Retail/Residential

Technical Reference Manual

Version 2024.3

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Table of Contents

Introduction

PURPOSE

The Efficiency Maine Trust Retail/Residential, Commercial/Industrial and Multifamily Technical Reference Manuals (TRMs) provide documentation for the Trust's calculation of energy and demand savings from energy-efficiency measures. Each TRM serves as a central repository and common point of reference for the methods, formulas, assumptions and sources that are used to estimate savings from energy-efficiency measures, and provides a common platform for analyzing energy savings across measures and programs. The importance of the TRM is derived from the importance of energy and demand savings calculations, which are at the foundation of the Trust's program planning and management, cost-effectiveness analysis, program evaluation, Annual Report and Independent System Operator – New England (ISO-NE) Forward Capacity Market (FCM) participation.

GENERAL FORMAT

The TRM is organized by program area and then by measure category, which may include one or more measures. Each measure category is presented in its own section as a measure characterization, following a standard format. The measure characterization includes a measure overview, energy and demand savings algorithms, baseline assumptions, deemed parameter values or instructions for inputs to savings algorithms, measure life and measure costs and impact factors for calculating adjusted gross savings and net savings. When there is a set of common values across measures, summary tables are provided at the end of the relevant section or in an appendix.

Where deemed savings values are specified, Efficiency Maine Trust (the Trust or EMT) uses integer values when reporting in units of kWh, three decimal places when reporting in units of MMBtu, and three decimal places for all demand (kW) values.

GUIDANCE & COMMON ASSUMPTIONS

In using the Trust's TRMs, it is helpful to note the following:

- ***Gross savings:*** Algorithms are specified for *gross* savings. To calculate *adjusted gross* savings or *net* savings, impact factors that account for verified measure performance (adjusted gross) and attribution (net) must be applied. The formulas used to calculate adjusted gross and net savings are described below.
- ***Annual savings:*** Algorithms are specified for *annual* savings. Unless otherwise noted, annual savings are assumed to be realized for each year of the measure life.
- ***Unit savings:*** Algorithms are specified for *per unit savings*. The Trust's program databases track and record the number of units of a given measure delivered through the program.
- ***Meter-level savings:*** Savings are assumed to be the savings that occur at the customer's meter (or point of use for non-electric savings); line losses are not included in these calculations.
- ***Non-electric savings:*** When applicable, savings are counted for natural gas, oil, propane, kerosene, wood and/or water. The deemed unit savings, algorithms and assumptions for these non-electric impacts are described in the measure characterizations whenever those savings are counted. If a non-electric impact is not described for a measure, it can be assumed that no non-electric impacts are counted for that measure.

- ***In-Service Rate (ISR)***: The in-service rate represents the percentage of program units that are installed or implemented. Unless otherwise stated in the measure-specific sections of this TRM, the ISR is set to 100 percent for the following reasons:
  - In the commercial sector, it is uncommon for customers to purchase equipment and not immediately install or use it.
  - The Trust's non-retail programs include some level of verification of the measure purchase and/or installation. These verification procedures ensure that projects and savings are counted only for measures that are implemented.
  - The effects of non-implemented units may be identified in the program impact evaluation and accounted for in the energy and demand realization rates.
  - Direct install measures result in 100 percent installation rates.
- ***Coincidence Factors (CF):*** Coincidence factors are provided for the summer and winter on-peak periods as defined by the ISO-New England for the Forward Capacity Market (FCM), and are calculated in accordance with the FCM methodology. Electric demand reduction during the ISO New England peak periods is defined as follows:
  - **Summer on-peak**: average demand reduction from 1:00 to 5:00 PM on non-holiday weekdays in June, July and August
  - **Winter on-peak**: average demand reduction from 5:00 to 7:00 PM on non-holiday weekdays in December and January
- ***Life:*** Life refers to the effective useful life of the measure. It represents the equivalent number of years the savings are expected to be realized. Lifetime savings = annual savings x life. Measure life takes one or more of the following aspects into consideration: 1) projected equipment life, 2) documented equipment warranty, 3) measure persistence[1], and 4) savings persistence[2]. Life is set to represent a conservative estimate of the aggregate life of all measures of that type installed and not the characterization of the life of a single, specific installed measure.
- ***Deemed savings value vs. deemed savings algorithm:*** For some measures, deemed savings values are provided representing the estimated average savings per unit for the measure. The deemed savings value may be based directly on the results from an evaluation or other research study, or may be based on a set of deemed input parameters applied to the stated energy and demand savings algorithms.

  For other measures, deemed values are provided for only some of the parameters in the algorithm and actual values for a given measure are required to calculate savings. In these cases, project-specific (or "Actual") data recorded in the relevant program tracking database is used in combination with the TRM deemed parameters to compute savings.

[1] Measure persistence is a quantification of how long the measure will remain in place. Causes of reduced measure persistence include any activity that removes the measure or eliminates the savings such as equipment upgrade, refurbishment or renovation of the building, closure of a business, or override of efficiency controls.
[2] Savings persistence is a quantification of how long the defined savings will remain. Causes of reduced savings persistence include a change to the baseline over the useful life of the measure so that future savings are less than first-year savings and changes in usage behavior over time.

- ***Project-specific ("actual") data for parameter inputs****:* The savings methods for some measures specify "actual" data for at least one of the input parameters. Actual data refers to values that are specific to the project. Unless otherwise stated, these actual project data should be collected and documented on the project application forms. For some measures, the TRM provides alternative values if the actual data are unknown.

- ***Data sources for deemed parameter inputs:*** Wherever possible, deemed parameter values and assumptions are based on Maine-specific research and data. When such data are not available, the TRM relies on relevant data sources from other areas within the U.S.; in doing so, data sources from neighboring states and regions are prioritized. In some cases, engineering judgment and scaling for regional differences are used.

- ***Decision type*****:** The decision type describes the underlying scenario that is assumed for the savings calculation of a given measure. The decision type has implications for the baseline efficiency case and the measure cost assumptions as shown below.[3] For each energy-efficiency measure, the TRM identifies the relevant decision type, or types, corresponding to the scenarios in which the given measure may be implemented.

Decision Type	Scenario	Baseline	Measure Cost
New Construction	Customer is in the market to purchase new equipment for a new construction or new capacity project or as part of a planned renovation or to add controls to improve the performance of new equipment	Federal standards or standard market practice for new equipment	Incremental cost: difference between the cost of baseline and cost of high-efficiency equipment
Replace on Burnout	Customer is in the market to purchase new equipment to replace existing equipment that has worn out or otherwise needs replacing	Federal standards or standard market practice for new equipment	Incremental cost: difference between the cost of baseline and cost of high-efficiency equipment
Retrofit	Customer's existing equipment is in working order and has remaining useful life or customer is adding controls to improve the performance of operating equipment in an existing facility.	Existing equipment or conditions	Full measure cost: cost of the high-efficiency equipment (including installation)

- ***Efficiency standards:*** The TRM anticipates the effects of changes in efficiency standards for some measures, including shifts in the baseline for CFL and LED bulbs due to changes in Federal Standards for lighting products under the Energy Independence & Security Act of 2007 (EISA).

- ***TRM updates:*** The TRMs are reviewed and updated annually, or more frequently if needed, to reflect new information obtained through research and evaluation studies, changes in program offerings (measures) and shifts in technology and baselines. Annual updates to the TRM are published as a new "version" (Version YYYY.1) with a specific effective date. Inter-year updates to the TRM are published as iterations to the version year (Version YYYY.x) with changes and effective date indicated.

[3] Table adapted from National Action Plan for Energy Efficiency (2008). Understanding Cost-Effectiveness of Energy Efficiency Programs: Best Practices, Technical Methods, and Emerging Issues for Policy-Makers. Energy and Environmental Economics, Inc. and Regulatory Assistance Project. https://www.epa.gov/sites/production/files/2015-08/documents/napee_report.pdf

SAVINGS FORMULAS

The formulas and inputs used to calculate the deemed gross annual energy (∆kWh/yr (electricity) and ∆MMBtu/yr (natural gas and other fuels)) and gross max demand (∆kW) savings for each measure are described in the measure sections. The formulas used to calculate adjusted gross savings, on-peak demand savings, and lifetime savings are described below. For measures that have different gross max demand savings for winter and summer, max heating (ΔkW_H) and max cooling (ΔkW_C) demand savings are reported. For measures where coincident demand reductions are estimated directly, winter (ΔkW_{WP}) and summer peak (ΔkW_{SP}) demand savings are reported and the coincidence factors set to 100 percent.

Adjusted Gross Savings

Adjusted gross savings represent the total energy and demand savings achieved by measures implemented through the Trust's programs. The adjusted gross savings values are calculated by applying various evaluation parameters to the gross annual energy and demand savings:

$$\text{Adjusted Gross Annual kWh} = \Delta \text{kWh/yr} \times \text{ISR} \times RR_E$$

$$\text{Adjusted Gross Lifetime kWh} = \Delta \text{kWh/yr} \times \text{ISR} \times RR_E \times \text{Measure Life}$$

$$\text{Adjusted Gross Annual MMBtu}^{4} = \Delta \text{MMBtu/yr} \times \text{ISR} \times RR_E$$

$$\text{Adjusted Gross Lifetime MMBtu}^{4} = \Delta \text{MMBtu/yr} \times \text{ISR} \times RR_E \times \text{Measure Life}$$

$$\text{Adjusted Gross Summer On-Peak kW} = \Delta \text{kW} \times \text{ISR} \times RR_D \times CF_S$$

$$\text{Adjusted Gross Winter On-Peak kW} = \Delta \text{kW} \times \text{ISR} \times RR_D \times CF_W$$

The Adjusted Gross Summer On-Peak kW value is equivalent to the Demand Reduction Value reported to the ISO-NE Forward Capacity Market.

Net Savings

Net Savings represent the total realized energy and demand savings that are attributable to the Trust's programs. These net savings are calculated by applying the net-to-gross (NTG) factors such as free-ridership (FR) and spillover (SO) to the adjusted gross savings.

$$\text{Net Annual kWh} = \Delta \text{kWh/yr} \times \text{ISR} \times RR_E \times (1 - \text{FR} + \text{SO})$$

$$\text{Net Lifetime kWh} = \Delta \text{kWh/yr} \times \text{ISR} \times RR_E \times (1 - \text{FR} + \text{SO}) \times \text{Measure Life}$$

$$\text{Net Summer On-Peak kW} = \Delta \text{kW} \times \text{ISR} \times RR_D \times CF_S \times (1 - \text{FR} + \text{SO})$$

$$\text{Net Winter On-Peak kW} = \Delta \text{kW} \times \text{ISR} \times RR_D \times CF_W \times (1 - \text{FR} + \text{SO})$$

Note the parameter (1 – FR + SO) may be replaced with the net-to-gross (NTG) ratio.

[4] In this document and other reporting documents, fossil fuel savings are reporting in unit of MMBtu. In the tracking data base (effRT), natural gas savings are calculated in units of therms and then must be converted to MMBtu.

SAVINGS CALCULATIONS

The actual calculation of energy-efficiency savings, pursuant to the algorithms and assumptions documented in the TRM, occurs in the Trust's program tracking databases. In 2012, the Trust initiated a significant effort to upgrade and transform its existing program-specific databases into a comprehensive, unified database system that supports multiple programs with standardized internal processes, features and quality. This initiative builds on the foundation of the successful Efficiency Maine Reporting and Tracking (effRT) database system that historically supported the Business Programs to create a new multi-program database system, effRT 2.0. As part of this effort, the Trust is mapping the TRM deemed values and algorithms into effRT, and establishing processes for updates to effRT to coincide with TRM updates.

As of January 1, 2014, the Trust added adjustment factors for the in-service rate (ISR) and the evaluated realization rate (RR) to the formulas used to calculate the demand reduction value (DRV) for Forward Capacity Market (FCM) monthly reporting. Results using these two additional factors are referred to as *Adjusted Gross Savings* in the effRT report.

TRM Change Log

Change Type	TRM Section	Description	Effective Date	effRT update
PY2014 Addendum				
Revision	Table B-1: Coincidence Factors and Energy Period Factors	Added coincidence and energy period factors for the new ductless heat pump and ductless heat pump retrofit measures to existing Table	11/12/2013	Y
New	Ductless Heat Pump	New measure section for Ductless Heat Pump	11/12/2013	N
Revision	CFL Bulb, LED Bulb	-Updated savings algorithm and savings values to account for evaluation findings indicating a share of retail lighting program measures being used in commercial settings	7/1/2013	Y
PY2015 Updates				
Revision	CFL Bulb, LED Bulb	-Updated savings to include new EISA update for PY2015	7/1/2014	Y
Revision	Refrigerator, Freezer, Dehumidifier	-Updated energy and demand savings based on new evaluation results and a baseline adjustment -Updated Coincidence Factors to be consistent with updated peak demand savings -Updated free ridership (FR) and spillover (SO) using new evaluation results	7/1/2014	Y
Revision	Room Air Conditioner	-Updated energy and demand savings using a new baseline condition accounting for new code standard -Updated FR and SO using new evaluation results	7/1/2014	Y
Revision	Room Air Purifier	-Updated FR and SO using new evaluation results	7/1/2014	Y
Revision	Clothes Washer, Dishwasher	-Updated distribution of water heater fuels based on new evaluation results -Updated FR and SO using new evaluation results (the values for the dishwasher measure were based on overall program weighted average)	7/1/2014	Y
Revision	effRT schedules (Appliance Rebate and Retail Lighting Programs)	Savings, Pricing and Factor schedules in effRT updated to reflect 2014 TRM values and formulas	7/1/2014	Y
Revision	High-efficiency Electric Water Heater	Temperature setpoint of the water heater was updated based on recent evaluation results	7/1/2014	Y
Revision	Heat Pump Water Heater	-Updated savings based on a Heat Pump Water Heaters Field Evaluation report -Updated FR and SO using new evaluation results	7/1/2014	Y

Change Type	TRM Section	Description	Effective Date	effRT update
Revision	Table B-1: Coincidence Factors	-Updated Coincidence Factors for the following measures: CFL Bulb, LED Bulb, Refrigerator, Freezer, Dehumidifier, Clothes Washer, Heat Pump Water Heater -Added Coincidence Factors for all newly added measures	7/1/2014	Y
Revision	Table B-1: Energy Period Factors	-Updated Energy Period Factors for the following measures: CFL Bulb, LED Bulb, Refrigerator, Freezer, Dehumidifier, Clothes Washer, Heat Pump Water Heater -Added Energy Period Factors for all newly added measures	7/1/2014	Y
Revision	Ductless Heat Pump	Energy/demand impacts, description of methodology, coincidence factors, and energy period factors for the Ductless Heat Pump measure (added to the TRM as a PY2014 addendum) were updated based on a revised savings model	7/1/2014	N
New	Direct Install CFL Bulb	New measure section for Direct Install CFL in Low-income Program	7/1/2014	N
New	Ductless Heat Pump Retrofit	New measure section for Ductless Heat Pump Retrofit in Low-income Program	7/1/2014	N
New	Low-income Multifamily Gas Heat, Furnaces and Boilers, Furnace and Boiler Retrofit	New measure sections for heating measures: Low-income Multifamily Gas Heat, Furnaces and Boilers, Furnace and Boiler Retrofit	7/1/2014	N
New	Home Energy Savings Program	New measure sections for the following measures: Custom Path, Air Sealing, Attic/Roof Insulation, Wall Insulation, Basement Insulation, High-Efficiency Furnaces/Boilers, Furnace and Boiler Retrofit, Pellet/Wood Stove, Pellet Boiler, Central Air-Source Heat Pump (Ducted), Central Geothermal (Ground Source) Heat Pump, On-Demand Natural Gas Water Heater	7/1/2014	N
Removal	Advanced Power Strip	This measure was discontinued, and the TRM entry was removed accordingly	7/1/2014	Y
Revision	Ductless Heat Pump Retrofit	Updated measure life, updated measure cost	9/27/2014	N
Revision	Central Geothermal (Ground Source) Heat Pump	Changed baseline to Oil Boiler	9/27/2014	N
Revision	CFL Bulb, LED Bulb, CFL Direct Install	Adjusted measure life to 5 years	7/1/2014	Y

Change Type	TRM Section	Description	Effective Date	effRT update
New	Heat Pump Water Heater Direct Install	New measure section for Heat Pump Water Heater Direct Install in Low-income Program	1/1/2015	Y
Revision	Low-flow Kitchen Aerator, Low-flow Showerhead, CFL Direct Install, Ductless Heat Pump Retrofit	Measure costs updated to reflect program costs under the direct install program	3/1/2015	Y
Revision	Ductless Heat Pump Retrofit	Updated savings to account for fuel distribution	3/1/2015	Y
Other	Low-income Multifamily Gas Heat	Added Replace on Burnout decision type	3/1/2015	N
New	Distributor Lighting LED	Added distributor LED measure	1/1/2015	Y
Revision	High-Efficiency Furnaces and Boilers	Adjusted measure cost based on program data	7/1/2014	Y
Revision	Wood and Pellet Stoves	Adjusted savings estimates to account for outdoor make up air kit efficiency	7/1/2014	Y
PY2016 Updates				
Other	Introduction	Expanded description of in-service rate; revised deemed savings value vs. deemed savings algorithm, data sources for deemed parameter inputs, decision type and TRM updates descriptions to make them applicable and consistent across all TRMs		N
Revision	CFL Retail, LED Retail, LED Distributor, CFL Direct Install	Updated to incorporate evaluation results	7/1/2015	Y
Revision	Refrigerator, Freezer, Room Air Conditioner	Updated to reflect latest ENERGY STAR® calculator	7/1/2015	Y
Revision	Clothes Washer	Updated to reflect new federal standard	7/1/2015	N
New	Retail: Low-flow Kitchen Aerator, Low-flow Bathroom Aerator, Low-flow Showerhead	Added measures to retail section	7/1/2015	N
New	Thermostatic Shower Valve	Added to retail and low-income sections	7/1/2015	N
Revision	High-efficiency Electric Water Heater	Updated to reflect updated federal standard effective 4/16/2015	7/1/2015	N

