_ERII)	EC1e039

Algorithms for Calculating Primary Energy Impact:

For lab grade equipment, savings are deemed (average across all equipment types).[1] [2]

Refrigerator and Freezer unit savings are deemed in accordance with the following table and based on the Energy Star Commercial Kitchen Equipment Calculator.[3]

Refrigerated Chef Base savings are found using the following calculations:
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

Description	kWh	kW[4]
Lab Grade Cold Storage	2,712	0.310
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

Description	kWh	kW[4]
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
Refrigerated Chef Base, 35-54"	1,051	0.12
Refrigerated Chef Base, 55-73"	1,637	0.18
Refrigerated Chef Base, 74-89"	1,985	0.21
Refrigerated Chef Base, 90-120"	2,673	0.29

For the upstream HECU measure, prescriptive deemed savings are claimed based on a unit's temperature application, 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[5] :

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

Temp	Phase	HP	Scroll Compressor	Condenser Fan(s)	Floating Head Pressure Controls	Total
		4	0.30654	0.16487	0.29764	0.76905
		4.5	0.31200	0.16780	0.30294	0.78275
		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
	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

Temp	Phase	HP	Scroll Compressor	Condenser Fan(s)	Floating Head Pressure Controls	Total
		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

Weighted average for BC model

Measure Name	BCR ID	kWh	kW
Midstream - Refrigeration	EC1e039	1,176	0.24

Baseline Efficiency:

For Refrigerators and Freezers, the baseline efficiency case is a refrigerator or freezer with standard energy consumption. 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 is an Energy Star rated refrigerator or freezer. 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 12 years.[6]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Refrigeration	CI_ERII	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	Core Initiative	PA	ISR	SPF	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Refrigeration	CI_ERII	All	1.00	1.00	1.00	n/a	1.00	1.00	0.68	0.72

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 based on the C&I Loadshape Study.[7]

Impact Factors for Calculating Net Savings:

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

Measure	Core Initiative	PA	FR	SO	NPSO	NTG
Refrigeration	CI_ERII	All	25.0%	0.2%	8.5%	87.7%

Non-Energy Impacts:

The non-energy impacts are based on study results.[9]

Measure	PA	Annual $ per Unit	One-time $ per Unit	Annual $ per kWh	One-time $ per kWh	Annual $ per Therm	One-time $ per Therm
Refrigeration	All	$0.00	$0.00	$0.01	$0.00	$0.00	$0.00

Endnotes:

1 : Covid Lab Equipment 2021 MA-RI Forecast by Percentage of Sales 012821
2 : DNV. (2023). Freezers (fix name) 2023_DNV_MA23C02-B-ISPREPOS_ULT_Freezers
3 : ENERGY STAR Calculator - New Baselines and Efficiencies 082721
4 : DNV. (2024). C&I Impact Shape Study. 2024_DNV_C&I_Impact Shape Study
5 : Ecotrope. (2003). Natural Gas Efficiency and Conservation Measure Resource Assessment. Ecotrope_2003_Natural_Gas_Efficiency_and_Conservation_Measure_Resource_Assessment
6 : ENERGY STAR Calculator - New Baselines and Efficiencies 082721
7 : DNV. (2024). C&I Impact Shape Study. 2024_DNV_C&I_Impact Shape Study
8 : NMR Group, Inc. (2021). C&I Prescriptive and Custom Net to Gross Omnibus Study 2021_NMR_C&I_Omnibus_NTG
9 : NMR, Group Inc. (2021). O&M and Non-O&M NEI Study 2021_NMR_CIOM and NonOM NEI Study

3.68 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 Misers	C&I Small Business Turnkey (CI_SBTR)	EC1c028
Vending Misers	C&I Multifamily (CI_MF)	EC1d019
Midstream - Vending Miser	C&I Equipment Rebates & Instant Incentives (CI_ERII)	EC1e040

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

Rolled up savings that match the BC model are in the table below.

Measure Name	Core Initiative	ΔkWh	ΔkW
Vending Misers	CI_SBTR CI_ERII	1,054	0.21

For C&I Multifamily, unit savings are deemed based on study results.[2] Demand savings are derived from the demand impact model which is developed as part of the Residential Baseline Study.[3]

Measure Name	Core Initiative	ΔkWh	ΔkW
Vending Misers	CI_MF	1,612	0.32

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.[3] [4]

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Vending Misers	CI_SBTR CI_MF CI_ERII	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}
Vending Misers	CI_SBTR	National Grid Unitil	1.00	0.95	1.00	1.27	1.42	0.68	0.72
Vending Misers	CI_SBTR	Eversource CLC	1.00	1.05	1.00	0.94	1.17	0.68	0.72

Measure Name	Core Initiative	PA	ISR	RR_E	RR_{NE}	RR_{SP}	RR_{WP}	CF_{SP}	CF_{WP}
Vending Misers	CI_MF	All	1.00	1.00	1.00	1.00	1.00	0.68	0.72
Vending Misers - Midstream	CI_ERII	All	1.00	1.00	1.00	1.00	1.00	0.68	0.72

In-Service Rates:

Assume 100% in service rate until evaluated.

Realization Rates:

Realization rates are set to 100% until evaluated for CI_MF and CI_ERII. For CI_SBTR realization rates are based on evaluation results.[5]

Coincidence Factors:

Coincidence factors derived from C&I Loadshape Model.[6]

Impact Factors for Calculating Net Savings:

All PAs use statewide prescriptive net-to-gross results for non-residential end uses.[7] For C&I Multifamily the PAs use results from a multifamily evaluation.[8]

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Vending Misers	CI_ERII	All				0.877
Vending Misers	CI_SBTR	All				0.964
Vending Misers	CI_MF	All	0.14	0.00	0.00	0.86

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
Vending Misers	CI_SBTR CI_ERII	All	$0.00	$0.00	$0.001	$0.00	$0.00	$0.00
Vending Misers	CI_MF	All	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00

Endnotes:

1 : USA Technologies Energy Management Product Sheets (2006).
USA_Tech_2006_Energy_Management_Product_Sheets
2 : Guidehouse (2024). Massachusetts Income-Eligible and Residential Coordinated Delivery

Multifamily Impact Evaluation 2024_Guidehouse_MF_Impact_Report
3 : Guidehouse (2023). MA RBUECS Demand Impact Model
2023_Guidehouse_MA_RBUECS_Demand_Impact_Model
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 : DNV (2024). C&I Impact Shape Study 2024_DNV_C&I_Impact Shape Study
7 : NMR (2024). C&I Prescriptive and Custom Electric Net-to-Gross Omnibus Study Final Report
2024_NMR_C&I_Omnibus_Study
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. (2021). O&M and Non-O&M NEI Study. 2021_NMR_CIOM and NonOM NEI Study

3.69 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
CINC High Rise (Multifamily)	C&I New Buildings & Major Renovations (CI_NB&MR)	EC1a072

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

3.70 Whole Building - Embodied Carbon

Measure Code	COM-WB-EC
Market	Commercial
Program Type	Carbon Mitigation
Category	Whole Building

Measure Description:

Measures that reduce the cradle-to-gate (materials and construction phase) GWP intensity of a structure.

BCR Measure IDs:

Measure Name	Core Initiative	BCR Measure ID
Embodied Carbon	C&I New Buildings & Major Renovations (CI_NB&MR)	EC1a071
Embodied Carbon	C&I Multifamily (CI_MF)	EC1a072

Algorithms for Calculating Primary Energy Impact:

No primary energy impacts.

Baseline Efficiency:

The baseline case is whatever materials would be used for the structure absent the program.

High Efficiency:

The high efficiency case is the bill of materials for the structure post program.