Change Type	TRM Section	Description	Effective Date	effRT update
Revision	Heat Pump Water Heater	Updated incremental measure cost based on rising cost of conventional electric resistance water heaters due to new federal standards	7/1/2015	Y
Revision	Air Sealing, Attic/Roof Insulation, Wall Insulation, Basement Insulation	Revised savings estimates based on temperature bin analysis using TMY3 data	7/1/2015	Y
Revision	Ductless Heat Pump, Ductless Heat Pump Retrofit	Updated to reflect refined assumptions and modeling	7/1/2015	Y
Other	Low-income Gas Heat	Removed multifamily designation and added modeled	7/1/2015	N
Other	Furnace and Boiler Retrofit (Prescriptive)	Clarified that measure is prescriptive	7/1/2015	N
Revision	Low-income: Low-flow Kitchen Aerator, Low-flow Bathroom Aerator, Low-flow Showerhead	Updated savings estimates to reflect heat pump water heat energy recovery factor	7/1/2015	Y
Revision	Appendix B	Updated coincidence factors and energy period factors for new and modified measures	7/1/2015	Y
Revision	Multiple	Updated MMBtu per kWh conversion factor from 0.003413 to 0.003412	7/1/2015	Y
Other	Appendix: Carbon Dioxide Emission Factors	Added carbon dioxide emission factors table	7/1/2015	N
New	CFL – Food Bank	Added new entry for CFL Food Bank measure	7/1/2015	Y
Other	Appendix: Coincidence and Energy Period Factors	Corrected footnotes	7/1/2015	N
Revision	Retail Products	Added Commercial Sector to Dehumidifier, Room Air Purifier, Clothes Washer and Heat Pump Water Heater – no savings adjustments at this time	7/1/2015	N
Revision	Distributor Lighting	Adjusted deemed savings to account for higher efficacy program requirement	7/1/2015	Y
New	Value-line LED	Added value-line LEDs for retail and distributor	1/1/2015	Y
Revision	CFL & LED	Made several corrections/refinements to CFL and LED entries	7/1/2015	Y

Change Type	TRM Section	Description	Effective Date	effRT update
Revision	Pellet Boiler	Added Cord Wood Boilers	3/1/2016	Y
Revision	Low-flow Devices	Minor corrections to calculations	7/1/2015	Y
Revision	On-Demand Natural Gas Water Heater	Updated efficiency, water use and cost assumptions	3/1/2016	Y
Revision	CFL and LED	Corrected avoided O&M estimates to properly account for delay of first purchase; corrected demand savings to apply cooling interactive demand factor to summer peak only	1/1/2016	Y
New	LED – Food Pantry & Appliance Packs	New entry for LED Food Pantry & Appliance Packs	3/1/2016	Y
Revision	Low-flow Kitchen Aerator & Low-flow Showerhead	Added Appliance Pack impact factors to Low-flow Kitchen Aerator and Low-flow Showerhead entries	3/1/2016	Y
Other	Introduction: Savings Formulas	Updated description to clarify demand savings terms	3/1/2016	N
PY2017 Updates				
Revision	All	Default FR for measures not yet evaluated changed from 0% to 25%.	7/1/2016	Y
Revision	CFL measures	Removed retail CFL measure, food pantry CFL retained to allow for "sell through" of existing inventory until LEDs are available in August 2016	7/1/2016	Y
Revision	LED measures	LED measures split into separate entries for standard and specialty bulbs. Savings estimates updated on FY16 bulb mix	7/1/2016	Y
Other	Various	Marked measures not currently offered as inactive. Inactive measures were not reviewed for revisions.	7/1/2016	Y
Correction	Refrigerator	Removed $RATIO_{BASE}$ which was an inadvertent holdover from a previous version	N/A	N
Revision	Dehumidifier	Parameters updated based on PY16 sales data and revised ENERGY STAR® standard	7/1/2016	Y
Correction	Dehumidifier	Winter coincidence factor set to 0%	N/A	N
Removal	High-efficiency Electric Resistance Water Heater	New federal standards has made high-efficiency electric resistance water heater the baseline	7/1/2016	Y
Revision	Room Air Purifier	CADR updated based on PY16 sales data	7/1/2016	Y
Revision	Heat Pump Water Heater	Retail and Low-income HPWH savings estimates adjusted for energy factors reflecting current program models and federal minimum standard	7/1/2016	Y
Revision	Heat Pump Water Heater	Updated measure life to reflect NREL, National Residential Efficiency Measure Database	7/1/2016	Y
Correction	Clothes Washer	Calculation correction made to energy savings	7/1/2016	Y

Change Type	TRM Section	Description	Effective Date	effRT update
Revision	Clothes Washer	Demand savings algorithm employed to allow calculation based on new efficiency values; evaluation results used to derive coincidence factors	7/1/2016	Y
Revision	Clothes Washer	Measure cost updated per ENERGY STAR®	7/1/2016	Y
Revision	Home Energy Savings Program	Baseline and energy-efficient measure assumptions updated based on most recent program data	7/1/2016	Y
Revision	Home Energy Savings Program	Fuel savings presented for known and unknown heating fuel type	7/1/2016	Y
New	Attic/Roof Insulation Natural Gas	Separate measure added for attic/roof insulation installed in homes heated with natural gas due to different baseline eligibility	7/1/2016	Y
Revision	Attic/Roof Insulation All Fuels	Natural gas removed from fuel distribution	7/1/2016	Y
Revision	Insulation measures	Separate free-ridership rate added for Low-income Home Energy Savings Program (AHI)	7/1/2016	Y
New	Home Energy Savings Program	Added new measures for mobile home underbelly insulation, insulate attic openings, duct insulation, duct sealing and hydronic heating pipe insulation	7/1/2016	Y
Revision	Ductless Heat Pump	Added savings for multi-head and multiple unit projects	7/1/2016	Y
Revision	High-Efficiency Furnaces and Boilers	Deemed measure cost updated based on data provided in Vermont and Illinois TRMs; separate baseline efficiencies, efficient efficiencies and savings presented by fuel type and equipment type; efficient equipment efficiencies updated based on recent program data	7/1/2016	Y
Revision	Pellet/Cord Wood Boiler	Baseline fuel mix assumption updated; updated annual heat load based on Residential Baseline Study	7/1/2016	Y
Revision	Central Heat Pumps	Savings algorithm updated to use annual heat and cooling loads from Residential Baseline Study; coincidence factors corrected	7/1/2016	Y
New	Air Sealing and Attic Insulation Direct Install	New measures added to low-income section (retroactive to July 1, 2015)	7/1/2015	Y
Revision	Furnace Boiler Retrofit	Savings algorithm updated to use annual heat loads from Residential Baseline Study, transitioned to actual for baseline and efficient-energy factors	7/1/2016	Y
Revision	Low-flow Devices	Measure life adjusted to reflect National Renewable Energy Laboratory's National Residential Efficiency Measure Database	7/1/2016	Y

Change Type	TRM Section	Description	Effective Date	effRT update
Revision	Ductless Heat Pump Retrofit	Savings updated to remove assumed fuel distribution; Savings will be allocated based on actual fuel type; Added parameters used in modeling that were not previously included; Modified efficient measure assumption to reflect program requirements; No impact on savings estimates.	7/1/2016	Y
Revision	Low-flow Devices – low-income only	Savings adjusted for revised water heater energy factors	7/1/2016	Y
Other	Appendix Retail Lighting Assumptions and EISA	Appendix renamed to Retail Lighting EISA History. This appendix is being maintained for historical reference only.	7/1/2016	N
Other	Appendix Standard Assumptions for Maine	Updated appendix to reflect baseline assumptions used in TRM entries for boilers and furnaces	7/1/2016	N
Other	Appendix Carbon Dioxide Emission Factors	Updated to current US Energy Information Administration (EIA) factors	7/1/2016	N
Revision	Ductless Heat Pump	Clarified unit definition to allow up to two units per dwelling	9/14/2016	Y
New	Seal/Insulate Pipe/Ducts	New measure based on weighted average of duct insulation, duct sealing and hydronic heating pipe insulation	7/1/2016	Y
Revision	LED (Retail and Distributor)	Updated measure costs, split specialty bulbs into more refined categories.	11/21/2016	Y
Revision	Heat Pump Water Heater	Updated measure cost based on price survey	11/21/2016	Y
Revision	Retail Products: Thermostatic Shower Valve	Decision type changed to retrofit. In Service Rate estimate updated based on customer survey data. Measure cost updated based on program actuals.	11/21/2016	Y
Revision	Room Air Purifier	Measure cost updated based on shelf survey	11/21/2016	Y
Revision	LED Standard Food Pantry, Direct Install, & Opt-in Mailed DIY Kit	Added 100 W sub measure	12/1/2016	Y
Revision	LED Specialty Food Pantry, Direct Install, & Opt-in Mailed DIY Kit	New measure for specialty bulbs	1/1/2017	Y
Revision	LED (Retail and Distributor)	Updated measure cost	2/1/2017	Y
Revision	On-Demand Natural Gas Water Heater	Revised assumptions and savings based on new program eligibility criteria	3/1/2017	Y

Change Type	TRM Section	Description	Effective Date	effRT update
Revision	Central Geothermal (Ground Source) Heat Pump	Revised measure cost based on updated assumed baseline cost	3/1/2017	Y
Revision	Low Income Heat Pump Water Heater	Scaling factors updated for current COP and assumed water use	4/1/2017	Y
Revision	Heat Pump Water Heater	Scaling factors updated for participating models	5/1/2017	Y
Revision	LED (Retail and Distributor)	Updated measure cost	5/1/2017	Y
Other	LED (all)	Removed reference to ENERGY STAR®	4/1/2017	N
Other	Glossary	Updated RR definition to distinguish between RR_E and RR_D	4/1/2017	N
PY2018 Updates				
Revision	LED (All)	Updated measure costs and delta watts based on program data analysis, revised FR based on pricing trial, updated interactive effects, updated savings estimates accordingly	7/1/2017	Y
Other	Consumer Products Low Flow Devices	Added note about application of ERWH % in effRT when water heat type is unknown.	7/1/2015	N
Revision	LFKA, LFBA, TSV	Updated measure cost to be actual cost. Changed LFKA to Retrofit. Added HPWH savings for direct install. Updated HPWH savings to reflect 3.5 COP.	7/1/2017	Y
Revision	Low Income Low Flow Devices	Combined with Consumer Products measures and clarified different savings for HPWH and ERWH.	7/1/2017	Y
Other	All Measures	Updated/added effRT measure codes for all measures	7/1/2017	N
Revision	HPWH	Updated measure cost based on program data analysis	7/1/2017	Y
Other	Glossary	Added definitions for interactive effects and waste heat factor	7/1/2017	N
Other	Appendix F	Updated bulb replacement schedule, added derivation of interactive effects, added price elasticity FR estimation formula	7/1/2017	N
Other	Retail Products	Renamed to Consumer Products	7/1/2017	N
Correction	Clothes Washer	Corrected $\%E_{DHW\_B}$ and $\%E_{DHW\_EE}$ values that were inverted. (retroactive to 7/1/2016)	7/1/2016	Y
Revision	Clothes Washer	Updated measure cost based on most recent program data	10/1/2017	Y
Revision	Distributor LEDs	Updated measure costs based on most recent program data	10/1/2017	Y

Change Type	TRM Section	Description	Effective Date	effRT update
Revision	Distributor LEDs	Updated FR and SO to reflect findings from BIP Evaluation	10/1/2017	Y
New	Distributor LEDs	Added Linear LED and Mogul based LEDs	10/1/2017	Y
New	Appendix B	Added Commercial Interior and Exterior Lighting factors	10/1/2017	Y
Revision	LEDs	Updated measure costs based on most recent program data	10/1/2017	Y
Revision	Heat Pump Water Heater	Measure cost update based on shelf survey performed Aug 2017	10/1/2017	Y
Revision	Heat Pump Water Heater	Measure cost update based on program data and shelf survey performed Nov 2017	1/1/2018	Y
Revision	LEDs	Updated measure costs based on most recent program data	1/1/2018	Y
Revision	LED and Appendix F	Updated free ridership rate estimate description and corrected free ridership rate values	1/1/2018	Y
Revision	LED, Appendix F	Refined derivation of interactive effects	4/1/2018	Y
Revision	LED	Updated measure cost and free ridership rate	4/1/2018	Y
Revision	Low-Flow Devices	Added non-electric savings	4/1/2018	Y
Revision	Smart Thermostat	Updated WiFi thermostat to Energy Star savings for Smart thermostats	4/1/2018	Y
Revision	Wood/Pellet Stove	Updated baseline and efficient assumptions and measure cost	4/1/2018	Y
Revision	Central Air Source Heat Pump	Updated baseline assumptions to reflect current federal minimum standards	4/1/2018	Y
Other	Heat Pump Water Heater	Refined parameter names, savings descriptions and added definitions	4/1/2018	N
Other	Appendix E	Refined precision of Distribution of Heating Fuel for Maine Residential Customers (added tenths of percent)	4/1/2018	N
Other	On-Demand Natural Gas Water Heater	Corrected end use to Domestic Hot Water	4/1/2018	N
PY2019 Updates				

Change Type	TRM Section	Description	Effective Date	effRT update
Revision	LEDs	Updated measure costs based on most recent program data, updated free ridership rates, updated avoided replacement costs, updated dual baseline assumptions for bulbs subject to EISA	7/1/2018	Y
Revision	LEDs & Appendix B	Moved Distributor Lighting Measures from Retail/Residential TRM to Commercial, Industrial, Multifamily TRM	7/1/2018	Y
Revision	Clothes Washer	Updated parameter values based on recent program data	7/1/2018	Y
Revision	HPWH	Updated measure costs based on most recent program data	7/1/2018	Y
Revision	Air Sealing and Insulation	Updated savings based on recent program parameters and adjusted base temperature to 60 degree F.	7/1/2018	Y
Revision	Duct Sealing, Duct Insulation	Updated savings to reflect cooling savings only for central cooling systems	7/1/2018	Y
New	Window Inserts	Added new measure	7/1/2018	Y
Correction	Smart Thermostat	Corrected heating savings value	7/1/2018	Y
Revision	Appendix E	Fuel distributions updated based on program participation for boilers, furnace, pipe and duct insulation, air sealing, insulation, smart thermostats and water heaters. Fuel distribution updated based on Residential Baseline Study for lighting interactive effects	7/1/2018	Y
Other	On-Demand Natural Gas Water Heater	Updated Efficient definition to reflect program eligibility requirements	7/1/2018	N
Revision	LED	Updated cost and wattage for efficient bulbs based on program data	10/12/2018	Y
Other	Low-Income Gas Heat	Expanded description to address heating/weatherization and retrofit/replace on burnout	10/1/2018	N
New	Hydronic Heating Smart Circulation Pump	New measure added to Home Energy Savings Program section.	10/1/2018	N
Revision	LED	Updated measure cost and efficient wattage based on program data. Savings and avoided O&M updated.	1/1/2019	Y
Revision	Low Income LED (all but AMP)	Applied updated fuel allocation	7/1/2018	Y
Revision	Low Income LED AMP	Applied updated savings and fuel allocation	10/1/2018	Y
Revision	Heat Pump Water Heater	Updated measure cost based on program data	1/1/2019	Y
Correction	Low Flow Thermostatic Shower Valve	Updated effRT savings allocation for assumed ERHW proportion	7/1/2018	N

Change Type	TRM Section	Description	Effective Date	effRT update
Revision	Appendix C: Carbon Dioxide Emission Factors	Updated Electricity emission factor to most recent ISO NE reported value.	1/1/2019	N
Revision	LED	Updated measure cost and FR based on program data. Baseline cost updated based on shelf survey. Avoided O&M updated to reflect new baseline cost.	4/1/2019	Y
PY2020 Updates				
Other	All	Reorganized TRM by measure type rather than program	7/1/2019	N
Revision	LEDs	Updated wattage and cost data with recent program data. Updated free ridership and baseline cost with CREED analysis. Updated equivalent measure life.	7/1/2019	Y
Revision	Air sealing, Insulation	Incorporated results from draft HESP Impact Evaluation – parameter assumptions, free ridership, and spillover	7/1/2019	Y
Revision	Boilers, furnaces	Incorporated results from draft HESP Impact Evaluation – realization rates, free ridership, and spillover. Updated baseline efficiency to industry standard.	7/1/2019	Y
Revision	Pellet/cord wood boiler, central geothermal	Incorporated results from draft HESP Impact Evaluation – program weighted free ridership, and spillover (non-evaluated measures)	7/1/2019	Y
Revision	Ductless heat pumps Ductless heat pumps Retrofit	Incorporated results from draft HESP Impact Evaluation – free ridership, spillover. Updated savings assumptions with new modeling and evaluated performance.	7/1/2019	Y
Revision	Wood and Pellet Stoves	Updated baseline efficiency assumption for 2020 NSPS compliant stoves	7/1/2019	Y
Revision	Heat Pump Water Heater, Heat Pump Water Heater Direct Install	Incorporated results from draft HPWH Impact Evaluation – updated savings formula, application of an efficiency adjustment, ISR, FR. Updated incremental cost with recent program data.	7/1/2019	Y
Revision	Pellet/Cord Wood Boiler	Updated description and efficiency assumption with program data.	7/1/2019	Y
Revision	Window Inserts	Updated load shape factors based on new modeling.	7/1/2019	Y
Revision	Appendix F Baseline Bulb Replacement Schedule and Avoided O&M	Updated baseline bulb replacement schedule and discount rate.	7/1/2019	N

Change Type	TRM Section	Description	Effective Date	effRT update
Revision	Low Flow Devices	Increased precision of kW value to avoid rounding errors in peak demand reduction.	7/1/2019	Y
Revision	Seal/Insulate Pipes/Ducts	Corrected fuel distribution for unknown fuel type	7/1/2019	Y
Revision	Carbon Dioxide Emission Factors	Updated electricity factor with ISO NE all LMUs from 2017 emissions report	7/1/2019	N
Revision	Heat Pumps	New measure codes and new savings estimates for Tier 1 and Tier 2. Refinement of model input assumptions and resultant savings estimates. Refined energy period factors.	8/1/2019	Y
Other	Low flow devices	Replaced Appliance Rebate with Retail Initiatives and added Low Income Initiatives to Programs	8/1/2019	N
Revision	Low flow devices and Direct Install LED	Updated In-Service Rate from HPWH Impact Evaluation	8/1/2019	Y
Revision	On Demand NG Water Heater	Updated EE assumptions to match updated program eligibility requirements	8/1/2019	Y
Correction	Basement Insulation	FR and SO updated with evaluation results	7/1/2019	N
Other	ECM Smart Pump	Distributor program added, commercial sector added, energy period factors added	7/1/2019	Y
Revision	HPWH	Revised input assumptions based on reviewed evaluation results Updated cost data with recent program data	11/1/2019	Y
Correction	Boilers and Furnaces	Corrected energy savings formula. Correct formula was used to calculate reported savings.	11/1/2019	N
Revision	Boilers and Furnaces	Measure codes updated to BOILM and FURNM to reflect their movement to midstream and addition of commercial use. FR and SO values reset to 25% and 0% due to their move to midstream. Added AHL formula for commercial savings calculation.	7/1/2019	Y
Revision	Tankless Water Heaters	Added TLWH measure code for distributor program. This measure is now also a commercial offering, and includes propane water heaters in addition to natural gas.	7/1/2019	Y
Revision	Tankless Water Heaters	Updated incremental measure cost with more recent data	7/1/2019	Y

Change Type	TRM Section	Description	Effective Date	effRT update
Other	Electronically Commutated Motor: Hydronic Heating Smart Circulation Pump	Added commercial savings. Residential and commercial measures are offered through the distributor program.	7/1/2019	Y
Correction	Window Inserts	Corrected the R-values.	7/1/2019	Y
Revision	LEDs	Updated wattage and cost data with recent program data.	11/1/2019	Y
Other	Emission Factors	Updated emission factors	11/1/2019	N
Revision	HPWH	Updated cost data with recent program data	1/1/2020	N
Revision	LED	Updated cost data with recent program data	1/1/2020	Y
Correction	CW	Corrected rounding error in reported kW reduction	7/1/2019	Y
Correction	Heat Pumps	Corrected winter peak demand reduction values for electric resistance back up heating system for HPSING<X>T<X> and HPMULT<X>T<X>	8/1/2019	N
Correction	Low Flow Devices	Corrected winter and summer peak demand reduction values for LFKA, LFBA, LFSH, TSV	7/1/2019	Y
Correction	Low Flow Devices	Corrected winter and summer peak demand reduction values for LILFKA, LILFBA, LILFSH	12/1/2019	Y
Other	TSTAT	Low Income measure added	2/1/2020	Y
Revision	ECM Smart Pump	Cost data updated with shelf study results for ECMHW	4/1/2020	Y
Other	Low Income NG Direct Install (DI) Insulation	Added LNBI measure code to LNAI removed inactive designator	7/1/2019	Y
Other	Low Income NG DI Air Sealing	Removed inactive designator	7/1/2019	Y
Other	Throughout	Clarified that EFF values are percentages	N/A	N
Correction	Appendix B	Corrected ECM coincidence factors	7/1/2019	N
Correction	Heat Pumps	Corrected projected share of retrofit for tier 2 units Corrected Tier 2 efficient eligibility to 12.5 HSPF	8/1/2019	N
Correction	Wood & Pellet Stoves	Savings were incorrectly updated for NSPS 2020 compliance ahead of compliance date. Savings for 7/1/2019-3/31/2020 were 2.556 MMBtu/y.	7/1/2019	N
Revision	Wood & Pellet Stoves	Updated baseline efficiency to reflect NSPS 2020 compliant models.	4/1/2020	Y
Revision	LED	Updated cost and wattage with recent program data	4/1/2020	Y

Change Type	TRM Section	Description	Effective Date	effRT update
Revision	HPWH	Updated cost data with recent program data. Updated savings for blended baseline assumptions and FR rate from survey data.	7/1/2020	Y
Revision	LIHPWH	Added non-electric baseline savings	7/1/2020	Y
Revision	LED	Updated cost and wattage with recent program data. Updated FR rate with CREED 2019 results. Updated measure life to account for market transformation.	7/1/2020	Y
Revision	Low Flow Devices	Added new measure codes for LI showerhead to distinguish handheld from wall mount. Added program negotiated prices for LI.	7/1/2020	Y
Other	Heat Pumps	Added cooling assumptions for retrofit scenarios. Corrected Low Income measure cost to “actual” (documentation only correction).	7/1/2020	N
Revision	Tankless Water Heater	Defined deemed hot water use for commercial applications. Replaced thermal efficiency and standby loss algorithm for commercial applications with equivalent energy factor.	7/1/2020	Y
Revision	Window Inserts	Added air infiltration reduction	7/1/2020	Y
Other	Pellet/Cord Wood Boiler	Added Commercial to Sector	7/1/2020	Y
Revision	LED	Updated cost and wattage with recent program data.	11/1/2020	Y
Revision	HPWH	Updated cost data with recent program data.	11/1/2020	Y
Revision	LED	Updated cost and wattage with recent program data.	3/1/2020	Y
Revision	HPWH	Updated cost data with recent program data.	3/1/2021	Y
Correction	LIHPWH	Added missing electric impact for non-electric baseline	7/1/2021	N
Revision	Carbon Dioxide Emission Factors	Updated electricity factor with ISO NE all LMUs from 2019 emissions report	7/1/2021	N
Revision	HPWH	Updated cost data based on distributor pricing due to rapid price increase	7/1/2021	Y
Revision	RAP	Updated efficiency assumptions	7/1/2021	Y
Revision	Table 11	Matched insulation fuel distribution to Air Sealing and Window Inserts	7/1/2021	Y
Revision	LED	Updated cost and wattage with recent program data. Updated interactive effects, CF and EPF from evaluation results. Updated incremental cost, and free ridership from CREED data.	7/1/2021	Y

Change Type	TRM Section	Description	Effective Date	effRT update
Revision	HPSING1T1, HPSING2T1, HPSING1T2, HPSING2T2, HPMULT1T1, HPMULT2T1	Updated savings from revised modeling with better matched baseline HP capacity and corrected peak demand coincidence. Added to footnote that weighted average of Retrofit and Lost Opportunity is used for Tier 2 units.	7/1/2021	Y
Addition	Transportation: BEV and PHEV	New transportation section and corresponding additions to Appendix B	Retroactive 7/1/2020	Y
Revision	Insulation	Replaced deemed per zone savings with site specific calculated savings.	Retroactive to 9/3/2021	Y
Revision	LED	Updated cost and wattage with recent program data.	3/10/2022	Y
Revision	HPWH	Updated cost data based on recent program data	3/10/2022	Y
Revision	BEV, PHEV	Modified peak demand impacts and energy period factors based on refined metering analysis	Retroactive to 7/1/2021	Y
Revision	LWI	Updated cost with recent program data	3/10/2022	Y
Revision	HPSING1T1, HPSING2T1, HPSING1T2, HPSING2T2, HPMULT1T1, HPMULT2T1, HPMULT1T2, HPMULT2T2	Updated retrofit HP measure cost. Added HPMULT1T2, HPMULT2T2 measure codes	Retroactive to 3/1/2022	Y
Correction	Specialty LED Bulb	Corrected summer and winter coincidence factors to reflect evaluation findings. effRT implementation was correct.	Retroactive to 7/1/2021 and 3/10/2022	N
Correction	Appendix B	Updated energy period factors to reflect updated HP savings modeling from 7/1/2021 TRM update. EPF were implemented correctly in effRT at the time of the update.	Retroactive to 7/1/2021	N
Revision	Appendix B	Updated energy period factors for air sealing and insulation to reflect electric portion of fuel blend (HESP) and proper cooling only factors (AHI).	5/1/2022	Y
Correction	LEDs	Corrected ISR to properly reflect evaluation findings.	Retroactive to 7/1/2021	Y
Revision	BEV, PHEV	Added avoided O&M costs	Retroactive to 7/1/2021	N
Revision	LED	Updated cost and wattage with recent program data. Updated baseline cost, avoided O&M, and free ridership from CREED data.	7/1/2022	Y
Revision	HPWH	Updated cost with recent program data	7/1/2022	Y
Revision	PHEV	Updated MPG for PHEV.	7/1/2022	Y

Change Type	TRM Section	Description	Effective Date	effRT update
Revision	MHBB	Added underbelly zone to suite of insulation measures, removed inactive mobile home underbelly (Component of LUB) measure. Added fuel distribution for "unknown" fuel specific to mobile homes.	7/1/2022	Y
Revision	HP	Updated assumed retrofit portion for tier 2 heat pumps based on recent program activity. Added new measure codes for multizone tier 2 measures.	7/1/2022	Y
Revision	Emission Factors	Updated emission factors with most recent EIA and ISO NE reported values	7/1/2022	N
Correction	LCHA, LCHL, LCHD	Corrected non-electric deemed savings. effRT implementation was correct	7/1/2020	N
Revision	HPWH	Updated cost with recent program data	10/1/2022	Y
Revision	LED	Updated cost and wattage with recent program data.	10/1/2022	Y
Correction	Insulation	Added CFM50 to CFH natural conversion. effRT formulas correct	9/3/2021	N
Correction	Table: Insulation Zone Parameters	Updated CFM row to be CFM50 values not CFM natural	9/3/2021	N
Revision	HPWH	Updated cost with recent program data	1/1/2023	Y
Revision	Electric Vehicles	Updated incremental cost with recent program data	1/1/2023	Y
Other	Lighting	Retail LEDs marked inactive (LILEDs remain active)	1/1/2023	Y
Revision	HPWH<X>	Updated cost with recent program data	7/1/2023	Y
Revision	LIHPWH; HPHW<X>	Updated electric baseline efficiency	7/1/2023	Y
Revision	BOILM	Updated baseline and efficient equipment efficiency, and incremental cost based on distributor interview. Marked measure inactive.	7/1/2023	Y[5]
Revision	TLWH	Updated baseline and efficient equipment efficiency, and incremental cost based on distributor interview. Marked measure inactive.	7/1/2023	Y[6]
Revision	B<X>, LB<X>, MB<X>, IR, LIR, MIR	Air sealing bonus removed from insulation measures. Air sealing measure modified to be calculated savings using pre/post CFM50 measurement to capture all air sealing savings in the IR, LIR and MIR measures. AA, LAA measures removed.	7/1/2023	Y
Revision	RAP	Updated measure cost based on shelf study and marked measure inactive.	7/1/2023	Y[7]

[5] Implementation of change in effRT will be delayed allowing for processing of carryover claims from previous year.
[6] Implementation of change in effRT will be delayed allowing for processing of carryover claims from previous year.
[7] Implementation of change in effRT will be delayed allowing for processing of carryover claims from previous year.

Change Type	TRM Section	Description	Effective Date	effRT update
Revision	APB	Updated baseline fuel efficiency and incremental cost based on recent program data	10/1/2023	Y
Revision	GHP	Updated incremental cost based on recent program data	10/1/2023	Y
New	<LI/MI/AI>WHHPR	Added Whole Home Heat Pump measure	9/18/2023	Y
Revision	GHP	Updated efficient measure to reflect water-to-air closed loop system (most common installation type) Updated baseline EER to match ASHRAE 2009 for single package system.	1/1/2024	Y
Revision	<LI/MI/AI>WHHPR	Distinguished freerider rates for all income, moderate, and low income. Update energy impacts based on DHP model scaled to whole home. Added separate entry in Appendix B for coincidence and energy period factors.	9/18/2023	Y

Correction: indicates a correction to an existing error in the previous TRM.
New: indicates a measure that was not included in the previous TRM
Revision: indicates a revision to the savings or costs of an existing measure
Removal: indicates a removal of measure that is discontinued
Other: indicates a change to an existing measure or existing text and that does not affect savings or cost calculation

Note: The Change Log provides a running history of changes in chronological order. More recent changes take precedence over previous changes. Previous change log entries are not updated so as to provide historic reference to past changes.

Lighting

Standard LED (Light Emitting Diode) Bulb – Retail (LEDSTDLL, LEDSTDSL) (Inactive)	
Last Revised Date	10/1/2022
MEASURE OVERVIEW	
Description	Standard (A-Line) LED Bulbs. This measure involves the installation of a new LED in place of an existing or new inefficient bulb.
Primary Energy Impact	Electric
Sector	Residential, Commercial
Program(s)	Consumer Products Program – Lighting - Retail
End-Use	Lighting
Decision Type	New Construction, Replace on Burnout
DEEMED GROSS ENERGY SAVINGS (UNIT SAVINGS)	
Demand savings	See Table 1
Annual energy savings	See Table 1
GROSS ENERGY SAVINGS ALGORITHMS (UNIT SAVINGS)	
Demand savings	$\Delta kW = \Delta Watt_{LED} / 1{,}000 \times IE_{COOL\_D}$ $\Delta kW_{SP} = \Delta Watt_{LED} / 1{,}000 \times CF_S \times IE_{COOL\_D}$ $\Delta kW_{WP} = \Delta Watt_{LED} / 1{,}000 \times CF_W$
Annual energy savings	$\Delta kWh/yr = \Delta Watts_{LED} / 1{,}000 \times [365 \times HPD_{RES} \times \%RES + HPY_{COMM} \times \%COMM] \times IE_{COOL\_E}$ $\Delta MMBtu = -\Delta Watts_{LED} / 1{,}000 \times [365 \times HPD_{RES} \times \%RES + HPY_{COMM} \times \%COMM] \times IE_{HEAT\_E}$ $\Delta MMBtu_{FUEL} = \Delta MMBtu \times \%FUEL$
Definitions	Unit = 1 bulb $\Delta Watt_{LED}$ = Average wattage difference between baseline bulbs and program LED (Watts) 1,000 = Conversion: 1,000 Watts per kW 365 = Conversion: 365 days per year HPD_{RES} = Average daily operating hours in residential setting (hrs/day) %RES = Share of bulb purchases that are installed in residential setting (%) HPY_{COMM} = Average annual operating hours in commercial setting (hrs/yr) %COMM = Share of bulb purchases that are installed in commercial setting (%) IE_{COOL_D} = Electric demand interactive effect multiplier, accounts for reduced cooling load IE_{COOL_E} = Electric energy interactive effect multiplier, accounts for reduced cooling load IE_{HEAT_E} = MMBtu energy interactive effect multiplier, accounts for increased heat load %FUEL = Home heating fuel distribution [8]
EFFICIENCY ASSUMPTIONS	
Baseline Efficiency	Halogen bulb
Efficient Measure	LED bulb

[8] Heating fuel distribution is used to allocate savings to different fuels because the interactive effects impact heating energy consumption.

Standard LED (Light Emitting Diode) Bulb – Retail (LEDSTDLL, LEDSTDSL) (Inactive)							
PARAMETER VALUES (DEEMED)							
Measure	$\Delta Watts_{LED}$	HPD_{RES}	HPY_{COMM}	%RES	%COMM	Life (yrs)	Cost ($)
LED Bulb	Table 1	2.1[9]	3,053[10]	93.75%[11]	6.25%[12]	Table 3	Table 3
	IE_{COOL_D}	IE_{COOL_E}	IE_{HEAT_D}	IE_{HEAT_E}	%FUEL	Avoided O&M ($)	
LED Bulb	1.062[13]	1.0095[14]	0.9884[15]	0.00131[16]	Table 15	Table 3	

IMPACT FACTORS							
Measure	ISR	RR_E	RR_D	CF_W	CF_S	FR	SO
LED Bulb	Table 2	100%[17]	100%[18]	18.5%[19]	10.9%[20]	66%[21]	0%[22]

[9] Demand Side Analytics, Retail and Distributor Lighting Impact Evaluation, March 2021.
[10] Ibid.
[11] Ibid.
[12] Ibid.
[13] Derived from the concept set forth in Rundquist, R.A., Johnson, K.F., Aumann, D.J. (1993). Calculating Lighting and HVAC Interactions. ASHRAE Journal, 35(11), 28-37. See Appendix F: Supplementary Information for Retail Products for derivation and input assumptions.
[14] Ibid.
[15] Ibid.
[16] Ibid.
[17] Realization rates are 100 percent since savings estimates are based on evaluation results.
[18] Ibid.
[19] Composite coincidence factors based on proportion of bulbs installed in residential and commercial settings. Demand Side Analytics, Retail and Distributor Lighting Impact Evaluation, March 2021.
[20] Ibid.
[21] CREED CY2021 Current and Past Market Effects Model.
[22] Spillover not estimated separately from net-to-gross. FR = 1 – NTG.