Measure Life:

Measure Name	Core Initiative	PA	EUL	OYF	RUL	AML
Embodied Carbon	CI_NB&MR and CI_MF	Statewide	1	n/a	n/a	1

Other Resource Impacts:

This measure is claiming credit for reduced GWP intensity of the built structure, as compared to the baseline case (e.g. from using locally sourced materials with fewer transport-associated GHG emissions, or using low- or zero-carbon concrete, etc.).

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}
Embodied Carbon	CI_NB&MR and CI_MF	Statewide	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Impact Factors for Calculating Net Savings:

Measure Name	Core Initiative	PA	FR	SO_P	SO_{NP}	NTG
Embodied Carbon	CI_NB&MR and CI_MF	Statewide	n/a	n/a	n/a	1.0

Non-Energy Impacts:

This measure reflects only Social Cost of Carbon impacts from reduced GWP intensity.

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
Multifamily	0.68	0.45

[3] IECC 2018 Interior Lighting Power Allowances: Building Area method, adapted from Table C405.3.2(1) with adjustments for MA code enhancements

Building Type	2018 IECC LPD (W/ft^2)	2018 IECC w/ MA enhancements LPD (W/ft^2)
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

[4] IECC 2018 Interior Lighting Power Allowances: Space-by-Space Method, Table C405.3.2(2)

Common Space Types	LPD Allowances, W/ft2
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

Common Space Types	LPD Allowances, W/ft2
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

Common Space Types	LPD Allowances, W/ft2
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

Common Space Types	LPD Allowances, W/ft2
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

Common Space Types	LPD Allowances, W/ft2
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
LED Lighting Fixtures		
1L002	2 WATT LED	2
1L003	3 WATT LED	3
1L004	4 WATT LED	04
1L005	5 WATT LED	05
1L006	6 WATT LED	06
1L007	7 WATT LED	07
1L008	8 WATT LED	08
1L009	9 WATT LED	09
1L010	10 WATT LED	10
1L011	11 WATT LED	11
1L012	12 WATT LED	12
1L013	13 WATT LED	13
1L014	14 WATT LED	14
1L015	15 WATT LED	15
1L016	16 WATT LED	16
1L017	17 WATT LED	17
1L018	18 WATT LED	18
1L019	19 WATT LED	19
1L020	20 WATT LED	20
1L021	21 WATT LED	21
1L022	22 WATT LED	22
1L023	23 WATT LED	23
1L024	24 WATT LED	24
1L025	25 WATT LED	25
1L026	26 WATT LED	26
1L027	27 WATT LED	27
1L028	28 WATT LED	28
1L029	29 WATT LED	29
1L030	30 WATT LED	30
1L031	31 WATT LED	31
1L032	32 WATT LED	32
1L033	33 WATT LED	33
1L034	34 WATT LED	34
1L035	35 WATT LED	35
1L036	36 WATT LED	36
1L037	37 WATT LED	37
1L038	38 WATT LED	38
1L039	39 WATT LED	39
1L040	40 WATT LED	40
1L041	41 WATT LED	41
1L042	42 WATT LED	42
1L043	43 WATT LED	43
1L044	44 WATT LED	44
1L045	45 WATT LED	45
1L046	46 WATT LED	46
1L047	47 WATT LED	47
1L048	48 WATT LED	48
1L049	49 WATT LED	49
1L050	50 WATT LED	50
1L053	53 WATT LED	53
1L055	55 WATT LED	55

Device Code	Device Description	Rated Watts
1L060	60 WATT LED	60
1L063	63 WATT LED	63
1L071	71 WATT LED	71
1L070	70 WATT LED	70
1L073	73 WATT LED	73
1L075	75 WATT LED	75
1L080	80 WATT LED	90
1L085	85 WATT LED	85
1L090	90 WATT LED	90
1L095	95 WATT LED	95
1L100	100 WATT LED	100
1L101	101 WATT LED	101
1L106	106 WATT LED	106
1L107	107 WATT LED	107
1L116	116 WATT LED	116
1L120	120 WATT LED	120
1L125	125 WATT LED	125
1L130	130 WATT LED	130
1L131	131 WATT LED	131
1L135	135 WATT LED	135
1L139	139 WATT LED	139
1L140	140 WATT LED	140
1L145	145 WATT LED	145
1L150	150 WATT LED	150

Device Code	Device Description	Rated Watts
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
1L240	240 WATT LED	240
1L256	256 WATT LED	256
1L279	279 WATT LED	279

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

Device Code	Device Description	Rated Watts
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

Device Code	Device Description	Rated Watts
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	58
	LOW PWR	
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

Device Code	Device Description	Rated Watts
2F28EEH	2L4’ 28WT8EE/ELEE HIGH PWR	64
2F28EEE	2L4’ 28W T8EE/ELEE	48
2F28EEL	2L4’ 28W T8EE/ELEE LOW PWR	42
3F28EEH	3L4’ 28W T8EE/ELEE HIGH PWR	96
3F28EEE	3L4’ 28W T8EE/ELEE	72
3F28EEL	3L4’ 28W T8EE/ELEE LOW PWR	63
4F28EEH	4L4’ 28W T8EE/ELEE HIGH PWR	126
4F28EEE	4L4’ 28W T8EE/ELEE	94
4F28EEL	4L4’ 28W T8EE/ELEE LOW PWR	83
1F30EEH	1L4’ 30W T8EE/ELEE HIGH PWR	36
1F30EEE	1L4’ 30W T8EE/ELEE	26
1F30EEL	1L4’ 30W T8EE/ELEE LOW PWR	24
2F30EEH	2L4’ 30WT8EE/ELEE HIGH PWR	69
2F30EEE	2L4’ 30W T8EE/ELEE	52
2F30EEL	2L4’ 30W T8EE/ELEE LOW PWR	45
3F30EEH	3L4’ 30W T8EE/ELEE HIGH PWR	103
3F30EEE	3L4’ 30W T8EE/ELEE	77
3F30EEL	3L4’ 30W T8EE/ELEE LOW PWR	68
4F30EEH	4L4’ 30W T8EE/ELEE HIGH PWR	133
4F30EEE	4L4’ 30W T8EE/ELEE	101
4F30EEL	4L4’ 30W T8EE/ELEE LOW PWR	89
1F32EEH	1L4’ 32W T8EE/ELEE HIGH PWR	38
1F32EEE	1L4’ 32W T8EE/ELEE	28
1F32EEL	1L4’ 32W T8EE/ELEE LOW PWR	25
2F32EEH	2L4’ 32W T8EE/ELEE HIGH PWR	73
2F32EEE	2L4’ 32W T8EE/ELEE	53
2F32EEL	2L4’ 32W T8EE/ELEE LOW PWR	47
3F32EEH	3L4’ 32W T8EE/ELEE HIGH PWR	109
3F32EEE	3L4’ 32W T8EE/ELEE	82
3F32EEL	3L4’ 32W T8EE/ELEE LOW PWR	72
4F32EEH	4L4’ 32W T8EE/ELEE HIGH PWR	141
4F32EEE	4L4’ 32W T8EE/ELEE	107
4F32EEL	4L4’ 32W T8EE/ELEE LOW PWR	95
5F32EEH	5L4’ 32W T8EE/ELEE HIGH PWR	182
6F28EEE	6L4’ 28W T8EE/ELEE	144
6F28EEH	6L4’ 28W T8EE/ELEE HIGH PWR	192
6F28EEL	6L4’ 28W T8EE/ELEE LOW PWR	126
6F30EEE	6L4’ 30W T8EE/ELEE	154
6F30EEL	6L4’ 30W T8EE/ELEE LOW PWR	136