Specialty LED Bulb – Retail (LEDSPCRFL, LEDSPCRFS, LEDSPCOL, LEDSPCOS, LEDSPCCDL, LEDSPCCDS) (Inactive)	
Last Revised Date	10/1/2022
MEASURE OVERVIEW	
Description	Specialty LED Bulbs (Globe, Candelabra, and 3-way). This measure involves the installation of a LED in place of an existing or new inefficient bulb (incandescent or halogen).
Primary Energy Impact	Electric
Sector	Residential, Commercial
Program(s)	Consumer Products Program – Lighting - Retail
End-Use	Lighting
Decision Type	New Construction, Replace on Burnout
DEEMED GROSS ENERGY SAVINGS (UNIT SAVINGS)	
Demand savings	See Table 1
Annual energy savings	See Table 1
GROSS ENERGY SAVINGS ALGORITHMS (UNIT SAVINGS)	
Demand savings	$\Delta\ kW = \Delta Watt_{LED}\ /\ 1{,}000 \times IE_{COOL\_D}$ $\Delta\ kW_{SP} = \Delta Watt_{LED}\ /\ 1{,}000 \times CF_{S} \times IE_{COOL\_D}$ $\Delta\ kW_{WP} = \Delta Watt_{LED}\ /\ 1{,}000 \times CF_{W}$
Annual energy savings	$\Delta kWh/yr = \Delta Watts_{LED}\ /\ 1{,}000 \times [365 \times HPD_{RES} \times \%RES + HPY_{COMM} \times \%COMM] \times IE_{COOL\_E}$ $\Delta\ MMBtu = -\Delta Watts_{LED}\ /\ 1{,}000 \times [365 \times HPD_{RES} \times \%RES + HPY_{COMM} \times \%COMM] \times IE_{HEAT\_E}$ $\Delta MMBtu_{FUEL} = \Delta MMBtu \times \%FUEL$
Definitions	Unit = 1 bulb $\Delta Watt_{LED}$ = Average wattage difference between baseline bulbs and program LED (Watts) 1,000 = Conversion: 1,000 Watts per kW 365 = Conversion: 365 days per year HPD_{RES} = Average daily operating hours in residential setting (hrs/day) %RES = Share of bulb purchases that are installed in residential setting (%) HPY_{COMM} = Average annual operating hours in commercial setting (hrs/yr) %COMM = Share of bulb purchases that are installed in commercial setting (%) IE_{COOL_D} = Electric demand interactive effect multiplier, accounts for reduced cooling load IE_{COOL_E} = Electric energy interactive effect multiplier, accounts for reduced cooling load IE_{HEAT_E} = MMBtu energy interactive effect multiplier, accounts for increased heat load %FUEL = Home heating fuel distribution[23]
EFFICIENCY ASSUMPTIONS	
Baseline Efficiency	Incandescent
Efficient Measure	LED bulb

[23] Heating fuel distribution is used to allocate savings to different fuels because the interactive effects impact heating energy consumption.

Specialty LED Bulb – Retail (LEDSPCRFL, LEDSPCRFS, LEDSPCOL, LEDSPCOS, LEDSPCCDL, LEDSPCCDS) (Inactive)							
PARAMETER VALUES (DEEMED)							
Measure	$\Delta Watts_{LED}$	HPD_{RES}	HPY_{COMM}	%RES	%COMM	Life (yrs)	Cost ($)
LED Bulb	Table 1	2.1[24]	3053[25]	93.75%[26]	6.25%[27]	Table 3	Table 3
	IE_{COOL_D}	IE_{COOL_E}	IE_{HEAT_D}	IE_{HEAT_E}	%FUEL	Avoided O&M ($)	
LED Bulb	1.062[28]	1.0095[29]	0.9884[30]	0.00131[31]	Table 15	Table 3	

IMPACT FACTORS							
Measure	ISR	RR_E	RR_D	CF_W	CF_S	FR	SO
LED Bulb	Table 2	100%[32]	100%[33]	18.5%[34]	10.9%[35]	66%[36]	0%[37]

[24] Demand Side Analytics, Retail and Distributor Lighting Impact Evaluation, March 2021.
[25] Average annual hours of use for commercial spaces. Efficiency Maine Commercial Technical Reference Manual Version 2015.1, Table 33.
[26] The Cadmus Group, Efficiency Maine Trust Residential Lighting Program Evaluation, November 1, 2012, p. 71.
[27] Ibid.
[28] Derived from the concept set forth in Rundquist, R.A., Johnson, K.F., Aumann, D.J. (1993). Calculating Lighting and HVAC Interactions. ASHRAE Journal, 35(11), 28-37. See Appendix F: Supplementary Information for Retail Products for derivation and input assumptions.
[29] Ibid.
[30] Ibid.
[31] Ibid.
[32] Realization rates are 100 percent since savings estimates are based on evaluation results.
[33] Realization rates are 100 percent since savings estimates are based on evaluation results.
[34] Composite coincidence factors based on proportion of bulbs installed in residential and commercial settings. Demand Side Analytics, Retail and Distributor Lighting Impact Evaluation, March 2021.
[35] Ibid.
[36] CREED CY2021 Current and Past Market Effects Model.
[37] Spillover not estimated separately from net-to-gross. FR = 1 – NTG.

Table 1. Wattage and Savings by Bulb Type for Retail Channel[38]

Bulb Type	Measure Codes	Baseline Wattage	Efficient Wattage	$\Delta Watts_{LED}$	Energy and Demand Savings with Interactive Effects							
					Electricity	Winter	Summer	Natural Gas	Propane	Wood	Kerosene	Oil
					kWh/y	kW	kW	MMBtu	MMBtu	MMBtu	MMBtu	MMBtu
Standard LEDs	**LEDSTDLL, LEDSTDSL**	42	9.4	32.6	29	0.006	0.004	-0.004	-0.003	-0.005	-0.001	-0.025
Specialty LEDs - Reflector	**LEDSPCRFL, LEDSPCRFS**	61	**10.4**	**50.6**	46	0.009	0.006	-0.006	-0.005	-0.008	-0.001	-0.038
Specialty LEDs - Other (Globe & 3-Way)	**LEDSPCOL, LEDSPCOS**	48	**9.0**	**39.0**	35	0.007	0.005	-0.004	-0.004	-0.006	-0.001	-0.030
Specialty LEDs - Candelabra	**LEDSPCCDL, LEDSPCCDS**	42	**4.5**	**37.5**	34	0.007	0.004	-0.004	-0.003	-0.006	-0.001	-0.028

Table 2. In-service rate by bulb style[39]

Bulb Style	ISR
A-line	94.3%
Reflector	97.5%
Globe & Three Way	98.3%
Candelabra	97.0%

[38] Weighted average wattage based on April – June 2022 program sales data for LEDs. Baseline wattage based on lumen equivalent baseline lamps. Savings calculated with delta watts and assumptions defined in TRM measure entries for hours of use, waste heat factors, and coincidence factors, and fuel distribution in Table 15.

[39] Weighted average of residential and non-residential in-service rates. Demand Side Analytics, Retail and Distributor Lighting Impact Evaluation, March 2021.

Table 3. Measure Cost, Measure Life, and O&M by Bulb Type for Retail Channel[40,41,42,43]

Bulb Type	Measure Codes	Baseline Retail Price	Average Efficient Product Retail Price Before Incentive		Incremental First Cost		Measure Life		Avoided O&M	
			≥20,000 hr	<20,000 hr	≥20,000 hr	<20,000 hr	≥20,000 hr	<20,000 hr	≥20,000 hr	<20,000 hr
Standard LEDs	LEDSTDLL, LEDSTDSL	$1.69	$3.29	$2.96	$1.60	$1.27	2		$0.88	$0.88
Specialty LEDs - Reflector	LEDSPCRFL, LEDSPCRFS	$4.97	$4.68	$8.02	$0[A]	$3.05	1		$0.00	$0.00
Specialty LEDs - Other (Globe & 3-Way)	LEDSPCOL, LEDSPCOS	$1.58	$8.68	$5.34	$7.10	$3.76	3		$0.87	$0.87
Specialty LEDs - Candelabra	LEDSPCCDL, LEDSPCCDS	$1.15	$5.83	$3.89	$4.68	$2.74	3		$0.63	$0.63

[A] Short life LED reflector bulbs have an average price before rebate less than the average price for baseline reflector bulbs. The incremental cost has been overridden to $0.

[40] Cost values based on weighted average pre-incentivized retail costs from April – June 2022 program sales data for efficient cost and baseline cost from CREED 2021 analysis.

[41] Although long-life LEDs have a useful life of 29 years based on rated lifetime of 25,000 hours and short-life LEDs have a useful life of 18 years based on a rated lifetime of 15,000 hours, an equivalent measure life has been defined for bulbs taking market transformation into account. As LEDs capture more market share, there is a point in the future where the current baseline selections will no longer be the standard practice. Therefore, in the counterfactual scenario, an LED bulb would be purchased in the future before the program supported bulb burns out.

[42] Because the efficient measure has a longer effective life than the baseline measure, future replacement costs are avoided. The avoided O&M cost is based on the NPV of avoided replacement costs for baseline products throughout the lifetime of the efficient products taking market transformation into account. No labor costs have been included. See Table 18 for baseline bulb replacement schedule.

[43] The free ridership rate is based on CREED 2021 regression modeling.

Standard LED Bulb –Direct Install & DIY Kit (LILEDSTANL, LILEDSTANS) (Inactive)		
Last Revised Date	7/1/2022	
MEASURE OVERVIEW		
Description	This measure involves giving LED bulbs to participants via food pantries direct mail or direct install channels. Bulbs distributed offset future purchase of inefficient bulbs (halogen).	
Primary Energy Impact	Electric	
Sector	Residential	
Program(s)	Arrearage Management Program, Food Pantry Lighting Program, Low Income Direct Install, Low Income Direct Mail	
End-Use	Lighting	
Decision Type	New Construction, Replace on Burnout	
DEEMED GROSS ENERGY SAVINGS (UNIT SAVINGS)		
Demand savings	60 W Equivalent LED Bulb: $\Delta kW = 0.036$ $\Delta kW_{WP} = 0.006$ $\Delta kW_{SP} = 0.003$ 100 W Equivalent LED Bulb: $\Delta kW = 0.058$ $\Delta kW_{WP} = 0.009$ $\Delta kW_{SP} = 0.004$	
Annual energy savings	60 W Equivalent $\Delta kWh/yr =$ 26 $\Delta MMBtu/yr_{GAS} =$ -0.031 $\Delta MMBtu/yr_{PROP} =$ -0.003 $\Delta MMBtu/yr_{WOOD} =$ -0.005 $\Delta MMBtu/yr_{KERO} =$ -0.001 $\Delta MMBtu/yr_{OIL} =$ -0.022 $\Delta MMBtu/yr_{NET} =$ 0.056	100 W Equivalent $\Delta kWh/yr =$ 42 $\Delta MMBtu/yr_{GAS} =$ -0.050 $\Delta MMBtu/yr_{PROP} =$ -0.004 $\Delta MMBtu/yr_{WOOD} =$ -0.007 $\Delta MMBtu/yr_{KERO} =$ -0.001 $\Delta MMBtu/yr_{OIL} =$ -0.035 $\Delta MMBtu/yr_{NET} =$ 0.091
GROSS ENERGY SAVINGS ALGORITHMS (UNIT SAVINGS)		
Demand savings	$\Delta kW = \Delta Watt_{LED} / 1{,}000 \times IE_{COOL\_D}$ $\Delta kW_{SP} = \Delta Watt_{LED} / 1{,}000 \times CF_S \times IE_{COOL\_D}$ $\Delta kW_{WP} = \Delta Watt_{LED} / 1{,}000 \times CF_W \times IE_{HEAT\_D}$	
Annual energy savings	$\Delta kWh/yr = \Delta Watts_{LED} / 1{,}000 \times [365 \times HPD_{RES}] \times IE_{COOL\_E}$ $\Delta MMBtu = -\Delta Watts_{LED} / 1{,}000 \times [365 \times HPD_{RES}] \times IE_{HEAT\_E}$ $\Delta MMBtu_{FUEL} = \Delta MMBtu \times \%FUEL$	
Definitions	Unit = 1 bulb $\Delta Watt_{LED}$ = Average wattage difference between baseline bulbs and program LED (Watts) 1,000 = Conversion: 1,000 Watts per kW 365 = Conversion: 365 days per year HPD_{RES} = Average daily operating hours in residential setting (hrs/day) IE_{COOL_D} = Electric demand interactive effect multiplier, accounts for reduced cooling load IE_{COOL_E} = Electric energy interactive effect multiplier, accounts for reduced cooling load IE_{HEAT_D} = Electric demand interactive effect multiplier, accounts for increased heating load IE_{HEAT_E} = MMBtu energy interactive effect multiplier, accounts for increased heat load %FUEL = Home heating fuel distribution[44]	
EFFICIENCY ASSUMPTIONS		
Baseline Efficiency	Halogen bulb	
Efficient Measure	ENERGY STAR® certified LED bulb	

[44] Heating fuel distribution is used to allocate savings to different fuels because the interactive effects impact heating energy consumption.

Standard LED Bulb –Direct Install & DIY Kit (LILEDSTANL, LILEDSTANS) (Inactive)							
PARAMETER VALUES (DEEMED)							
Measure	$\Delta Watts_{LED}$	HPD_{RES}				Life (yrs)	Cost ($)
60 W Equivalent	34[45]	2.1[46]				2[47]	2.5[48]
100 W Equivalent	55[49]						
	IE_{COOL_D}	IE_{COOL_E}	IE_{HEAT_D}	IE_{HEAT_E}	%FUEL	Avoided O&M ($)	
LED Bulb	1.061[50]	1.0087[51]	0.9879[52]	0.00130[53]	Table 15	0.88[54]	
IMPACT FACTORS							
Measure	ISR	RR_E	RR_D	CF_W	CF_S	FR	SO
Low-Income	77%[55]	100%[56]	100%[57]	17.2%[58]	7.3%[59]	0%[60]	0%[61]

[45] 9 watt A-line standard bulb replacing a 43 W halogen.
[46] Demand Side Analytics, Retail and Distributor Lighting Impact Evaluation, March 2021 (767 annual hours / 365 day/y).
[47] Although long-life LEDs have a useful life of 29 years based on rated lifetime of 25,000 hours and short-life LEDs have a useful life of 18 years based on a rated lifetime of 15,000 hours, an equivalent measure life has been defined for bulbs taking market transformation into account. As LEDs capture more market share, there is a point in the future where the current baseline selections will no longer be the standard practice. Therefore, in the counterfactual scenario, an LED bulb would be purchased in the future before the program supported bulb burns out.
[48] Actual cost paid by program.
[49] 17 watt A-line standard bulb replacing a 72 W halogen.
[50] Derived from the concept set forth in Rundquist, R.A., Johnson, K.F., Aumann, D.J. (1993). Calculating Lighting and HVAC Interactions. ASHRAE Journal, 35(11), 28-37. See Appendix F: Supplementary Information for Retail Products for derivation and input assumptions.
[51] Ibid.
[52] Ibid.
[53] Ibid.
[54] Because the efficient measure has a longer effective life than the baseline measure, future replacement costs are avoided. The avoided O&M cost is based on the NPV of avoided replacement costs for baseline products throughout the lifetime of the efficient products. No labor costs have been included. See Table 18 for baseline bulb replacement schedule.
[55] West Hill Energy and Computing, Heat Pump Water Heater Initiatives Impact Evaluation, Fiscal Years 2015-2017
[56] Realization rates are 100 percent since savings estimates are based on evaluation results.
[57] Ibid.
[58] Demand Side Analytics, Retail and Distributor Lighting Impact Evaluation, March 2021.
[59] Ibid.
[60] Assume same free ridership as Food Pantry CFL bulbs: NMR Group, Efficiency Maine Retail Lighting Program Overall Evaluation Report, April 16, 2015, p. 24.
[61] Assume same free ridership as Appliance Pack CFL bulbs NMR Group, Efficiency Maine Retail Lighting Program Overall Evaluation Report, April 16, 2015, p. 24.

Specialty LED Bulb – Food Pantry, Direct Install & DIY Kit (LEDSPCLFP, LEDSPCSFP, LILEDSPECL, LILEDSPECS) (Inactive)	
Last Revised Date	7/1/2022
MEASURE OVERVIEW	
Description	This measure involves giving LED bulbs to participants via food pantries, direct mail, direct install. Bulbs distributed offset future purchase of inefficient bulbs.
Primary Energy Impact	Electric
Sector	Residential
Program(s)	Arrearage Management Program, Food Pantry Lighting Program, Low Income Direct Install, Low Income Direct Mail
End-Use	Lighting
Decision Type	Retrofit
DEEMED GROSS ENERGY SAVINGS (UNIT SAVINGS)	
Demand savings	$\Delta kW = 0.057$ $\Delta kW_{WP} = 0.009$ $\Delta kW_{SP} = 0.004$
Annual energy savings	$\Delta kWh/yr =$ 41 $\Delta MMBtu/yr_{GAS} =$ -0.050 $\Delta MMBtu/yr_{PROP} =$ -0.004 $\Delta MMBtu/yr_{WOOD} =$ -0.007 $\Delta MMBtu/yr_{KERO} =$ -0.001 $\Delta MMBtu/yr_{OIL} =$ -0.035 $\Delta MMBtu/yr_{NET} =$ 0.088
GROSS ENERGY SAVINGS ALGORITHMS (UNIT SAVINGS)	
Demand savings	$\Delta kW = \Delta Watt_{LED} / 1,000 \times IE_{COOL\_D}$ $\Delta kW_{SP} = \Delta Watt_{LED} / 1,000 \times CF_S \times IE_{COOL\_D}$ $\Delta kW_{WP} = \Delta Watt_{LED} / 1,000 \times CF_W \times IE_{HEAT\_D}$
Annual energy savings	$\Delta kWh/yr = \Delta Watts_{LED} / 1,000 \times [365 \times HPD_{RES}] \times IE_{COOL\_E}$ $\Delta MMBtu = -\Delta Watts_{LED} / 1,000 \times [365 \times HPD_{RES}] \times IE_{HEAT\_E}$ $\Delta MMBtu_{FUEL} = \Delta MMBtu \times \%FUEL$
Definitions	Unit = 1 bulb $\Delta Watt_{LED}$ = Average wattage difference between baseline bulbs and program LED (Watts) 1,000 = Conversion: 1,000 Watts per kW 365 = Conversion: 365 days per year HPD_{RES} = Average daily operating hours in residential setting (hrs/day) IE_{COOL_D} = Electric demand interactive effect multiplier, accounts for reduced cooling load IE_{COOL_E} = Electric energy interactive effect multiplier, accounts for reduced cooling load IE_{HEAT_D} = Electric demand interactive effect multiplier, accounts for increased heating load IE_{HEAT_E} = MMBtu energy interactive effect multiplier, accounts for increased heat load %FUEL = Home heating fuel distribution[62]
EFFICIENCY ASSUMPTIONS	
Baseline Efficiency	Incandescent bulb
Efficient Measure	ENERGY STAR® certified LED bulb

[62] Heating fuel distribution is used to allocate savings to different fuels because the interactive effects impact heating energy consumption.

Specialty LED Bulb – Food Pantry, Direct Install & DIY Kit (LEDSPCLFP, LEDSPCSFP, LILEDSPECL, LILEDSPECS) (Inactive)							
PARAMETER VALUES (DEEMED)							
Measure	$\Delta Watts_{LED}$	HPD_{RES}				Life (yrs)	Cost ($)
LED Bulb	54[63]	2.1[64]				3[65]	2.95[66]
	IE_{COOL_D}	IE_{COOL_E}	IE_{HEAT_D}	IE_{HEAT_E}	%FUEL	Avoided O&M ($)	
LED Bulb	1.061[67]	1.0087[68]	0.9879[69]	0.00130[70]	Table 15	2.73[71]	
IMPACT FACTORS							
Measure	ISR	RR_E	RR_D	CF_W	CF_S	FR	SO
Low-Income	77%[72]	100%[73]	100%[74]	17.2%[75]	7.3%[76]	0%[77]	0%[78]

[63] 10 watt reflector bulb replacing a 64 W incandescent bulb (based on weighted average of retail program).
[64] Demand Side Analytics, Retail and Distributor Lighting Impact Evaluation, March 2021 (767 annual hours / 365 day/y).
[65] Although long-life LEDs have a useful life of 29 years based on rated lifetime of 25,000 hours and short-life LEDs have a useful life of 18 years based on a rated lifetime of 15,000 hours, an equivalent measure life has been defined for bulbs taking market transformation into account. As LEDs capture more market share, there is a point in the future where the current baseline selections will no longer be the standard practice. Therefore, in the counterfactual scenario, an LED bulb would be purchased in the future before the program supported bulb burns out.
[66] Actual cost paid by program.
[67] Derived from the concept set forth in Rundquist, R.A., Johnson, K.F., Aumann, D.J. (1993). Calculating Lighting and HVAC Interactions. ASHRAE Journal, 35(11), 28-37. See Appendix F: Supplementary Information for Retail Products for derivation and input assumptions.
[68] Ibid.
[69] Ibid.
[70] Ibid.
[71] Because the efficient measure has a longer effective life than the baseline measure, future replacement costs are avoided. The avoided O&M cost is based on the NPV of avoided replacement costs for baseline products throughout the lifetime of the efficient products. No labor costs have been included. See Table 18 for baseline bulb replacement schedule.
[72] West Hill Energy and Computing, Heat Pump Water Heater Initiatives Impact Evaluation, Fiscal Years 2015-2017.
[73] Realization rates are 100 percent since savings estimates are based on evaluation results.
[74] Ibid.
[75] Demand Side Analytics, Retail and Distributor Lighting Impact Evaluation, March 2021.
[76] Ibid.
[77] Assume same free ridership as Food Pantry CFL bulbs: NMR Group, Efficiency Maine Retail Lighting Program Overall Evaluation Report, April 16, 2015, p. 24.
[78] Assume same free ridership as Appliance Pack CFL bulbs NMR Group, Efficiency Maine Retail Lighting Program Overall Evaluation Report, April 16, 2015, p. 24.

Appliances

Refrigerator (Inactive) (RF)							
Last Revised Date	7/1/2015						
MEASURE OVERVIEW							
Description	ENERGY STAR® Refrigerator. This measure involves the purchase and installation of a new ENERGY STAR®-certified refrigerator in place of a new code-compliant or standard efficiency refrigerator. The ENERGY STAR® key efficiency criteria requires that full-size refrigerators be at least 20 percent more energy efficient than the minimum federal standard.[79] A list of certified ENERGY STAR® refrigerators is available at: http://downloads.energystar.gov/bi/qplist/refrigerators.xls						
Primary Energy Impact	Electric						
Sector	Residential						
Program(s)	Appliance Rebate Program						
End-Use	Refrigeration						
Decision Type	New Construction, Replace on Burnout						
DEEMED GROSS ENERGY SAVINGS (UNIT SAVINGS)							
Demand savings	$\Delta kW_{SP} = 0.015$[80] $\Delta kW_{WP} = 0.017$[81]						
Annual energy savings	$\Delta kWh/yr = 49.1$						
GROSS ENERGY SAVINGS ALGORITHMS (UNIT SAVINGS)							
Demand savings	ΔkW_{SP} = Deemed based on evaluated results ΔkW_{WP} = Deemed based on evaluated results						
Annual energy savings	$\Delta kWh/yr = (kWh_{BASE} - kWh_{EE}) \times ISA$						
Definitions	kWh_{BASE} = Average annual energy consumption for baseline models (kWh/yr) kWh_{EE} = Average annual energy consumption for ENERGY STAR® models (kWh/yr) ISA = In-situ adjustment factor (%)						
EFFICIENCY ASSUMPTIONS							
Baseline Efficiency	Residential refrigerator that meets the current federal minimum efficiency requirement, effective September 15, 2014[82]						
Efficient Measure	ENERGY STAR®-certified refrigerator						
PARAMETER VALUES (DEEMED)							
Measure	kWh_{BASE}	kWh_{EE}	ISA		Life (yrs)	Cost ($)	
Refrigerator	509.7[83]	460.0[83]	98.8%[84]		12[83]	20[85]	
IMPACT FACTORS							
Measure	ISR	RR_E	RR_D	CF_S	CF_W	FR	SO
Refrigerator	100%[86]	100%[87]	100%[87]	100%[88]	100%[88]	67.8%[89]	3.3%[89]

[79] ENERGY STAR® Refrigerators and Freezers Key Product Criteria: http://www.energystar.gov/index.cfm?c=refrig.pr_crit_refrigerators
[80] NMR Group, Inc., Efficiency Maine Appliance Rebate Program Evaluation Overall Report – FINAL, July 18, 2014, p. 30.
[81] Memo provided to supplement NMR Group, Inc., Efficiency Maine Appliance Rebate Program Evaluation Overall Report – FINAL, July 18, 2014.
[82] Federal Standard, Code of Federal Regulations, Title 10, Part 430, Subpart C.
[83] Table 17.
[84] Ibid., p. 28. The in-situ adjustment (ISA) factor is a correction factor applied to a refrigerator's rated kWh consumption to reflect real world conditions, such as door openings, food in the refrigerators, internal temperature settings, and ambient conditions. The ISA factor for refrigerators was derived by comparing the *actual* (metered) kWh consumption with the *rated* kWh consumption; the ratio of each refrigerator's actual metered kWh consumption to its rated kWh consumption was calculated and averaged to calculate the ISA factor.
[85] ENERGY STAR Appliance Calculator.
[86] NMR Group, Inc., Efficiency Maine Appliance Rebate Program Evaluation Overall Report – FINAL, July 18, 2014, Table 2-41.
[87] Realization rates are 100 percent since savings estimates are based on evaluation results.
[88] Peak coincidence factors for this measure are embedded in the evaluated peak demand impacts.
[89] NMR Group, Inc., Efficiency Maine Appliance Rebate Program Evaluation Overall Report – FINAL, July 18, 2014, Table 2-41.

Freezer (Inactive) (FR)	
Last Revised Date	7/1/2015
MEASURE OVERVIEW	
Description	ENERGY STAR® Freezer. This measure involves the purchase and installation of a new ENERGY STAR®-certified freezer in place of a new code-compliant or standard efficiency freezer. The ENERGY STAR® key efficiency criteria requires that full-size freezers be at least 10 percent more energy efficient than the minimum federal standard.[90] A list of certified ENERGY STAR® freezers is available at: http://downloads.energystar.gov/bi/qplist/Freezers%20Product%20List.xls
Primary Energy Impact	Electric
Sector	Residential
Program(s)	Appliance Rebate Program
End-Use	Refrigeration
Decision Type	New Construction, Replace on Burnout
DEEMED GROSS ENERGY SAVINGS (UNIT SAVINGS)	
Demand savings	$\Delta kW_{SP} = 0.009$ $\Delta kW_{WP} = 0.010$
Annual energy savings	$\Delta kWh/yr = 30$
GROSS ENERGY SAVINGS ALGORITHMS (UNIT SAVINGS)	
Demand savings	$\Delta kW_{SP} = \Delta kW_{SP\text{-}Refrig} \times (\Delta kWh_{FREEZER} / \Delta kWh_{REFRIG})$ $\Delta kW_{WP} = \Delta kW_{WP\text{-}Refrig} \times (\Delta kWh_{FREEZER} / \Delta kWh_{REFRIG})$
Annual energy savings	$\Delta kWh/yr = \Delta kWh_{FREEZER}$
Definitions	Unit = 1 Freezer $\Delta kWh_{FREEZER}$ = Average annual energy savings for ENERGY STAR® freezer compared to non-certified models (kWh/yr) ΔkWh_{REFRIG} = Average annual energy savings for ENERGY STAR® refrigerator compared to non-certified models (kWh/yr) $\Delta kW_{SP\text{-}Refrig}$ = Evaluated summer peak demand reduction for Refrigerator measure (kW) $\Delta kW_{WP\text{-}Refrig}$ = Evaluated winter peak demand reduction for Refrigerator measure (kW) $RATIO_{BASE}$ = Adjustment factor to account for baseline update (%)
EFFICIENCY ASSUMPTIONS	
Baseline Efficiency	Standard residential freezer that meets the current federal minimum efficiency requirement, effective September 15, 2014[91]
Efficient Measure	ENERGY STAR®-certified freezer

PARAMETER VALUES (DEEMED)

Measure	$\Delta kWh_{FREEZER}$	ΔkWh_{REFRIG}	$\Delta kW_{SP\text{-}Refrig}$	$\Delta kW_{WP\text{-}Refrig}$	Life (yrs)	Cost ($)
ENERGY STAR® Freezer	30[92]	49.1[93]	0.015[93]	0.017[93]	12[92]	0[92]

IMPACT FACTORS

Measure	ISR	RR_E	RR_D	CF_S	CF_W	FR	SO
ENERGY STAR® Freezer	100%[94]	100%[95]	100%[95]	100%[96]	100%[96]	65.5%[97]	3.3%[97]

[90] ENERGY STAR® Refrigerators and Freezers Key Product Criteria: http://www.energystar.gov/index.cfm?c=refrig.pr_crit_refrigerators
[91] Federal Standard, Code of Federal Regulations, Title 10, Part 430, Subpart C.
[92] United States Environmental Protection Agency (USEPA), ENERGY STAR Appliance Savings Calculator, May 2015. Annual energy savings are based on savings of 30kWh at the default settings (15.4 cubic feet, chest freezer).
[93] See Refrigerator measure entry.
[94] Efficiency Maine Trust (EMT) assumes that all purchased units are installed (i.e. ISR = 100%). This is consistent with evaluation findings for other appliance measures.
[95] Realization rates are 100 percent since savings estimates are based on evaluation results.
[96] Peak coincidence factors for this measure are embedded in the evaluated peak demand impacts.

Room Air Purifier (RAP) (Inactive)

Last Revised Date	7/1/2023
MEASURE OVERVIEW	
Description	ENERGY STAR®-certified room air purifier (RAP). This measure involves the purchase and installation of a new ENERGY STAR®-certified room air purifier (also called room air cleaners) in place of a standard efficiency room air purifier. The ENERGY STAR® key efficiency criteria require that room air purifiers have a minimum efficiency of 2.0 CADR/Watt and maximum standby power of 2.0 Watts.[98] A list of certified ENERGY STAR® room air purifiers is available at: *http://downloads.energystar.gov/bi/qplist/Room_Air_Cleaners_Qualified_Product_List.xls*
Primary Energy Impact	Electric
Sector	Residential, Commercial
Program(s)	Appliance Rebate Program
End-Use	Appliance
Decision Type	New Construction, Replace on Burnout
DEEMED GROSS ENERGY SAVINGS (UNIT SAVINGS)	
Demand Savings	$\Delta kW = 0.011$ $\Delta kW_{SP} = 0.007$ $\Delta kW_{WP} = 0.007$
Annual Energy Savings	$\Delta kWh/y = 63$
GROSS ENERGY SAVINGS ALGORITHMS (UNIT SAVINGS)	
Demand Savings	$\Delta kW = \Delta kWh/y$ / Hours
Annual Energy Savings	$\Delta kWh/y$ = weighted average of EnergyStar reported savings based on CADR of program rebated models.
Definitions	Unit = 1 room air purifier Hours = Annual operating hours (hrs/yr)
EFFICIENCY ASSUMPTIONS	
Baseline Efficiency	Non-ENERGY STAR® model
Efficient Measure	ENERGY STAR®V.2 certified model

PARAMETER VALUES (DEEMED)

Measure	Savings by CADR					Hours	Life (yrs)	Cost ($)
RAP	Table 4					5,840[99]	9[100]	-13.68[101]

Measure	%RES	%COMM
RAP	99%[102]	1%[102]

IMPACT FACTORS

Measure	ISR	RR_E	RR_D	CF_S	CF_W	FR	SO
RAP	100%[103]	100%[104]	100%[104]	66.7%[105]	66.7%[105]	65.5%[106]	3.3%[106]

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97 NMR Group, Inc., Efficiency Maine Appliance Rebate Program Evaluation Overall Report – FINAL, July 18, 2014, Table 2-41.
98 ENERGY STAR® Room Air Cleaners Key Product Criteria: http://www.energystar.gov/index.cfm?c=room_airclean.pr_crit_room_airclean
99 Assume average 16 hours per day operating (from ENERGY STAR® Appliance Savings Calculator, accessed 3/31/2013).
100 Appliance Magazine, Portrait of the U.S. Appliance Industry 1998 (from ENERGY STAR® Appliance Savings Calculator, accessed 3/31/2013).
101 Shelf and on-line survey October 2022 of ENERGY STAR® and non-ENERGY STAR® units sold through Home Depot, Walmart, Lowe's.
102 EFI program data analysis Sept 23, 2015. Since commercial sector participation is currently very low, no savings estimates adjustments are being made at this time.
103 EMT assumes that all purchased units are installed (i.e. ISR = 100%). This is consistent with evaluation findings for other appliance measures.
104 This measure has not yet been evaluated. Until the next program impact evaluation, EMT assumes 100 percent realization rate.
105 See Appendix B: Coincidence and Energy Period Factors.
106 NMR Group, Inc., Efficiency Maine Appliance Rebate Program Evaluation Overall Report – FINAL, July 18, 2014, Table 2-41.

Table 4. ENERGY STAR Deemed Savings by Smoke Clean Air Delivery Rate (CADR)[107,108]

CADR Range	Electrical Savings (kWh)	Program Proportion
30 ≤ Smoke CADR < 100	39	78%
100 ≤ Smoke CADR < 150	95	16%
150 ≤ Smoke CADR < 200	173	2%
200 ≤ Smoke CADR	328	5%
Weighted Average	63	100%

[107] https://www.energystar.gov/sites/default/files/ENERGY%20STAR%20V2%20Room%20Air%20Cleaners%20Data%20Package.xlsx
[108] Program proportion based on analysis of models rebated through 3/30/2021.