Device Code	Device Description	Rated Watts
6F32EEH	6L4’ 32W T8EE/ELEE HIGH PWR	218
6F32EEE	6L4’ 32W T8EE/ELEE	168
6F32EEL	6L4’ 32W T8EE/ELEE LOW PWR	146
7F32EEH	7L4’ 32W T8EE/ELEE HIGH PWR	250
Eight Foot T8 Systems		
1F59SSE	1L8’ T8/ELIG	60
1F80SSE	1L8’ T8 HO/ELIG	85
2F59SSE	2L8’ T8/ELIG	109
2F59SSL	2L8’ T8/ELIG LOW PWR	100
2F80SSE	2L8’ T8 HO/ELIG	160
Tandem Wired T8 High Efficient		
2W32EEE	2L4’ TW T8EE/ELIG	27
2W32EEL	2L4’ TW T8EE/ELEE LOW PWR	24
3W32EEE	3L4’ TW T8EE/ELIG	39
3W32EEL	3L4’ TW T8EE/ELEE LOW PWR	34
4W32EEE	4L4’ TW T8EE/ELIG	51
4W32EEL	4L4’ TW T8EE/ELEE LOW PWR	45
Tandem-Wired Fluorescent Systems		
2W32SSE	2L4’ TW T8/ELIG	30
2W32SSH	2L4’ TW T8/HI-LUM	39
2W40SEE	2L4’ TW EE/ELIG	30
2W40SSE	2L4’ TW STD/ELIG	36
2W59HSE	2L8’ TW T8 HO/ELIG	80
2W59SSE	2L8’ TW T8/ELIG	55
2W96HEE	2L8’ TW HO-EE/ELIG	85
2W96HSE	2L8’ TW HO-STD/ELIG	98
2W96SEE	2L8’ TW EE/ELIG	55
2W96SSE	2L8’ TW STD/ELIG	67
3W32SSE	3L4’ TW T8/ELIG	29
4D17SSE	4L2’ TW T8/ELIG	31
4D32EEE	4L4’ DTW T8EE/ELIG	51
4D32EEL	4L4’ DTW T8EE/ELEE LOW PWR	45
4D32SSE	4L4’ DTW T8/ELIG	53
4D32SSL	4L4 DTWT8/ELIG LOW POWER	49
4W32SSE	4L4’ TW T8/ELIG	27
4W32SSL	4L4 TWT8/ELIG LOW POWER	25
LED Lighting Fixtures		
1L002	2 WATT LED	2
1L003	3 WATT LED	3
1L004	4 WATT LED	4
1L005	5 WATT LED	5
1L006	6 WATT LED	6
1L007	7 WATT LED	7
1L008	8 WATT LED	8
1L009	9 WATT LED	9
1L010	10 WATT LED	10
1L011	11 WATT LED	11

Device Code	Device Description	Rated Watts
1L012	12 WATT LED	12
1L013	13 WATT LED	13
1L014	14 WATT LED	14
1L015	15 WATT LED	15
1L016	16 WATT LED	16
1L017	17 WATT LED	17
1L018	18 WATT LED	18
1L019	19 WATT LED	19
1L020	20 WATT LED	20
1L021	21 WATT LED	21
1L022	22 WATT LED	22
1L023	23 WATT LED	23
1L024	24 WATT LED	24
1L025	25 WATT LED	25
1L026	26 WATT LED	26
1L027	27 WATT LED	27
1L028	28 WATT LED	28
1L029	29 WATT LED	29
1L030	30 WATT LED	30
1L031	31 WATT LED	31
1L032	32 WATT LED	32
1L033	33 WATT LED	33
1L034	34 WATT LED	34
1L035	35 WATT LED	35
1L036	36 WATT LED	36
1L037	37 WATT LED	37

Device Code	Device Description	Rated Watts
1L038	38 WATT LED	38
1L039	39 WATT LED	39
1L040	40 WATT LED	40
1L041	41 WATT LED	41
1L042	42 WATT LED	42
LED Lighting Fixtures		
1L043	43 WATT LED	43
1L044	44 WATT LED	44
1L045	45 WATT LED	45
1L046	46 WATT LED	46
1L047	47 WATT LED	47
1L048	48 WATT LED	48
1L049	49 WATT LED	49
1L050	50 WATT LED	50
1L053	53 WATT LED	53
1L055	55 WATT LED	55
1L060	60 WATT LED	60
1L063	63 WATT LED	63
1L070	70 WATT LED	70
1L071	71 WATT LED	71
1L073	73 WATT LED	73
1L075	75 WATT LED	75
1L080	90 WATT LED	90
1L085	85 WATT LED	85
1L090	90 WATT LED	90
1L095	95 WATT LED	95

Device Code	Device Description	Rated Watts
1L100	100 WATT LED	100
1L101	101 WATT LED	101
1L106	106 WATT LED	106
1L107	107 WATT LED	107
1L116	116 WATT LED	116
1L120	120 WATT LED	120
1L125	125 WATT LED	125
1L130	130 WATT LED	130
1L131	131 WATT LED	131
1L135	135 WATT LED	135
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

Device Code	Device Description	Rated Watts
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
1L240	240 WATT LED	240
1L256	256 WATT LED	256
1L279	279 WATT LED	279
1LED015	15 Watt LED	15

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

[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]

[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 Low-Income 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	One time per Therm
Residential	RNC Heating		$142.33					
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		$142.33					
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					

Sector	NEI Description	NEI Category	Annual per Unit	One time per Unit	Annual per kWh	One time per KWh	Annual per Therm	One time per Therm
Residential	Residential Insulation	Home Durability	$9.82					
Residential	Residential Insulation	Health Benefits	$0.80					
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 Furnace		$99.74					
Residential	Residential Furnace	Thermal Comfort	$36.35					
Residential	Residential Furnace	Home Durability	$11.53					
Residential	Residential Furnace	Equipment Maintenance	$50.69					
Residential	Residential Furnace	Health Benefits	$1.17					
Residential	Residential Water Heater	Home Durability	$0.70					

Sector	NEI Description	NEI Category	Annual per Unit	One time per Unit	Annual per kWh	One time per KWh	Annual per Therm	One time per Therm
	Replacement							
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 Insulation	Health Benefits	$0.80					
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					

Sector	NEI Description	NEI Category	Annual per Unit	One time per Unit	Annual per kWh	One time per KWh	Annual per Therm	One time per Therm
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 Thermostat	Reduced Tenant Complaints	$2.16					
Residential	Residential MF Common-Area Lighting	O&M	$26.00		$0.03			
Residential	Residential Retail Thermostats		$3.63					
Residential	Residential Retail Thermostats	Thermal Comfort	$3.99					
Residential	Residential Retail	Home Durability	$1.33					

Sector	NEI Description	NEI Category	Annual per Unit	One time per Unit	Annual per kWh	One time per KWh	Annual per Therm	One time per Therm
	Thermostats							
Residential	Residential Retail Thermostats	Health Benefits	$0.13					
Residential	Residential Retail Heat Pump		$8.11					
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 Pump	Health Benefits						
Residential	Residential Retail Mini Split Heat Pump		$4.21					
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 - MSHP Displacing		$196.46					

Sector	NEI Description	NEI Category	Annual per Unit	One time per Unit	Annual per kWh	One time per KWh	Annual per Therm	One time per Therm
	Electric Heat							
Residential	Residential - MSHP Displacing Electric Heat	Thermal Comfort						
Residential	Residential - MSHP Displacing Electric Heat	Home Durability						
Residential	Residential - MSHP Displacing Electric Heat	Equipment Maintenance						
Residential	Residential - MSHP Displacing Electric Heat	Health Benefits						
Residential	Residential - MSHP Displacing Electric Heat	Noise Reduction						
Residential	Residential - Windows	Property Value Increase	$6.72					
Residential	Residential - Cooking Induction Stove		$194.49	$(57.78)				
Residential	Residential - MSHP Integrated Controls Retrofit		$292.19					
Residential	Residential - Central HP partial displacement		$56.18					
Residential	Residential - MSHP partial displacement		$104.35					

Sector	NEI Description	NEI Category	Annual per Unit	One time per Unit	Annual per kWh	One time per KWh	Annual per Therm	One time per Therm
Residential	Residential - Central HP full displacement		$64.24					
Residential	Residential - MSHP full displacement		$94.14					
Residential	Residential - Air-to-Water displacement		$46.85					
Residential	Residential - GSHP displacement - Closed Loop		$75.48					
Residential	Residential - CVEO Battery Storage		$162.08					
Low-Income	IE Rate-Discount Only		$-	$-	Varies by PA	$0.01	Varies by PA	$-
Low-Income	IE Rate-Discount Only	Rate Discounts			Varies by PA		Varies by PA	
Low-Income	IE Rate-Discount Only	Price Hedging				$0.01		$-
Low-Income	IE SF Participant		$10.37	$56.00	Varies by PA	$0.01	Varies by PA	$-
Low-Income	IE SF Participant	Arrearages	$2.61					
Low-Income	IE SF Participant	Bad Debt Write-offs	$3.74					
Low-Income	IE SF Participant	Terminations and Reconnections	$0.43					
Low-Income	IE SF Participant	Customer Calls and Collections	$0.58					
Low-Income	IE SF Participant	Notices	$0.34					
Low-Income	IE SF	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	One time per Therm
	Participant							
Low-Income	IE SF Participant	Lighting Quality and Lifetime		$56.00				
Low-Income	IE SF Participant	Rate Discounts			Varies by PA		Varies by PA	
Low-Income	IE SF Participant	Price Hedging				$0.01		$-
Low-Income	IE SF Weatherization		$558.21	$-	Varies by PA	$0.01	Varies by PA	$-
Low-Income	IE SF Weatherization	Thermal Comfort	$66.02					
Low-Income	IE SF Weatherization	Noise Reduction	$29.95					
Low-Income	IE SF Weatherization	Home Durability	$19.37					
Low-Income	IE SF Weatherization	Health Benefits	$423.23					
Low-Income	IE SF Weatherization	Improved Safety	$19.64					
Low-Income	IE SF Weatherization	Rate Discounts			Varies by PA		Varies by PA	
Low-Income	IE SF Weatherization	Price Hedging				$0.01		$-
Low-Income	IE SF Air Sealing		$295.21	$-	Varies by PA	$0.01	Varies by PA	$-
Low-Income	IE SF Air Sealing	Thermal Comfort	$35.89					
Low-Income	IE SF Air Sealing	Noise Reduction	$16.39					
Low-Income	IE SF Air Sealing	Home Durability	$10.61					
Low-Income	IE SF Air Sealing	Health Benefits	$230.08					

Sector	NEI Description	NEI Category	Annual per Unit	One time per Unit	Annual per kWh	One time per KWh	Annual per Therm	One time per Therm
Low-Income	IE SF Air Sealing	Improved Safety	$2.24					
Low-Income	IE SF Air Sealing	Rate Discounts			Varies by PA		Varies by PA	
Low-Income	IE SF Air Sealing	Price Hedging				$0.01		$-
Low-Income	IE SF Insulation		$263.00	$-	Varies by PA	$0.01	Varies by PA	$-
Low-Income	IE SF Insulation	Thermal Comfort	$30.13					
Low-Income	IE SF Insulation	Noise Reduction	$13.56					
Low-Income	IE SF Insulation	Home Durability	$8.76					
Low-Income	IE SF Insulation	Health Benefits	$193.15					
Low-Income	IE SF Insulation	Improved Safety	$17.40					
Low-Income	IE SF Insulation	Rate Discounts			Varies by PA		Varies by PA	
Low-Income	IE SF Insulation	Price Hedging				$0.01		$-
Low-Income	IE Windows		$0.19	$-	Varies by PA	$0.01	Varies by PA	$-
Low-Income	IE Windows	Rate Discounts			Varies by PA		Varies by PA	
Low-Income	IE Windows	Price Hedging				$0.01		
Low-Income	IE SF Heating System Retrofit		$310.82	$-	Varies by PA	$0.01	Varies by PA	$-
Low-Income	IE SF Heating System Retrofit	Safety Related Emergency Calls	$8.43					
Low-Income	IE SF Heating System Retrofit	Thermal Comfort	$33.24					
Low-Income	IE SF Heating System Retrofit	Equipment Maintenance	$9.72					
Low-Income	IE SF Heating System Retrofit	Home Durability	$27.43					

Sector	NEI Description	NEI Category	Annual per Unit	One time per Unit	Annual per kWh	One time per KWh	Annual per Therm	One time per Therm
Low-Income	IE SF Heating System Retrofit	Health Benefits	$213.13					
Low-Income	IE SF Heating System Retrofit	Improved Safety	$18.87					
Low-Income	IE SF Heating System Retrofit	Rate Discounts			Varies by PA		Varies by PA	
Low-Income	IE SF Heating System Retrofit	Price Hedging	$-			$0.01		$-
Low-Income	IE SF HP Water Heater		$4.64	$-	Varies by PA	$0.01	Varies by PA	$-
Low-Income	IE SF HP Water Heater	Home Durability	$0.20					
Low-Income	IE SF HP Water Heater	Improved Safety	$4.44					
Low-Income	IE SF HP Water Heater	Rate Discounts			Varies by PA		Varies by PA	
Low-Income	IE SF HP Water Heater	Price Hedging				$0.01		$-
Low-Income	IE SF Duct Sealing		$6.21	$-	Varies by PA	$0.01	Varies by PA	$-
Low-Income	IE SF Duct Sealing	Thermal Comfort	$0.81					
Low-Income	IE SF Duct Sealing	Home Durability	$0.23					
Low-Income	IE SF Duct Sealing	Health Benefits	$5.17					
Low-Income	IE SF Duct Sealing	Rate Discounts			Varies by PA		Varies by PA	
Low-Income	IE SF Duct Sealing	Price Hedging				$0.01		$-
Low-Income	IE SF Pipe Wrap		$48.94	$-	Varies by PA	$0.01	Varies by PA	$-
Low-Income	IE SF Pipe Wrap	Thermal Comfort	$6.60					

Sector	NEI Description	NEI Category	Annual per Unit	One time per Unit	Annual per kWh	One time per KWh	Annual per Therm	One time per Therm
Low-Income	IE SF Pipe Wrap	Health Benefits	$42.34					
Low-Income	IE SF Pipe Wrap	Rate Discounts			Varies by PA		Varies by PA	
Low-Income	IE SF Pipe Wrap	Price Hedging				$0.01		$-
Low-Income	IE SF Showerhead		$-	$1.72	Varies by PA	$0.01	Varies by PA	$-
Low-Income	IE SF Showerhead	Property Value Increase		$1.72				
Low-Income	IE SF Showerhead	Rate Discounts			Varies by PA		Varies by PA	
Low-Income	IE SF Showerhead	Price Hedging				$0.01		$-
Low-Income	IE SF Replacement Freezer		$1.40	$-	Varies by PA	$0.01	Varies by PA	$-
Low-Income	IE SF Replacement Freezer	Improved Safety	$1.40					
Low-Income	IE SF Replacement Freezer	Property Value Increase		$26.61				
Low-Income	IE SF Replacement Freezer	Rate Discounts			Varies by PA		Varies by PA	
Low-Income	IE SF Replacement Freezer	Price Hedging				$0.01		$-
Low-Income	IE SF Refrigerator		$1.40	$-	Varies by PA	$0.01	Varies by PA	$-
Low-Income	IE SF Refrigerator	Improved Safety	$1.40					
Low-Income	IE SF Refrigerator	Property Value Increase		$26.61				
Low-Income	IE SF	Rate Discounts			Varies		Varies	