Dehumidifier (DH) (Inactive)	
Last Revised Date	7/1/2016
MEASURE OVERVIEW	
Description	ENERGY STAR® dehumidifiers. This measure involves the purchase and installation of a new ENERGY STAR®-certified dehumidifier in place of a new code-compliant or standard efficiency dehumidifier. The ENERGY STAR® key efficiency criteria specify a minimum energy factor of 2.0 Liters/kWh for dehumidifiers < 75 pints per day and a minimum energy factor of 2.80 for dehumidifiers up to 185 pints per day.[109] A list of certified ENERGY STAR® dehumidifiers is available at: http://downloads.energystar.gov/bi/qplist/dehumid_prod_list.xls
Primary Energy Impact	Electric
Sector	Residential, Commercial
Program(s)	Appliance Rebate Program
End-Use	Appliance
Decision Type	New Construction, Replace on Burnout
DEEMED GROSS ENERGY SAVINGS (UNIT SAVINGS)	
Demand savings	$\Delta kW = 0.092$ $\Delta kW_{SP} = 0.034$ $\Delta kW_{WP} = 0.000$
Annual energy savings	$\Delta kWh/yr = 150$
GROSS ENERGY SAVINGS ALGORITHMS (UNIT SAVINGS)	
Demand savings	$\Delta kW = CAP_{EE} \times 0.473 \times (1 / EF_{BASE} - 1 / EF_{EE}) / 24 \times ISA$
Annual energy savings	$\Delta kWh/yr = CAP_{EE} \times 0.473 \times (1 / EF_{BASE} - 1 / EF_{EE}) \times Hours / 24 \times ISA$
Definitions	Unit = 1 dehumidifier CAP_{EE} = Rated capacity of the dehumidifier in pints per day (pints/day) EF_{BASE} = Rated Energy Factor for baseline dehumidifier (liters/kWh) EF_{EE} = Rated Energy Factor for ENERGY STAR® dehumidifier (liters/kWh) Hours = Annual operating hours (hrs/yr) 0.473 = Conversion: 0.473 liters per pint 24 = Conversion: 24 hours per day ISA = In-situ Adjustment Factor
EFFICIENCY ASSUMPTIONS	
Baseline Efficiency	Standard dehumidifier that meets the current federal minimum efficiency requirements, effective October 2012[110]
Efficient Measure	ENERGY STAR®-certified dehumidifier

[109] ENERGY STAR® Dehumidifiers Key Product Criteria: https://www.energystar.gov/sites/default/files/ENERGY%20STAR_Dehumidifiers_V4%200_Specification_Final.pdf

[110] Federal Standard, Code of Federal Regulations, Title 10, Part 430, Subpart C.

Dehumidifier (DH) (Inactive)									
PARAMETER VALUES (DEEMED)									
Measure	%RES	%COMM	CAP_{EE}	EF_{BASE}	EF_{EE}	Hours	ISA	Life (yrs)	Cost ($)
ENERGY STAR® Dehumidifier	97%[111]	3%[111]	54[112]	1.65[112]	2.0[113]	1,632[114]	81.6%[115]	12[116]	50[117]

IMPACT FACTORS							
Measure	ISR	RR_E	RR_D	CF_S	CF_W	FR	SO
ENERGY STAR® Dehumidifier	100%[118]	100%[119]	100%[119]	37.1%[120]	0%[121]	65.3%[122]	3.3%[123]

[111] EFI program data analysis Sept 23, 2015. Since commercial sector participation is currently very low, no adjustments to savings estimates are being made at this time.
[112] Average capacity based on PY16 sales data as of 4/21/16.
[113] https://www.energystar.gov/sites/default/files/ENERGY%20STAR_Dehumidifiers_V4%200_Specification_Final.pdf
[114] NMR Group, Inc., Efficiency Maine Appliance Rebate Program Evaluation Overall Report – FINAL, July 18, 2014, p. 53.
[115] Ibid, p. 53. The in-situ adjustment (ISA) factor is a correction factor applied to a dehumidifier's *rated* power draw to accurately represent its *actual* power draw. The ISA factor for dehumidifiers was derived by averaging the ratio of actual (metered) power draw of each metered dehumidifier to its rated power draw.
[116] https://www.energystar.gov/sites/default/files/asset/document/appliance_calculator.xlsx
[117] https://www.energystar.gov/sites/default/files/asset/document/appliance_calculator.xlsx
[118] NMR Group, Inc., Efficiency Maine Appliance Rebate Program Evaluation Overall Report – FINAL, July 18, 2014, p. 51.
[119] Realization rates are 100 percent since savings estimates are based on evaluation results.
[120] Derived from summer peak demand, NMR Group, Inc., Efficiency Maine Appliance Rebate Program Evaluation Overall Report – FINAL, July 18, 2014, p. 55.
[121] Assumed that dehumidifiers are not operating in the winter.
[122] NMR Group, Inc., Efficiency Maine Appliance Rebate Program Evaluation Overall Report – FINAL, July 18, 2014, Table 2-42.
[123] Ibid.

Dishwasher (DW) (Inactive)	
Last Revised Date	7/1/2015
MEASURE OVERVIEW	
Description	ENERGY STAR® Dishwashers. This measure involves the purchase and installation of a new ENERGY STAR®-certified dishwasher in place of a new code-compliant or standard efficiency dishwasher. The current ENERGY STAR® requirements, effective as of January 20, 2012, specify a maximum 295 kWh/year and minimum 4.25 gallons/cycle.[124] The associated water heater may be electric or non-electric. The deemed unit energy savings are weighted averages based on the percentages of homes with electric and non-electric water heaters. A list of certified ENERGY STAR® dishwashers is available at: *http://downloads.energystar.gov/bi/qplist/Dishwashers%20Product%20List.xls*
Primary Energy Impact	Electric (additional impacts include: natural gas, heating oil, propane and water)
Sector	Residential
Program(s)	Appliance Rebate Program
End-Use	Process
Decision Type	New Construction, Replace on Burnout
GROSS ENERGY SAVINGS (UNIT SAVINGS)	
Demand Savings	$\Delta kW = 0.159$ $\Delta kW_{WP} = 0.006$ $\Delta kW_{SP} = 0.003$
Annual Energy Savings	$\Delta kWh/yr = 6.6$ $\Delta MMBtu_{GAS}/yr = 0.003$ $\Delta MMBtu_{OIL}/yr = 0.02$ $\Delta MMBtu_{PROP}/yr = 0.003$
Annual water savings	$\Delta Gallons/yr = 468$
GROSS ENERGY SAVINGS ALGORITHMS (UNIT SAVINGS)	
Demand savings	$\Delta kW = \Delta kWh/yr / Hours$
Annual energy savings	$\Delta kWh/yr = (kWh_{BASE} - kWh_{EE}) / RCycles \times Cycles \times [(1 - \%E_{HW}) + (\%E_{HW} \times \%HW_{ELEC})]$ $\Delta MMBtu_{GAS}/yr = (kWh_{BASE} - kWh_{EE}) / RCycles \times Cycles \times \%E_{HW} \times 0.003412 / Eff_{GAS} \times \%HW_{GAS}$ $\Delta MMBtu_{OIL}/yr = (kWh_{BASE} - kWh_{EE}) / RCycles \times Cycles \times \%E_{HW} \times 0.003412 / Eff_{OIL} \times \%HW_{OIL}$ $\Delta MMBtu_{PROP}/yr = (kWh_{BASE} - kWh_{EE}) / RCycles \times Cycles \times \%E_{HW} \times 0.003412 / Eff_{PROP} \times \%HW_{PROP}$
Annual water savings	$\Delta Gallons/yr = (WC_{BASE} - WC_{EE}) \times Cycles$

[124] ENERGY STAR® Dishwashers Key Product Criteria: http://www.energystar.gov/index.cfm?c=dishwash.pr_crit_dishwashers

Dishwasher (DW) (Inactive)									
Definitions	Unit = 1 dishwasher kWh_{BASE} = Rated annual energy use of baseline dishwasher (kWh/yr) kWh_{EE} = Rated annual energy use of ENERGY STAR® dishwasher (kWh/yr) RCycles = Rated dishwasher cycles per year (cycles/yr) Cycles = Annual dishwasher cycles (cycles/yr) Hours = Annual operating hours (hrs/yr) $\%E_{HW}$ = Percentage of dishwasher energy used for water heating (%) $\%HW_{ELEC}$ = Percentage of homes with electric water heating (%) $\%HW_{GAS}$ = Percentage of homes with natural gas water heating (%) $\%HW_{OIL}$ = Percentage of homes with oil water heating (%) $\%HW_{PROP}$ = Percentage of homes with propane or LNG water heating (%) Eff_{GAS} = Efficiency of existing gas-fired water heaters (%) Eff_{OIL} = Efficiency of existing oil-fired water heaters (%) Eff_{PROP} = Efficiency of existing propane-fired water heaters (%) WC_{BASE} = Rated water consumption per cycle for the baseline dishwasher (gallons/cycle) WC_{EE} = Rated water consumption per cycle for the ENERGY STAR® dishwasher (gallons/cycle) 0.003412 = Conversion factor: 0.003412 MMBtu per kWh								
EFFICIENCY ASSUMPTIONS									
Baseline Efficiency	Standard dishwasher that meets the current federal minimum efficiency requirement, effective May 2013. The requirement states that Standard size dishwashers shall not exceed 355 kWh/year and 6.5 gallons per cycle.[125]								
Efficient Measure	ENERGY STAR®-certified dishwasher								
PARAMETER VALUES (DEEMED)									
Measure	kWh_{BASE}	kWh_{EE}	RCycles	Cycles	Hours	WC_{BASE}	WC_{EE}	$\%E_{HW}$	
ENERGY STAR® Dishwasher	307[126]	295[126]	215[126]	208[126]	208[127]	6.5[126]	4.25[126]	56%[126]	
Measure	$\%HW_{ELEC}$	$\%HW_{GAS}$	$\%HW_{OIL}$	$\%HW_{PROP}$	Eff_{GAS}	Eff_{OIL}	Eff_{PROP}	Life (yrs)	Cost ($)
ENERGY STAR® Dishwasher	23%[128]	10%[128]	53%[128]	9%[128]	75%[126]	75%[129]	75%[129]	10[126]	10[126]
IMPACT FACTORS									

Measure	ISR	RR_E	RR_D	CF_S	CF_W	FR	SO
ENERGY STAR® Dishwasher	100%[130]	100%[131]	100%[131]	2.2%[132]	4.0%[132]	54.9%[133]	3.3%[133]

[125] Federal Standard, Code of Federal Regulations, Title 10, Part 430, Subpart C.
[126] Minimum federal efficiency standard (effective May 30, 2013).
[127] Assume that each cycle is 1 hour so the total operating hours is equal to the total number of cycles.
[128] NMR Group, Inc., Efficiency Maine Appliance Rebate Program Evaluation Overall Report – FINAL, July 18, 2014, Table 2-15
[129] Values are assumed to be the same as a gas-fired water heater.
[130] EMT assumes that all purchased units are installed (i.e. ISR = 100%). This is consistent with evaluation findings for other appliance measures.
[131] This measure has not yet been evaluated. Until the next program impact evaluation, EMT assumes 100 percent realization rate.
[132] See Appendix B: Coincidence and Energy Period Factors.
[133] NMR Group, Inc., Efficiency Maine Appliance Rebate Program Evaluation Overall Report – FINAL, July 18, 2014, Table 2-42; used program average.

Clothes Washer (CW)	
Last Revised Date	4/1/2020 (retroactive to 7/1/2019)
MEASURE OVERVIEW	
Description	ENERGY STAR® clothes washer. This measure involves the purchase and installation of a new ENERGY STAR®-certified clothes washer in place of a new code-compliant or standard efficiency clothes washer. The current ENERGY STAR® requirements, effective as of February 1, 2013, specify a minimum Integrated Modified Energy Factor (IMEF) of 2.06 and maximum integrated water factor (IWF) of 4.3 for top-loading machines and IMEF of 2.38 and WF of 3.7 for front-loading machines.[134] The associated water heater and clothes dryer may be electric or non-electric. The deemed unit energy savings are weighted averages based on percentages of homes with electric and non-electric water heaters and clothes dryers. A list of certified ENERGY STAR® clothes washers is available at: http://www.energystar.gov/productfinder/product/certified-clothes-washers/
Primary Energy Impact	Electric (additional impacts include: natural gas, heating oil, propane and water)
Sector	Residential, Commercial
Program(s)	Appliance Rebate Program
End-Use	Process
Decision Type	New Construction, Replace on Burnout
DEEMED GROSS ENERGY SAVINGS (UNIT SAVINGS)	
Demand savings	$\Delta kW = 0.57$ $\Delta kW_{SP} = 0.027$ $\Delta kW_{WP} = 0.036$
Annual energy savings	$\Delta kWh/yr = 183$ $\Delta MMBtu_{GAS}/yr = 0.114$ $\Delta MMBtu_{OIL}/yr = 0.338$ $\Delta MMBtu_{PROP}/yr = 0.074$
Annual water savings	$\Delta Gallons/yr = 3{,}438$
GROSS ENERGY SAVINGS ALGORITHMS (UNIT SAVINGS)	
Demand savings	$\Delta kW = \Delta kWh/yr \,/\, Loads$[135]
Annual energy savings	$\Delta kWh/yr = CAP_{EE} \times Loads \times [(1/IMEF_{BASE}) \times (\%E_{MACHINE\_B} + \%E_{DHW\_B} \times \%DHW_{ELEC} + \%E_{DRYER\_B} \times \%Dryer_{ELEC} \times \%Dried) - (1/IMEF_{EE}) \times (\%E_{MACHINE\_EE} + \%E_{DHW\_EE} \times \%DHW_{ELEC} + \%E_{DRYER\_EE} \times \%Dryer_{ELEC} \times \%Dried)]$ $\Delta MMBtu_{GAS}/yr = CAP_{EE} \times Loads \times [(1/IMEF_{BASE}) \times (\%E_{DHW\_B} \times \%DHW_{GAS} + \%E_{DRYER\_B} \times \%Dryer_{GAS} \times \%Dried) - (1/IMEF_{EE}) \times (\%E_{DHW\_EE} \times \%DHW_{GAS} + \%E_{DRYER\_EE} \times \%Dryer_{GAS} \times \%Dried)] \times 0.003412 \,/\, Eff_{GAS}$ $\Delta MMBtu_{OIL}/yr = CAP_{EE} \times Loads \times [(1/IMEF_{BASE}) \times (\%E_{DHW\_B} \times \%DHW_{OIL}) - (1/IMEF_{EE}) \times (\%E_{DHW\_EE} \times \%DHW_{OIL})] \times 0.003412 \,/\, Eff_{OIL}$ $\Delta MMBtu_{PROP}/yr = CAP_{EE} \times Loads \times [(1/IMEF_{BASE}) \times (\%E_{DHW\_B} \times \%DHW_{PROP} + \%E_{DRYER\_B} \times \%Dryer_{PROP} \times \%Dried) - (1/IMEF_{EE}) \times (\%E_{DHW\_EE} \times \%DHW_{PROP} + \%E_{DRYER\_EE} \times \%Dryer_{PROP} \times \%Dried)] \times 0.003412 \,/\, Eff_{PROP}$
Annual water savings	$\Delta Gallons/yr = CAP_{EE} \times (IWF_{BASE} - IWF_{EE}) \times Loads$

[134] ENERGY STAR® Clothes Washers Key Product Criteria: http://www.energystar.gov/index.cfm?c=clotheswash.pr_crit_clothes_washers
[135] Demand savings algorithm assumes that the average load time is one hour.

Clothes Washer (CW)	
Definitions	Unit = 1 clothes washer $\%DHW_{ELEC}$ = Percentage of homes with electric domestic hot water $\%Dryer_{ELEC}$ = Percentage of homes with electric dryers $IMEF_{BASE}$ = Rated Integrated Modified Energy Factor for baseline model (ft^3/kWh/cycle) $IMEF_{EE}$ = Rated Integrated Modified Energy Factor for ENERGY STAR® model (ft^3/kWh/cycle) Loads = Washer loads per year (cycles/yr) $\%E_{MACHINE\_B}$ = Percentage of baseline clothes washer system energy used for washer machine $\%E_{MACHINE\_EE}$ = Percentage of ENERGY STAR® clothes washer system energy used for washer machine $\%E_{DHW\_B}$ = Percentage of baseline clothes washer system energy used for water heating $\%E_{DHW\_EE}$ = Percentage of ENERGY STAR® clothes washer system energy used for water heating $\%E_{DRYER\_B}$ = Percentage of baseline clothes washer system energy used for the clothes dryer $\%E_{DRYER\_EE}$ = Percentage of ENERGY STAR® clothes washer system energy used for the clothes dryer %Dried = Percentage of washed loads that are dried in dryer (%) CAP_{EE} = Rated capacity of the installed clothes washer (ft^3) $\%DHW_{GAS}$ = Percentage of homes with natural gas water heating (%) $\%DHW_{OIL}$ = Percentage of homes with oil water heating (%) $\%DHW_{PROP}$ = Percentage of homes with propane or LNG water heating (%) $\%Dryer_{GAS}$ = Percentage of homes with gas clothes dryers (%) $\%Dryer_{PROP}$ = Percentage of homes with propane or LNG clothes dryers (%) Eff_{GAS} = Efficiency of existing gas-fired water heaters (%) Eff_{OIL} = Efficiency of existing oil-fired water heaters (%) Eff_{PROP} = Efficiency of existing propane-fired water heaters (%) IWF_{BASE} = Rated integrated water factor for the baseline clothes washer (gallons/cycle/ft^3) IWF_{EE} = Rated integrated water factor for the ENERGY STAR® clothes washer (gallons/cycle/ft^3) 0.003412 = Conversion factor: 0.003412 MMBtu per kWh
EFFICIENCY ASSUMPTIONS	
Baseline Efficiency	Standard clothes washer. The current federal standard requires a minimum IMEF of 1.29 and IWF of 8.4 for top loading machines and IMEF of 1.84 and IWF of 4.7 for front loading machines. These standards are valid for clothes washers manufactured on or after March 7, 2015.
Efficient Measure	ENERGY STAR®-certified clothes washer.