Sector	NEI Description	NEI Category	Annual per Unit	One time per Unit	Annual per kWh	One time per KWh	Annual per Therm	One time per Therm
	Refrigerator				by PA		by PA	
Low-Income	IE SF Refrigerator	Price Hedging				$0.01		$-
Low-Income	IE SF Thermostat		$10.01	0	Varies by PA	$0.01	Varies by PA	$-
Low-Income	IE SF Thermostat	Thermal Comfort	$5.78					
Low-Income	IE SF Thermostat	Home Durability	$1.68					
Low-Income	IE SF Thermostat	Health Benefits	$37.07					
Low-Income	IE SF Thermostat	Rate Discounts			Varies by PA		Varies by PA	
Low-Income	IE SF Thermostat	Price Hedging				$0.01		$-
Low-Income	IE SF Window AC Replacement		$49.50	$-	Varies by PA	$0.01	Varies by PA	$-
Low-Income	IE SF Window AC Replacement	Window Air Conditioner Replacement	$49.50					
Low-Income	IE SF Window AC Replacement	Rate Discounts			Varies by PA		Varies by PA	
Low-Income	IE SF Window AC Replacement	Price Hedging				$0.01		$-
Low-Income	IE MF Participant		$7.70	$56.00	Varies by PA	$0.01	Varies by PA	$-
Low-Income	IE MF Participant NEI	Arrearages	$2.61					
Low-Income	IE MF Participant NEI	Bad Debt Write-offs	$3.74					
Low-Income	IE MF	Terminations and	$0.43					

Sector	NEI Description	NEI Category	Annual per Unit	One time per Unit	Annual per kWh	One time per KWh	Annual per Therm	One time per Therm
	Participant NEI	Reconnections						
Low-Income	IE MF Participant NEI	Customer Calls and Collections	$0.58					
Low-Income	IE MF Participant NEI	Notices	$0.34					
Low-Income	IE MF Participant NEI	Lighting Quality and Lifetime		$56.00				
Low-Income	IE MF Participant NEI	Rate Discounts			Varies by PA		Varies by PA	
Low-Income	IE MF Participant NEI	Price Hedging				$0.01		$-
Low-Income	IE MF Weatherization		$771.73	$-	Varies by PA	$0.01	Varies by PA	$-
Low-Income	IE MF Weatherization	Thermal Comfort	$684.48					
Low-Income	IE MF Weatherization	Health Benefits	$23.52					
Low-Income	IE MF Weatherization	Home Productivity	$23.52					
Low-Income	IE MF Weatherization	Improved Safety	$6.24					
Low-Income	IE MF Weatherization	Noise Reduction	$29.95					
Low-Income	IE MF Weatherization	Property Durability	$2.58					
Low-Income	IE MF Weatherization	Rental Units Marketability	$0.07					
Low-Income	IE MF Weatherization	Reduced Tenant Complaints	$1.37					
Low-Income	IE MF Weatherization	Rate Discounts			Varies by PA		Varies by PA	
Low-Income	IE MF Weatherization	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	One time per Therm
Low-Income	IE MF Air Sealing		$389.29	$-	Varies by PA	$0.01	Varies by PA	$-
Low-Income	IE MF Air Sealing	Thermal Comfort	$342.24					
Low-Income	IE MF Air Sealing	Health Benefits	$11.76					
Low-Income	IE MF Air Sealing	Home Productivity	$11.76					
Low-Income	IE MF Air Sealing	Improved Safety	$3.12					
Low-Income	IE MF Air Sealing	Noise Reduction	$16.39					
Low-Income	IE MF Air Sealing	Property Durability	$2.58					
Low-Income	IE MF Air Sealing	Rental Units Marketability	$0.07					
Low-Income	IE MF Air Sealing	Reduced Tenant Complaints	$1.37					
Low-Income	IE MF Air Sealing	Rate Discounts			Varies by PA		Varies by PA	
Low-Income	IE MF Air Sealing	Price Hedging				$0.01		$-
Low-Income	IE MF Insulation		$391.20	$-	Varies by PA	$0.01	Varies by PA	$-
Low-Income	IE MF Insulation	Thermal Comfort	$342.24					
Low-Income	IE MF Insulation	Health Benefits	$11.76					
Low-Income	IE MF Insulation	Home Productivity	$11.76					
Low-Income	IE MF Insulation	Improved Safety	$3.12					
Low-Income	IE MF Insulation	Noise Reduction	$13.56					

Sector	NEI Description	NEI Category	Annual per Unit	One time per Unit	Annual per kWh	One time per KWh	Annual per Therm	One time per Therm
Low-Income	IE MF Insulation	Home Durability	$8.76					
Low-Income	IE MF Insulation	Rate Discounts			Varies by PA		Varies by PA	
Low-Income	IE MF Insulation	Price Hedging				$0.01		$-
Low-Income	IE MF Heating		$836.39	$-	Varies by PA	$0.01	Varies by PA	$-
Low-Income	IE MF Heating	Thermal Comfort	$741.52					
Low-Income	IE MF Heating	Health Benefits	$25.48					
Low-Income	IE MF Heating	Home Productivity	$25.48					
Low-Income	IE MF Heating	Improved Safety	$6.76					
Low-Income	IE MF Heating	Equipment Maintenance	$9.72					
Low-Income	IE MF Heating	Home Durability	$27.43					
Low-Income	IE MF Heating	Rate Discounts			Varies by PA		Varies by PA	
Low-Income	IE MF Heating	Price Hedging	$-			$0.01		$-
Low-Income	IE MF Duct Sealing		$1.04	$-	Varies by PA	$0.01	Varies by PA	$-
Low-Income	IE MF Duct Sealing	Thermal Comfort	$0.68					
Low-Income	IE MF Duct Sealing	Home Durability	$0.23					
Low-Income	IE MF Duct Sealing	Health Benefits	$0.13					
Low-Income	IE MF Duct Sealing	Rate Discounts			Varies by PA		Varies by PA	
Low-Income	IE MF Duct Sealing	Price Hedging				$0.01		$-
Low-Income	IE MF Pipe Wrap		$6.61	$-	Varies by PA	$0.01	Varies by PA	$-

Sector	NEI Description	NEI Category	Annual per Unit	One time per Unit	Annual per kWh	One time per KWh	Annual per Therm	One time per Therm
Low-Income	IE MF Pipe Wrap	Thermal Comfort	$5.56					
Low-Income	IE MF Pipe Wrap	Health Benefits	$1.05					
Low-Income	IE MF Pipe Wrap	Rate Discounts			Varies by PA		Varies by PA	
Low-Income	IE MF Pipe Wrap	Price Hedging				$0.01		$-
Low-Income	IE MF Water Heater		$5.02	$-	Varies by PA	$0.01	Varies by PA	$-
Low-Income	IE MF Water Heater	Rate Discounts			Varies by PA		Varies by PA	
Low-Income	IE MF Water Heater	Price Hedging				$0.01		$-
Low-Income	IE MF Water Heater	Improved Safety	$4.44					
Low-Income	IE MF Water Heater	Rental Units Marketability	$0.01					
Low-Income	IE MF Water Heater	Property Durability	$0.37					
Low-Income	IE MF Water Heater	Reduced Tenant Complaints	$0.20					
Low-Income	IE MF Showerhead		$0.58	$-	Varies by PA	$0.01	Varies by PA	$-
Low-Income	IE MF Showerhead	Rate Discounts			Varies by PA		Varies by PA	
Low-Income	IE MF Showerhead	Price Hedging				$0.01		$-
Low-Income	IE MF Showerhead	Rental Units Marketability	$0.01					
Low-Income	IE MF Showerhead	Home Durability	$0.37					
Low-Income	IE MF Showerhead	Reduced Tenant Complaints	$0.20					

Sector	NEI Description	NEI Category	Annual per Unit	One time per Unit	Annual per kWh	One time per KWh	Annual per Therm	One time per Therm
Low-Income	IE MF Aerator		$0.58	$-	Varies by PA	$0.01	Varies by PA	$-
Low-Income	IE MF Aerator	Rate Discounts			Varies by PA		Varies by PA	
Low-Income	IE MF Aerator	Price Hedging				$0.01		$-
Low-Income	IE MF Aerator	Rental Units Marketability	$0.01					
Low-Income	IE MF Aerator	Home Durability	$0.37					
Low-Income	IE MF Aerator	Reduced Tenant Complaints	$0.20					
Low-Income	IE MF Thermostat		$4.38	$-	Varies by PA	$0.01	Varies by PA	$-
Low-Income	IE MF Thermostat	Thermal Comfort	$4.87					
Low-Income	IE MF Thermostat	Health Benefits	$0.92					
Low-Income	IE MF Thermostat	Rental Unit Marketability	$0.11					
Low-Income	IE MF Thermostat	Equipment Maintenance Reliability Due to Thermostats	$3.91					
Low-Income	IE MF Thermostat	Property Durability	$4.05					
Low-Income	IE MF Thermostat	Reduced Tenant Complaints	$2.16					
Low-Income	IE MF Thermostat	Rate Discounts			Varies by PA		Varies by PA	
Low-Income	IE MF Thermostat	Price Hedging				$0.01		$-
Low-Income	IE MF Common Area Lighting		$29.64	$-	Varies by PA	$0.01	Varies by PA	$-
Low-Income	IE MF Common Area Lighting	Rate Discounts			Varies by PA		Varies by PA	

Sector	NEI Description	NEI Category	Annual per Unit	One time per Unit	Annual per kWh	One time per KWh	Annual per Therm	One time per Therm
Low-Income	IE MF Common Area Lighting	Price Hedging				$0.01		$-
Low-Income	IE MF Common Area Lighting	Lighting Quality and Lifetime	$29.64		$0.03			
Low-Income	IE MF Freezer		$20.29	$-	Varies by PA	$0.01	Varies by PA	$-
Low-Income	IE MF Freezer	Rental Units Marketability	$0.34					
Low-Income	IE MF Freezer	Property Durability	$12.90					
Low-Income	IE MF Freezer	Reduced Tenant Complaints	$6.86					
Low-Income	IE MF Freezer	Improved Safety	$0.19					
Low-Income	IE MF Freezer	Rate Discounts			Varies by PA		Varies by PA	
Low-Income	IE MF Freezer	Price Hedging				$0.01		$-
Low-Income	IE MF Refrigerator		$20.29	$-	Varies by PA	$0.01	Varies by PA	$-
Low-Income	IE MF Refrigerator	Rental Units Marketability	$0.34					
Low-Income	IE MF Refrigerator	Property Durability	$12.90					
Low-Income	IE MF Refrigerator	Reduced Tenant Complaints	$6.86					
Low-Income	IE MF Refrigerator	Improved Safety	$0.19					
Low-Income	IE MF Refrigerator	Rate Discounts			Varies by PA		Varies by PA	
Low-Income	IE MF Refrigerator	Price Hedging				$0.01		$-
Low-Income	IE MF Window AC Replacement		$49.50	$-	Varies by PA	$0.01	Varies by PA	$-

Sector	NEI Description	NEI Category	Annual per Unit	One time per Unit	Annual per kWh	One time per KWh	Annual per Therm	One time per Therm
Low-Income	IE MF Window AC Replacement	Window Air Conditioner Replacement	$49.50					
Low-Income	IE MF Window AC Replacement	Rate Discounts			Varies by PA		Varies by PA	
Low-Income	IE MF Window AC Replacement	Price Hedging				$0.01		$-
Low-Income	IE - MSHP Displacing Electric Heat		$196.46		Varies by PA	$0.01	Varies by PA	
Low-Income	IE - MSHP Displacing Electric Heat	Rate Discounts			Varies by PA		Varies by PA	
Low-Income	IE - MSHP Displacing Electric Heat	Price Hedging				$0.01		$-
Low-Income	IE - Central HP partial displacement		$56.18		Varies by PA	$0.01	Varies by PA	
Low-Income	IE - Central HP partial displacement	Rate Discounts			Varies by PA		Varies by PA	
Low-Income	IE - Central HP partial displacement	Price Hedging				$0.01		$-
Low-Income	IE - MSHP partial displacement		$104.35		Varies by PA	$0.01	Varies by PA	
Low-Income	IE - MSHP partial displacement	Rate Discounts			Varies by PA		Varies by PA	
Low-Income	IE - MSHP partial displacement	Price Hedging				$0.01		$-
Low-Income	IE - Central HP		$64.24		Varies	$0.01	Varies	

Sector	NEI Description	NEI Category	Annual per Unit	One time per Unit	Annual per kWh	One time per KWh	Annual per Therm	One time per Therm
	full displacement				by PA		by PA	
Low-Income	IE - Central HP full displacement	Rate Discounts			Varies by PA		Varies by PA	
Low-Income	IE - Central HP full displacement	Price Hedging				$0.01		$-
Low-Income	IE - MSHP full displacement		$94.14		Varies by PA	$0.01	Varies by PA	
Low-Income	IE - MSHP full displacement	Rate Discounts			Varies by PA		Varies by PA	
Low-Income	IE - MSHP full displacement	Price Hedging				$0.01		$-
Low-Income	MF - Custom HPs		$392.92		Varies by PA	$0.01	Varies by PA	
Low-Income	MF - Custom HPs	Heat Related Mortality Risk	$115.06					
Low-Income	MF - Custom HPs	Productivity Gains	$21.03					
Low-Income	MF - Custom HPs	Avoided Home Fires	$0.02					
Low-Income	MF - Custom HPs	Thermal Comfort (Summer)	$69.43					
Low-Income	MF - Custom HPs	Thermal Comfort (Winter)	$88.05					
Low-Income	MF - Custom HPs	Noise Reduction	$73.25					
Low-Income	MF - Custom HPs	Equipment Maintenance	$26.08					
Low-Income	MF - Custom HPs	Rate Discounts			Varies by PA		Varies by PA	
Low-Income	MF - Custom HPs	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	One time per Therm
Low-Income	IE - Deep Energy Retrofit - EE Savings		$1,608.12		Varies by PA	$0.01	Varies by PA	
Low-Income	IE - Deep Energy Retrofit - EE Savings	Rate Discounts			Varies by PA		Varies by PA	
Low-Income	IE - Deep Energy Retrofit - EE Savings	Price Hedging				$0.01		$-
Low-Income	Income Eligible - CVEO Battery Storage		$162.08		Varies by PA	$0.01	Varies by PA	
Low-Income	Income Eligible - CVEO Battery Storage	Rate Discounts			Varies by PA		Varies by PA	
Low-Income	Income Eligible - CVEO Battery Storage	Price Hedging				$0.01		$-
Low-Income	IE Participant, Gas		$7.70	$-	$-	$-	$-	$-
Low-Income	IE Participant, Gas	Arrearages	$2.61					
Low-Income	IE Participant, Gas	Bad-Debt Write-off	$3.74					
Low-Income	IE Participant, Gas	Terminations & Reconnections	$0.43					
Low-Income	IE Participant, Gas	Customer Calls & Collections	$0.58					
Low-Income	IE Participant, Gas	Notices	$0.34					
Low-Income	IE SF DHW - Condensing/Indirect		$0.70	$-	Varies by PA	$-	Varies by PA	$0.08
Low-Income	IE SF DHW - Condensing/Indirect	Home Durability	$0.70					