Clothes Washer (CW)

PARAMETER VALUES (DEEMED)

Measure	CAP_{EE}	$IMEF_{BASE}$	$IMEF_{EE}$	Eff_{GAS}	Eff_{PROP}	Eff_{OIL}	Life (yrs)	Cost ($)
ENERGY STAR® CW	4.5[136]	1.66[137]	2.55[136]	75%[138]	75%[138]	75%[138]	11[139]	92[140]

Measure	$\%E_{MACHINE\_B}$	$\%E_{MACHINE\_EE}$	$\%E_{DRYER\_B}$	$\%E_{DRYER\_EE}$	$\%E_{DHW\_B}$	$\%E_{DHW\_EE}$
ENERGY STAR® CW	8%[141]	8%[141]	61%[141]	69%[141]	31%[141]	23%[141]

Measure	IWF_{BASE}	IWF_{EE}	$\%DHW_{ELEC}$	$\%DHW_{GAS}$	$\%DHW_{PROP}$	$\%DHW_{OIL}$
ENERGY STAR® CW	5.92[137]	3.55[136]	23%[142]	10%[142]	9%[142]	53%[142]

Measure	Loads	%Dried	$\%Dryer_{ELEC}$	$\%Dryer_{GAS}$	$\%Dryer_{PROP}$	%RES	%COMM
ENERGY STAR® CW	322.4[143]	100%[144]	89.6%[145]	7.8%[145]	2.6%[145]	99%[146]	1%[146]

IMPACT FACTORS

Measure	ISR	RR_E	RR_D	CF_S	CF_W	FR	SO
ENERGY STAR® CW	100%[147]	100%[148]	100%[148]	4.8%%[149]	6.3%[150]	56.7%[151]	3.3%[151]

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[136] Average of models incentivized 1/1/2018-3/31/2018.
[137] Weighted average IMEF and IWF of Federal Standard rating for Front Loading and Top Loading units. Weighting is based upon the relative top- versus front-loading percentage of available non-ENERGY STAR® product in the CEC database.
[138] EMT assumes 75 percent efficiency for existing fossil fuel-fired water heaters.
[139] NMR Group, Inc., Efficiency Maine Appliance Rebate Program Evaluation Overall Report – FINAL, July 18, 2014, Table 2-18.
[140] Based on program data 7/1/2016-6/30/2017 and shelf survey of non-program units conducted in August 2017. Average price of program unit: $647. Weighted average price of surveyed non-program unit using assumed sales shares: $555.
[141] Illinois Statewide TRM Effective 06/01/15.
[142] Ibid., Table 2-15.
[143] Ibid., Table 2-14.
[144] NMR Group, Inc., Efficiency Maine Appliance Rebate Program Evaluation Overall Report – FINAL, July 18, 2014, p. 40: consistent with implicit assumption used in the savings algorithm for clothes washers.
[145] Ibid., Table 2-16.
[146] EFI program data analysis Sept 23, 2015. Since commercial sector participation is currently very low, no adjustments to savings estimates are being made at this time.
[147] NMR Group, Inc., Efficiency Maine Appliance Rebate Program Evaluation Overall Report – FINAL, July 18, 2014, p. 38.
[148] Realization rates are 100 percent since savings estimates are based on evaluation results.
[149] Derived from summer peak demand NMR Group, Inc., Efficiency Maine Appliance Rebate Program Evaluation Overall Report – FINAL, July 18, 2014, p. 45.
[150] Derived from winter peak demand Memo provided to supplement NMR Group, Inc., Efficiency Maine Appliance Rebate Program Evaluation Overall Report – FINAL, July 18, 2014.
[151] NMR Group, Inc., Efficiency Maine Appliance Rebate Program Evaluation Overall Report – FINAL, July 18, 2014, Table 2-41

Water Heating and Water Use

Low-flow Kitchen Aerator (LFKA, LILFKA, Component of LUB)	
Last Revised Date	4/1/2020 (retroactive to 11/1/2019 for Low Income, 7/1/2019 for Retail)
MEASURE OVERVIEW	
Description	This measure involves the replacement of existing kitchen aerators with low-flow aerators.
Primary Energy Impact	Electric (additional impacts include: water)
Sector	Residential
Program(s)	Retail Initiatives, Low Income Initiatives
End-Use	Domestic Hot Water
Decision Type	Retrofit
DEEMED GROSS ENERGY SAVINGS (UNIT SAVINGS)	
Demand Savings[152]	HPWH:ΔkW_{WP} = 0.012 ΔkW_{SP} = 0.010 ERWH:ΔkW_{WP} = 0.043 ΔkW_{SP} = 0.034
Annual Energy Savings[153]	HPWH: ΔkWh/y = 79 ERWH: ΔkWh/y = 283 Natural Gas or Propane Fired Water Heater: ΔMMBtu/y = 1.40 Oil or Kerosene Fired Water Heater: ΔMMBtu/y = 1.61
Annual Water Savings	ΔGallons/yr = 2,696
GROSS ENERGY SAVINGS ALGORITHMS (UNIT SAVINGS)	
Demand Savings	$\Delta kW_{SP} = \Delta kWh/y \times F_{ED,SP}$ $\Delta kW_{WP} = \Delta kWh/y \times F_{ED,WP}$
Annual Energy Savings	$\Delta kWh/y = N_{ppl} \times t \times 365 \times (GPM_{BASE} - GPM_{EE}) / N_{fixtures} \times \rho_{H20} \times Cp_{H20} / 3{,}412 \times (T_{pou} - T_{in}) / RE_{WH}$ $\Delta MMBtu/y = N_{ppl} \times t \times 365 \times (GPM_{BASE} - GPM_{EE}) / N_{fixtures} \times \rho_{H20} \times Cp_{H20} / 1{,}000{,}000 \times (T_{pou} - T_{in}) / RE_{WH}$
Annual Water Savings	$\Delta Gallons/y = N_{ppl} \times t \times 365 \times (GPM_{BASE} - GPM_{EE}) / N_{fixtures}$
Definitions	Unit = 1 kitchen aerator $F_{ED,WP}$ = Energy to Winter Peak Demand ratio (kW/kWh) $F_{ED,SP}$ = Energy to Summer Peak Demand ratio (kW/kWh) N_{ppl} = Number of people per home (person/home) t = Total time all kitchen aerators are used per day per person (min/day/person) GPM_{BASE} = Baseline flowrate of kitchen aerator (gallon/min) GPM_{EE} = Measure flowrate of kitchen aerator (gallon/min) $N_{fixtures}$ = Number of kitchen sinks (sinks/home) T_{pou} = Temperature at point of use (°F) T_{in} = Temperature of water mains (°F) RE_{WH} = Recovery efficiency of water heater ρ_{H20} = Density of water (8.33 lbs per gallons) Cp_{H20} = Specific heat of water: 1 Btu/lb/°F 3,412 = Conversion: 3,412 Btu per kWh 1,000,000 = Conversion: 1,000,000 Btu per MMBtu 365 = Conversion: 365 days per year
EFFICIENCY ASSUMPTIONS	
Baseline Efficiency	Federal standards set a maximum 2.2 GPM for faucet aerators manufactured after January 1, 1994.[154]
Efficient Measure	High-efficiency Kitchen Faucet Aerator (1.5 GPM)

[152] For consumer products where water heater type is unknown, in effRT, savings listed in TRM are multiplied by the distribution of water heater fuel types found in the NMR, 2015 Maine Residential Baseline Study. The factors are 25% for ERWH, and 5% for HPWH.
[153] For consumer products where water heater type is unknown, in effRT, savings listed in TRM are multiplied by the distribution of water heater fuel types found in the NMR, 2015 Maine Residential Baseline Study. The factors are 25% for ERWH, 5% for HPWH, 5% for Natural Gas, 5% for Propane, 60% for Oil.
[154] Federal Standard, Code of Federal Regulations, Title 10, Part 430, Subpart C.

Low-flow Kitchen Aerator (LFKA, LILFKA, Component of LUB)							
PARAMETER VALUES (DEEMED)							
Measure	t	N_{ppl}	GPM_{BASE}	GPM_{EE}	$N_{fixtures}$	Life (yrs)	Cost ($)
Low-flow Kitchen Aerator	4.51[155]	2.34[156]	2.2[154]	1.5	1[157]	10[158]	1.77[159]

	$F_{ED,SP}$	$F_{ED,WP}$	T_{pou}	T_{in}	RE_{WH}
ERWH	0.00012[160]	0.00015[161]	93[155]	50.8[162]	0.98[163]
HPWH					3.5[164]
Natural Gas and Propane					0.675[165]
Oil and Kerosene					0.59[166]

IMPACT FACTORS

Measure	ISR	RR_E	RR_D	CF_S	CF_W	FR	SO
Retail	100%[167]	100%[168]	100%[168]	100%[169]	100%[169]	25%[170]	0%[171]
Low Income	85%[172]	100%[173]	100%[173]	100%[174]	100%[174]	0%[175]	0%[176]

155 The Cadmus Group and Opinion Dynamics, MEMD: Showerhead and Faucet Aerator Meter Study, June 2013. Prepare for Michigan Evaluation Working Group.
156 American Community Survey, 2011 1-year estimate for population of Maine: http://www.census.gov/acs/www/
157 Assumed value: 1 kitchen faucet per home.
158 NREL, National Residential Efficiency Measure Database.
159 Total cost. For direct install it includes installation cost.
160 State of Pennsylvania, Technical Reference Manual, Rev date: March 2015, p. 126.
161 State of Pennsylvania, Technical Reference Manual, Rev date: March 2015, p. 126.
162 Standard Building America DHW Schedules, weighted average by population of all Maine water main sources.
163 NREL, Building America Research Benchmark Definition, 2009, p.12, http://www.nrel.gov/docs/fy10osti/47246.pdf
164 Program heat pump water heater required energy factor.
165 US DOE energy efficiency standard (10 CFR Part 430)
166 US DOE energy efficiency standard (10 CFR Part 430) and IECC 2009
167 EMT assumes that all purchased units are installed (i.e. ISR = 100%). This is consistent with the MA 2013-2015 TRM.
168 This measure has not yet been evaluated. Until the next program impact evaluation, EMT assumes 100 percent realization rate.
169 See Appendix B: Coincidence and Energy Period Factors.
170 Program not yet evaluated, assume default FR of 25%.
171 Program not yet evaluated, assume default SO of 0%.
172 West Hill Energy and Computing, Heat Pump Water Heater Initiatives Impact Evaluation, Fiscal Years 2015-2017
173 This measure has not yet been evaluated. Until the next program impact evaluation, EMT assumes 100 percent realization rate.
174 See Appendix B: Coincidence and Energy Period Factors.
175 Program assumes no free ridership for Low Income programs.
176 Program not yet evaluated, assume default SO of 0%.

Low-flow Bathroom Aerator (LFBA, LILFBA, Component of LUB)	
Last Revised Date	4/1/2020 (retroactive to 11/1/2019 for Low Income, 7/1/2019 for Retail)
MEASURE OVERVIEW	
Description	EPA WaterSense Low-flow Aerator. This measure involves the replacement of existing bathroom aerators with low-flow aerators.
Primary Energy Impact	Electric (additional impacts include: water)
Sector	Residential
Program(s)	Retail Initiatives, Low Income Initiatives
End-Use	Domestic Hot Water
Decision Type	Retrofit
DEEMED GROSS ENERGY SAVINGS (UNIT SAVINGS)	
Demand Savings[177]	HPWH: ΔkW_{WP} = 0.0012 ΔkW_{SP} = 0.00098 ERWH: ΔkW_{WP} = 0.0044 ΔkW_{SP} = 0.0035
Annual Energy Savings[178]	HPWH: ΔkWh/y = 8 ERWH: ΔkWh/y = 29 Natural Gas or Propane Fired Water Heater: ΔMMBtu/y = 0.15 Oil or Kerosene Fired Water Heater: ΔMMBtu/y = 0.17
Annual Water Savings	ΔGallons/y = 333
GROSS ENERGY SAVINGS ALGORITHMS (UNIT SAVINGS)	
Demand Savings	$\Delta kW_{SP} = \Delta kWh/y \times F_{ED,SP}$ $\Delta kW_{WP} = \Delta kWh/y \times F_{ED,WP}$
Annual Energy Savings	$\Delta kWh/y = N_{ppl} \times t \times 365 \times (GPM_{BASE} - GPM_{EE}) / N_{fixture} \times \rho_{H20} \times Cp_{H20} / 3{,}412 \times (T_{pou} - T_{in}) / RE_{WH}$ $\Delta MMBtu/y = N_{ppl} \times t \times 365 \times (GPM_{BASE} - GPM_{EE}) / N_{fixtures} \times \rho_{H20} \times Cp_{H20} / 1{,}000{,}000 \times (T_{pou} - T_{in}) / RE_{WH}$
Annual Water Savings	$\Delta Gallons/y = N_{ppl} \times t \times 365 \times (GPM_{BASE} - GPM_{EE}) / N_{fixture}$
Definitions	Unit = 1 bathroom aerator $F_{ED,WP}$ = Energy to Winter Peak demand ratio (kW/kWh) $F_{ED,SP}$ = Energy to Summer Peak Demand ratio (kW/kWh) GPM_{BASE} = Baseline flowrate of bathroom aerator (gallon/min) GPM_{EE} = Measure flowrate of bathroom aerator (gallon/min) t = Total time all bathroom aerators are used per day per person (min/day/person) N_{ppl} = Number of people per home (person/home) $N_{fixture}$ = Number of bathroom sinks (sinks/home) T_{pou} = Temperature at point of use (°F) T_{in} = Temperature of water mains (°F) RE_{WH} = Recovery efficiency of water heater ρ_{H20} = Density of water (8.33 lbs per gallons) Cp_{H20} = Specific heat of water: 1 Btu/lb/°F 3,412 = Conversion: 3,412 Btu per kWh 1,000,000 = Conversion: 1,000,000 Btu per MMBtu 365 = Conversion: 365 days per year
EFFICIENCY ASSUMPTIONS	
Baseline Efficiency	Federal standards set a maximum 2.2 GPM for faucet aerators manufactured after January 1, 1994.[179]
Efficient Measure	USEPA WaterSense High-efficiency Bathroom Sink Faucet (1.5 GPM)[180]

[177] For consumer products where water heater type is unknown, in effRT, savings listed in TRM are multiplied by the distribution of water heater fuel types found in the NMR, 2015 Maine Residential Baseline Study. The factors are 25% for ERWH, and 5% for HPWH.
[178] For consumer products where water heater type is unknown, in effRT, savings listed in TRM are multiplied by the distribution of water heater fuel types found in the NMR, 2015 Maine Residential Baseline Study. The factors are 25% for ERWH, 5% for HPWH, 5% for Natural Gas, 5% for Propane, 60% for Oil.
[179] Federal Standard, Code of Federal Regulations, Title 10, Part 430, Subpart C.
[180] http://www.epa.gov/WaterSense/docs/faucet_spec508.pdf

Low-flow Bathroom Aerator (LFBA, LILFBA, Component of LUB)							
PARAMETER VALUES (DEEMED)							
Measure	t	N_{ppl}	$N_{fixture}$	GPM_{BASE}	GPM_{EE}	Life (yrs)	Cost ($)
Low-flow Bathroom Aerator	1.65[181]	2.34[182]	2.96[183]	2.2[179]	1.5[180]	10[184]	0.49[185]

	$F_{ED,SP}$	$F_{ED,WP}$	T_{pou}	T_{in}	RE_{EWH}
ERWH	0.00012[186]	0.00015[187]	86[181]	50.8[188]	0.98[189]
HPWH					3.5[190]
Natural Gas and Propane					0.675[191]
Oil and Kerosene					0.59[192]

IMPACT FACTORS

Measure	ISR	RR_E	RR_D	CF_S	CF_W	FR	SO
Retail	100%[193]	100%[194]	100%[195]	100%[196]	100%[197]	25%[198]	0%[199]
Low Income	77%[200]	100%[201]	100%[202]	100%[203]	100%[204]	0%[205]	0%[206]

[181] The Cadmus Group and Opinion Dynamics, MEMD: Showerhead and Faucet Aerator Meter Study, June 2013. Prepare for Michigan Evaluation Working Group.
[182] American Community Survey, 2011 1 year estimate for population of Maine: http://www.census.gov/acs/www/
[183] 2009 Residential Energy Consumption Survey (RECS). Microdata for CT, ME, NH, RI, and VT single-family detached homes; assuming 1.5 faucets per full bathroom and 1 per half bathroom.
[184] NREL, National Residential Efficiency Measure Database.
[185] Total cost. For direct install it includes installation cost.
[186] State of Pennsylvania, Technical Reference Manual, Rev date: March 2015, p. 126.
[187] State of Pennsylvania, Technical Reference Manual, Rev date: March 2015, p. 126.
[188] Standard Building America DHW Schedules, weighted average by population of all Maine water main sources.
[189] NREL, Building America Research Benchmark Definition, 2009, p.12, http://www.nrel.gov/docs/fy10osti/47246.pdf
[190] Program heat pump water heater required energy factor.
[191] US DOE energy efficiency standard (10 CFR Part 430)
[192] US DOE energy efficiency standard (10 CFR Part 430) and IECC 2009
[193] EMT assumes that all purchased units are installed (i.e. ISR = 100%). This is consistent with the MA 2013-2015 TRM.
[194] This measure has not yet been evaluated. Until the next program impact evaluation, EMT assumes 100 percent realization rate.
[195] Ibid.
[196] See Appendix B: Coincidence and Energy Period Factors.
[197] Ibid.
[198] Program not yet evaluated, assume default FR of 25%.
[199] Program not yet evaluated, assume default SO of 0%.
[200] West Hill Energy and Computing, Heat Pump Water Heater Initiatives Impact Evaluation, Fiscal Years 2015-2017
[201] This measure has not yet been evaluated. Until the next program impact evaluation, EMT assumes 100 percent realization rate.
[202] Ibid.
[203] See Appendix B: Coincidence and Energy Period Factors.
[204] Ibid.
[205] Program assumes no free ridership for Low Income programs.
[206] Program not yet evaluated, assume default SO of 0%.