Sector	NEI Description	NEI Category	Annual per Unit	One time per Unit	Annual per kWh	One time per KWh	Annual per Therm	One time per Therm
Low-Income	IE SF DHW - Condensing/Indirect	Rate Discounts			Varies by PA		Varies by PA	
Low-Income	IE SF DHW - Condensing/Indirect	Price Hedging				$-		$0.08
Low-Income	IE DHW - Stand Alone		$1.30	$-	Varies by PA	$-	Varies by PA	$0.08
Low-Income	IE DHW - Stand Alone	Home Durability	$1.30					
Low-Income	IE DHW - Stand Alone	Rate Discounts			Varies by PA		Varies by PA	
Low-Income	IE DHW - Stand Alone	Price Hedging				$-		$0.08
Low-Income	IE SF Air Sealing (mod income)		$295.21	$-				
Low-Income	IE SF Air Sealing (mod income)	Thermal Comfort	$35.89					
Low-Income	IE SF Air Sealing (mod income)	Noise Reduction	$16.39					
Low-Income	IE SF Air Sealing (mod income)	Home Durability	$10.61					
Low-Income	IE SF Air Sealing (mod income)	Health Benefits	$230.08					
Low-Income	IE SF Air Sealing (mod income)	Improved Safety	$2.24					
Low-Income	IE SF Air Sealing (mod income)	Rate Discounts						
Low-Income	IE SF Air	Price Hedging						

Sector	NEI Description	NEI Category	Annual per Unit	One time per Unit	Annual per kWh	One time per KWh	Annual per Therm	One time per Therm
	Sealing (mod income)							
Low-Income	IE SF Insulation (mod income)		$263.00	$-				
Low-Income	IE SF Insulation (mod income)	Thermal Comfort	$30.13					
Low-Income	IE SF Insulation (mod income)	Noise Reduction	$13.56					
Low-Income	IE SF Insulation (mod income)	Home Durability	$8.76					
Low-Income	IE SF Insulation (mod income)	Health Benefits	$193.15					
Low-Income	IE SF Insulation (mod income)	Improved Safety	$17.40					
Low-Income	IE SF Insulation (mod income)	Rate Discounts						
Low-Income	IE SF Insulation (mod income)	Price Hedging						
Low-Income	IE - Deep Energy Retrofit - EE Savings		$1,608.12		Varies by PA	$-	Varies by PA	$0.08
Low-Income	IE - Deep Energy Retrofit - EE Savings	Rate Discounts			Varies by PA		Varies by PA	
Low-Income	IE - Deep Energy Retrofit - EE Savings	Price Hedging				$-		$0.08
Low-Income	IE - Central HP partial displacement		$56.18		Varies by PA	$-	Varies by PA	$0.08
Low-Income	IE - Central HP partial displacement	Rate Discounts			Varies by PA		Varies by PA	

Sector	NEI Description	NEI Category	Annual per Unit	One time per Unit	Annual per kWh	One time per KWh	Annual per Therm	One time per Therm
Low-Income	IE - Central HP partial displacement	Price Hedging				$-		$0.08
Low-Income	IE - MSHP partial displacement		$104.35		Varies by PA	$-	Varies by PA	$0.08
Low-Income	IE - MSHP partial displacement	Rate Discounts			Varies by PA		Varies by PA	
Low-Income	IE - MSHP partial displacement	Price Hedging				$-		$0.08
Low-Income	IE - Central HP full displacement		$67.24		Varies by PA	$-	Varies by PA	$0.08
Low-Income	IE - Central HP full displacement	Rate Discounts			Varies by PA		Varies by PA	
Low-Income	IE - Central HP full displacement	Price Hedging				$-		$0.08
Low-Income	IE - MSHP full displacement		$94.14		Varies by PA	$-	Varies by PA	$0.08
Low-Income	IE - MSHP full displacement	Rate Discounts			Varies by PA		Varies by PA	
Low-Income	IE - MSHP full displacement	Price Hedging				$-		$0.08

Sources:

Residential and Low-Income 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.*
NMR, ThreeCubed (2021). *RNC NEI Quick Hit Assessment*
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 Unit	Annual per kWh
Commercial & Industrial	C&I New Custom Motors (including compressed air)	Total		$0.02
Commercial & Industrial	C&I New Custom Motors (including compressed air)	O&M		$0.00
Commercial & Industrial	C&I New Custom Motors (including compressed air)	nO&M, nH&S		$0.02
Commercial & Industrial	C&I New Custom Motors (including compressed air)	H&S		$-
Commercial & Industrial	C&I Retrofit Custom Motors (including compressed air)	Total		$0.02
Commercial & Industrial	C&I Retrofit Custom Motors (including compressed air)	O&M		$0.00
Commercial & Industrial	C&I Retrofit Custom Motors (including compressed air)	nO&M, nH&S		$0.02
Commercial & Industrial	C&I Retrofit Custom Motors (including compressed air)	H&S		$-
Commercial & Industrial	C&I Retrofit Custom HVAC	Total		$0.15
Commercial & Industrial	C&I Retrofit Custom HVAC	O&M		$0.01
Commercial & Industrial	C&I Retrofit Custom HVAC	nO&M, nH&S		$0.02
Commercial & Industrial	C&I Retrofit Custom HVAC	H&S		$0.11
Commercial & Industrial	C&I - Custom Lighting	Total		$0.10
Commercial & Industrial	C&I - Custom Lighting	O&M		$0.06
Commercial & Industrial	C&I - Custom Lighting	nO&M, nH&S		$0.04
Commercial & Industrial	C&I - Custom Lighting	H&S		$-
Commercial & Industrial	C&I - Prescriptive Lighting	Total		$0.05
Commercial & Industrial	C&I - Prescriptive Lighting	O&M		$0.02
Commercial & Industrial	C&I - Prescriptive Lighting	nO&M, nH&S		$0.02
Commercial & Industrial	C&I - Prescriptive Lighting	H&S		$-
Commercial & Industrial	C&I Retrofit Custom Process	Total		$0.10

Sector	NEI Description	NEI Category	Annual per Unit	Annual per kWh
Commercial & Industrial	C&I Retrofit Custom Process	O&M		$0.01
Commercial & Industrial	C&I Retrofit Custom Process	nO&M, nH&S		$0.09
Commercial & Industrial	C&I Retrofit Custom Process	H&S		$-
Commercial & Industrial	C&I Retrofit Custom Refrigeration	Total		$0.08
Commercial & Industrial	C&I Retrofit Custom Refrigeration	O&M		$0.01
Commercial & Industrial	C&I Retrofit Custom Refrigeration	nO&M, nH&S		$0.07
Commercial & Industrial	C&I Retrofit Custom Refrigeration	H&S		$-
Commercial & Industrial	C&I - Prescriptive Refrigeration	Total		$0.00
Commercial & Industrial	C&I - Prescriptive Refrigeration	O&M		$0.00
Commercial & Industrial	C&I - Prescriptive Refrigeration	nO&M, nH&S		$-
Commercial & Industrial	C&I - Prescriptive Refrigeration	H&S		$-
Commercial & Industrial	C&I Comprehensive Design	Total		$0.10
Commercial & Industrial	C&I Comprehensive Design	O&M		$0.01
Commercial & Industrial	C&I Comprehensive Design	nO&M, nH&S		$0.09
Commercial & Industrial	C&I Comprehensive Design	H&S		$-
Commercial & Industrial	C&I Comprehensive Retrofit	Total		$0.11
Commercial & Industrial	C&I Comprehensive Retrofit	O&M		$0.02
Commercial & Industrial	C&I Comprehensive Retrofit	nO&M, nH&S		$0.09
Commercial & Industrial	C&I Comprehensive Retrofit	H&S		$-
Commercial & Industrial	C&I - Custom Hot Water & Other	Total		$0.07
Commercial & Industrial	C&I - Custom Hot Water & Other	O&M		$(0.03)
Commercial & Industrial	C&I - Custom Hot Water & Other	nO&M, nH&S		$0.09
Commercial & Industrial	C&I - Custom Hot Water & Other	H&S		$-
Commercial & Industrial	C&I - Foodservice	Total		$0.01
Commercial & Industrial	C&I - Foodservice	O&M		$0.00
Commercial & Industrial	C&I - Foodservice	nO&M, nH&S		$-

Sector	NEI Description	NEI Category	Annual per Unit	Annual per kWh
Commercial & Industrial	C&I - Foodservice	H&S		$0.00
Commercial & Industrial	C&I New Lighting Controls	Total		$0.12
Commercial & Industrial	C&I New Lighting Controls	O&M		$0.05
Commercial & Industrial	C&I New Lighting Controls	nO&M, nH&S		$0.02
Commercial & Industrial	C&I New Lighting Controls	H&S		$0.05
Commercial & Industrial	C&I Retrofit Lighting Controls	Total		$0.13
Commercial & Industrial	C&I Retrofit Lighting Controls	O&M		$0.06
Commercial & Industrial	C&I Retrofit Lighting Controls	nO&M, nH&S		$0.02
Commercial & Industrial	C&I Retrofit Lighting Controls	H&S		$0.05
Commercial & Industrial	C&I Retrofit Prescriptive Compressed Air	Total		$0.01
Commercial & Industrial	C&I Retrofit Prescriptive Compressed Air	O&M		$0.01
Commercial & Industrial	C&I Retrofit Prescriptive Compressed Air	nO&M, nH&S		$0.00
Commercial & Industrial	C&I Retrofit Prescriptive Compressed Air	H&S		$-
Commercial & Industrial	C&I Retrofit Prescriptive HVAC Controls (inc. EMS & Hotel Occ.)	Total		$0.24
Commercial & Industrial	C&I Retrofit Prescriptive HVAC Controls (inc. EMS & Hotel Occ.)	O&M		$0.01
Commercial & Industrial	C&I Retrofit Prescriptive HVAC Controls (inc. EMS & Hotel Occ.)	nO&M, nH&S		$0.10
Commercial & Industrial	C&I Retrofit Prescriptive HVAC Controls (inc. EMS & Hotel Occ.)	H&S		$0.13
Commercial & Industrial	C&I New Prescriptive HVAC	Total		$0.10
Commercial & Industrial	C&I New Prescriptive HVAC	O&M		$(0.00)
Commercial & Industrial	C&I New Prescriptive HVAC	nO&M, nH&S		$0.10
Commercial & Industrial	C&I New Prescriptive HVAC	H&S		$-
Commercial & Industrial	C&I - Prescriptive Motors (including compressed air)	Total		$0.00
Commercial & Industrial	C&I - Prescriptive Motors (including compressed air)	O&M		$0.00

Sector	NEI Description	NEI Category	Annual per Unit	Annual per kWh
Commercial & Industrial	C&I - Prescriptive Motors (including compressed air)	nO&M, nH&S		$0.00
Commercial & Industrial	C&I - Prescriptive Motors (including compressed air)	H&S		$-
Commercial & Industrial	C&I Retrocommissioning	Total		$0.27
Commercial & Industrial	C&I Retrocommissioning	O&M		$0.04
Commercial & Industrial	C&I Retrocommissioning	nO&M, nH&S		$0.10
Commercial & Industrial	C&I Retrocommissioning	H&S		$0.13
Commercial & Industrial	C&I Retrofit Showerheads & Building Operator Training	Total		$0.00
Commercial & Industrial	C&I Retrofit Showerheads & Building Operator Training	O&M		$0.00
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 Thermostat	Total		$0.18
Commercial & Industrial	C&I Retrofit Thermostat	O&M		$0.08
Commercial & Industrial	C&I Retrofit Thermostat	nO&M, nH&S		$0.10
Commercial & Industrial	C&I Retrofit Thermostat	H&S		$-
Commercial & Industrial	C&I Downstream Electric Resistance HP Replacement	Total	$183.56	$-
Commercial & Industrial	C&I Downstream Electric Resistance HP Replacement	O&M	$(5.80)	
Commercial & Industrial	C&I Downstream Electric Resistance HP Replacement	nO&M, nH&S	$189.36	
Commercial & Industrial	C&I Downstream Electric Resistance HP Replacement	H&S	$-	
Commercial & Industrial	C&I Downstream Full Displacement HP	Total	$158.12	$-
Commercial & Industrial	C&I Downstream Full Displacement HP	O&M	$13.80	
Commercial & Industrial	C&I Downstream Full Displacement HP	nO&M, nH&S	$25.47	

Sector	NEI Description	NEI Category	Annual per Unit	Annual per kWh
Commercial & Industrial	C&I Downstream Full Displacement HP	H&S	$118.85	
Commercial & Industrial	C&I Downstream Partial Displacement HP	Total	$82.99	$-
Commercial & Industrial	C&I Downstream Partial Displacement HP	O&M	$7.24	
Commercial & Industrial	C&I Downstream Partial Displacement HP	nO&M, nH&S	$13.37	
Commercial & Industrial	C&I Downstream Partial Displacement HP	H&S	$62.38	

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*

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). C&I Health & Safety NEI Study (MA21X19-B-CIHSNE).

2022_DNV_C&I_Heath_&_Safety_NEIs

Table B-3: Gas C&I Non-Energy Impacts

Sector	NEI Description	NEI Category	Annual per Unit	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		$-
Commercial & Industrial	C&I - New Bldg - Custom - Commercial Kitchen, Gas	H&S		$-
Commercial & Industrial	C&I - Custom Heating Systems			$(0.04)

Sector	NEI Description	NEI Category	Annual per Unit	Annual per Therm
	& Controls			
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 - 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
Commercial & Industrial	C&I - Prescriptive Steam Trap & Pipe Wrap	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 -	Total		$0.36

Sector	NEI Description	NEI Category	Annual per Unit	Annual per Therm
	Retrofit			
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
Commercial & Industrial	C&I - Ductwork - Retrofit	H&S		$-
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 - Retrocomissioning, Gas	Total		$1.62

Sector	NEI Description	NEI Category	Annual per Unit	Annual per Therm
Commercial & Industrial	C&I - Retrocomissioning, Gas	O&M		$0.04
Commercial & Industrial	C&I - Retrocomissioning, Gas	nO&M, nH&S		$0.68
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 - Custom Foodservice	Total		$4.58
Commercial & Industrial	C&I - Custom Foodservice	O&M		$3.40
Commercial & Industrial	C&I - Custom Foodservice	nO&M, nH&S		$-
Commercial & Industrial	C&I - Custom Foodservice	H&S		$1.18
Commercial & Industrial	C&I Downstream Full Displacement HP	Total	$158.12	
Commercial & Industrial	C&I Downstream Full Displacement HP	O&M	$13.80	
Commercial & Industrial	C&I Downstream Full Displacement HP	nO&M, nH&S	$25.47	

Sector	NEI Description	NEI Category	Annual per Unit	Annual per Therm
Commercial & Industrial	C&I Downstream Full Displacement HP	H&S	$118.85	
Commercial & Industrial	C&I Downstream Partial Displacement HP	Total	$82.99	
Commercial & Industrial	C&I Downstream Partial Displacement HP	O&M	$7.24	
Commercial & Industrial	C&I Downstream Partial Displacement HP	nO&M, nH&S	$13.37	
Commercial & Industrial	C&I Downstream Partial Displacement HP	H&S	$62.38	

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*

DNV GL (2016). *Commercial and Industrial New Construction Non-Energy Impacts Study.*

NMR, DNV, ThreeCubed (2021). *O&M and Non-O&M 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.