Low-flow Showerhead (LFSH)	
Last Revised Date	4/1/2020 (retroactive to 7/1/2019)
MEASURE OVERVIEW	
Description	EPA WaterSense Low-flow Showerhead. This measure involves the replacement of existing showerheads with low-flow showerheads.
Primary Energy Impact	Electric (additional impacts include: water)
Sector	Residential
Program(s)	Retail Initiatives
End-Use	Domestic Hot Water
Decision Type	Retrofit
DEEMED ENERGY SAVINGS (UNIT SAVINGS)	
Demand Savings[207]	HPWH: $\Delta kW_{WP} = 0.0042$ $\Delta kW_{SP} = 0.0034$ ERWH: $\Delta kW_{WP} = 0.015$ $\Delta kW_{SP} = 0.012$
Annual Energy Savings[208]	HPWH: $\Delta kWh/y = 42$ ERWH: $\Delta kWh/y = 150$ Natural Gas or Propane Fired Water Heater: $\Delta MMBtu/y = 0.74$ Oil or Kerosene Fired Water Heater: $\Delta MMBtu/y = 0.85$
Annual Water Savings	$\Delta Gallons/y = 1{,}200$
GROSS ENERGY SAVINGS ALGORITHMS (UNIT SAVINGS)	
Demand Savings	$\Delta kW_{SP} = \Delta kWh/y \times F_{ED,SP}$ $\Delta kW_{WP} = \Delta kWh/y \times F_{ED,WP}$
Annual Energy Savings	$\Delta kWh/y = N_{ppl} \times t \times 365 \times N_{showers} / N_{fixture} \times (GPM_{BASE} - GPM_{EE}) \times \rho_{H20} \times C_{H20} / 3{,}412 \times (T_{pou} - T_{in}) / RE_{EWH}$
Annual Water Savings	$\Delta Gallons/y = N_{ppl} \times t \times 365 \times N_{showers} / N_{fixture} \times (GPM_{BASE} - GPM_{EE})$
Definitions	Unit = 1 efficient showerhead $F_{ED,WP}$ = Energy to Winter Peak demand ratio (kW/kWh) $F_{ED,SP}$ = Energy to Summer Peak Demand ratio (kW/kWh) GPM_{BASE} = Baseline flowrate of showerhead (gallon/min) GPM_{EE} = Measure flowrate of showerhead (gallon/min) t = Length of shower (minutes/shower) N_{ppl} = Number of people per home (person/home) $N_{showers}$ = Number of showers per person per day (showers/person/day) $N_{fixture}$ = Number of showerheads (showerhead/home) T_{pou} = Temperature at point of use (°F) T_{in} = Temperature of water mains (°F) RE_{EWH} = Recovery efficiency of electric hot water heater ρ_{H20} = Density of water: 8.33 lbs per gallons C_{H20} = Specific heat of water: 1 Btu/lb/°F 3,412 = Conversion: 3,412 Btu per kWh 1,000,000 = Conversion: 1,000,000 Btu per MMBtu 365 = Conversion: 365 day per year
EFFICIENCY ASSUMPTIONS	
Baseline Efficiency	Federal standards set a maximum 2.5 GPM for all showerheads manufactured after January 1, 1994.[209]
Efficient Measure	USEPA WaterSense High-efficiency Showerhead (2.0 GPM)[210]

[207] For consumer products where water heater type is unknown, in effRT, savings listed in TRM are multiplied by the distribution of water heater fuel types found in the NMR, 2015 Maine Residential Baseline Study. The factors are 25% for ERWH, and 5% for HPWH.
[208] For consumer products where water heater type is unknown, in effRT, savings listed in TRM are multiplied by the distribution of water heater fuel types found in the NMR, 2015 Maine Residential Baseline Study. The factors are 25% for ERWH, 5% for HPWH, 5% for Natural Gas, 5% for Propane, 60% for Oil.
[209] Federal Standard, Code of Federal Regulations, Title 10, Part 430, Subpart C.
[210] Water-Efficient Showerheads, WaterSense: An EPA Partnership Program, http://www.epa.gov/WaterSense/products/showerheads.html

Low-flow Showerhead (LFSH)

PARAMETER VALUES (DEEMED)

Measure	t	N_{ppl}	$N_{showers}$	$N_{fixture}$	GPM_{BASE}	GPM_{EE}	Life (yrs)	Cost ($)
Low-flow Showerhead	7.83[211]	2.34[212]	0.61[213]	1.7[214]	2.5[209]	2.0[215]	10[216]	actual[217]

Measure	$F_{ED,SP}$	$F_{ED,WP}$	T_{pou}	T_{in}	RE_{EWH}
ERWH	0.00008[218]	0.00010[219]	101[220]	50.8[221]	0.98[222]
HPWH					3.5[223]
Natural Gas and Propane					0.675[224]
Oil and Kerosene					0.59[225]

IMPACT FACTORS

Measure	ISR	RR_E	RR_D	CF_S	CF_W	FR	SO
Retail	100%[226]	100%[227]	100%[227]	100%[228]	100%[228]	25%[229]	0%[230]
Low Income	100%[231]	100%[232]	100%[232]	100%[233]	100%[233]	0%[234]	0%[235]

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[211] The Cadmus Group and Opinion Dynamics, MEMD: Showerhead and Faucet Aerator Meter Study, June 2013. Prepare for Michigan Evaluation Working Group.
[212] American Community Survey, 2011 1 year estimate for population of Maine: http://www.census.gov/acs/www/
[213] The Cadmus Group and Opinion Dynamics, MEMD: Showerhead and Faucet Aerator Meter Study, June 2013. Prepare for Michigan Evaluation Working Group.
[214] 2009 Residential Energy Consumption Survey (RECS). Number of full bathrooms for single family detached home, microdata for CT, ME, NH, RI, and Vermont.
[215] Measure flowrate: http://www.epa.gov/WaterSense/products/showerheads.html
[216] NREL, National Residential Efficiency Measure Database.
[217] Total cost. For direct install it includes installation cost.
[218] State of Pennsylvania, Technical Reference Manual, Rev date: March 2015, p. 126.
[219] State of Pennsylvania, Technical Reference Manual, Rev date: March 2015, p. 126.
[220] The Cadmus Group and Opinion Dynamics, MEMD: Showerhead and Faucet Aerator Meter Study, June 2013. Prepare for Michigan Evaluation Working Group.
[221] Standard Building America DHW Schedules, weighted average by population of all Maine water main sources.
[222] NREL, Building America Research Benchmark Definition, 2009, p.12, http://www.nrel.gov/docs/fy10osti/47246.pdf
[223] Program heat pump water heater required energy factor.
[224] US DOE energy efficiency standard (10 CFR Part 430)
[225] US DOE energy efficiency standard (10 CFR Part 430) and IECC 2009
[226] EMT assumes that all purchased units are installed (i.e. .ISR = 100%). This is consistent with the MA 2013-2015 TRM.
[227] This measure has not yet been evaluated. Until the next program impact evaluation, EMT assumes 100 percent realization rate.
[228] See Appendix B: Coincidence and Energy Period Factors.
[229] Program not yet evaluated, assume default FR of 25%.
[230] Program not yet evaluated, assume default SO of 0%.
[231] EMT assumes that all received units are installed (i.e. ISR = 100%). This is consistent with the MA 2013-2015 TRM.
[232] This measure has not yet been evaluated. Until the next program impact evaluation, EMT assumes 100% realization rate.
[233] See Appendix B: Coincidence and Energy Period Factors.
[234] Program assumes no free ridership for Low Income programs.
[235] Program not yet evaluated, assume default SO of 0%.

Thermostatic Shower Valve with Low-flow Showerhead (TSV, LILFSH, LILHSH, LILWSH, Component of LUB)	
Last Revised Date	4/1/2020 (retroactive to 11/1/2019 for Low Income, 7/1/2019 for Retail)
MEASURE OVERVIEW	
Description	This measure involves the replacement of existing showerheads with thermostatically controlled low-flow showerheads that shutoff water when set temperature is reached until restarted. Savings are achieved by eliminating wasted hot water between the time hot water reaches the shower and when the shower begins to be used.
Primary Energy Impact	Electric (additional impacts include: water)
Sector	Residential
Program(s)	Retail Initiatives, Low Income Initiatives
End-Use	Domestic Hot Water
Decision Type	Retrofit
DEEMED ENERGY SAVINGS (UNIT SAVINGS)	
Demand Savings[236]	HPWH: $\Delta kW_{WP} = 0.012$ $\Delta kW_{SP} = 0.010$ ERWH: $\Delta kW_{WP} = 0.044$ $\Delta kW_{SP} = 0.035$
Annual Energy Savings[237]	HPWH: $\Delta kWh/y = 123$ ERWH: $\Delta kWh/y = 442$ Natural Gas or Propane Fired Water Heater: $\Delta MMBtu/y = 2.19$ Oil or Kerosene Fired Water Heater: $\Delta MMBtu/y = 2.50$
Annual Water Savings	$\Delta Gallons/y = 3{,}153$
GROSS ENERGY SAVINGS ALGORITHMS (UNIT SAVINGS)	
Demand Savings	$\Delta kW_{SP} = \Delta kWh/y \times F_{ED,SP}$ $\Delta kW_{WP} = \Delta kWh/y \times F_{ED,WP}$
Annual Energy Savings	$\Delta kWh/y = N_{ppl} \times 365 \times N_{showers} / N_{fixture} \times \rho_{H20} \times C_{H20} / 3{,}412 \times (t \times (GPM_{BASE} - GPM_{EE}) \times (T_{pou} - T_{in}) + GPM_{BASE} \times t_W/60 \times (T_{WH} - T_{in})\ ) / RE_{EWH}$
Annual Water Savings	$\Delta Gallons/y = N_{ppl} \times 365 \times N_{showers} / N_{fixture} \times (t \times (GPM_{BASE} - GPM_{EE}) + GPM_{BASE} \times t_W/60)$

Definitions		
	Unit	= 1 efficient showerhead
	GPM_{BASE}	= Baseline flowrate of showerhead (gallon/min)
	GPM_{EE}	= Measure flowrate of showerhead (gallon/min)
	t	= Length of shower (minutes/shower)
	t_W	= Seconds of wasted hot water between when water gets hot and user steps in
	N_{ppl}	= Number of people per home (person/home)
	$N_{showers}$	= Number of showers per person per day (showers/person/day)
	$N_{fixture}$	= Number of showerheads (showerhead/home)
	T_{pou}	= Temperature at point of use (°F)
	T_{in}	= Temperature of water mains (°F)
	T_{WH}	= Water heater set temperature (°F)
	RE_{EWH}	= Recovery efficiency of electric hot water heater
	ρ_{H20}	= Density of water: 8.33 lbs per gallons
	C_{H20}	= Specific heat of water: 1 Btu/lb/°F
	3,412	= Conversion: 3,412 Btu per kWh
	1,000,000	= Conversion: 1,000,000 Btu per MMBtu
	365	= Conversion: 365 day per year
	60	= Conversion: 60 seconds per minute
	$F_{ED,WP}$	= Energy to Winter Peak Demand factor
	$F_{ED,SP}$	= Energy to Summer Peak Demand ratio (kW/kWh)

[236] For consumer products where water heater type is unknown, in effRT, savings listed in TRM are multiplied by the distribution of water heater fuel types found in the NMR, 2015 Maine Residential Baseline Study. The factors are 25% for ERWH, and 5% for HPWH.
[237] For consumer products where water heater type is unknown, in effRT, savings listed in TRM are multiplied by the distribution of water heater fuel types found in the NMR, 2015 Maine Residential Baseline Study. The factors are 25% for ERWH, 5% for HPWH, 5% for Natural Gas, 5% for Propane, 60% for Oil.

Thermostatic Shower Valve with Low-flow Showerhead (TSV, LILFSH, LILHSH, LILWSH, Component of LUB)

EFFICIENCY ASSUMPTIONS

Baseline Efficiency	Federal standards set a maximum 2.5 GPM for all showerheads manufactured after January 1, 1994.[238]
Efficient Measure	USEPA WaterSense High-efficiency Showerhead with Thermostatic Control Valve (1.5 GPM)[239]

PARAMETER VALUES (DEEMED)

Measure	t	N_{ppl}	$N_{showers}$	GPM_{BASE}	GPM_{EE}	$N_{fixture}$	Life (yrs)	Cost ($)
Retail	7.83[240]	2.34[241]	0.61[242]	2.5[243]	1.5[244]	1.7[245]	10[246]	$30[247]
Low Income Handheld								32.44[248]
Low Income Wall Mount								26.50[249]

Measure	$F_{ED,SP}$	$F_{ED,WP}$	T_{pou}	T_{in}	T_{WH}	t_W	RE_{HPWH}
ERWH	0.00008[250]	0.00010[251]	101[252]	50.8[253]	126.2[254]	59[255]	0.98[256]
HPWH							3.5[257]
Natural Gas and Propane							0.675[258]
Oil and Kerosene							0.59[259]

IMPACT FACTORS

Measure	ISR	RR_E	RR_D	CF_S	CF_W	FR	SO
Retail	70%[260]	100%[261]	100%[262]	100%[263]	100%[264]	25%[265]	0%[266]
Low Income	88%[267]	100%[268]	100%[269]	100%[270]	100%[271]	0%[272]	0%[273]

[238] Federal Standard, Code of Federal Regulations, Title 10, Part 430, Subpart C.
[239] http://thinkevolve.com/wp-content/uploads/2014/11/evolve-1.5-gpm-Single-Function-Showerhead-with-ShowerStart-TSV.pdf
[240] The Cadmus Group and Opinion Dynamics, MEMD: Showerhead and Faucet Aerator Meter Study, June 2013. Prepare for Michigan Evaluation Working Group.
[241] American Community Survey, 2011 1 year estimate for population of Maine: http://www.census.gov/acs/www/
[242] Ibid.
[243] Federal Standard, Code of Federal Regulations, Title 10, Part 430, Subpart C.
[244] Measure flowrate: http://www.epa.gov/WaterSense/products/showerheads.html
[245] 2009 Residential Energy Consumption Survey (RECS). Number of full bathrooms for single family detached home, microdata for CT, ME, NH, RI, and Vermont.
[246] 2010 Ohio TRM: conservative estimate based on review of TRM assumptions from other states.
[247] Based on program data. $40 TSV showerhead and $10 non-WaterSense showerhead.
[248] Actual cost paid by program.
[249] Actual cost paid by program.
[250] State of Pennsylvania, Technical Reference Manual, Rev date: March 2015, p. 126.
[251] State of Pennsylvania, Technical Reference Manual, Rev date: March 2015, p. 126.
[252] The Cadmus Group and Opinion Dynamics, MEMD: Showerhead and Faucet Aerator Meter Study, June 2013. Prepare for Michigan Evaluation Working Group.
[253] Standard Building America DHW Schedules, weighted average by population of all Maine water main sources.
[254] NMR Group, Inc., Efficiency Maine Appliance Rebate Program Evaluation Overall Report – FINAL, July 18, 2014
[255] State of Pennsylvania, Technical Reference Manual, Rev date: March 2015, p. 126.
[256] NREL, Building America Research Benchmark Definition, 2009, p.12, http://www.nrel.gov/docs/fy10osti/47246.pdf
[257] Program heat pump water heater required energy factor.
[258] US DOE energy efficiency standard (10 CFR Part 430)
[259] US DOE energy efficiency standard (10 CFR Part 430) and IECC 2009
[260] Assumes same ISR as mailed kits.
[261] This measure has not yet been evaluated. Until the next program impact evaluation, EMT assumes 100 percent realization rate.
[262] This measure has not yet been evaluated. Until the next program impact evaluation, EMT assumes 100 percent realization rate.
[263] See Appendix B: Coincidence and Energy Period Factors.
[264] See Appendix B: Coincidence and Energy Period Factors.
[265] Program not yet evaluated, assume default FR of 25%.
[266] Program not yet evaluated, assume default SO of 0%.
[267] West Hill Energy and Computing, Heat Pump Water Heater Initiatives Impact Evaluation, Fiscal Years 2015-2017
[268] This measure has not yet been evaluated. Until the next program impact evaluation, EMT assumes 100 percent realization rate.
[269] This measure has not yet been evaluated. Until the next program impact evaluation, EMT assumes 100 percent realization rate.
[270] See Appendix B: Coincidence and Energy Period Factors.
[271] See Appendix B: Coincidence and Energy Period Factors.
[272] Program assumes no free ridership for Low Income programs
[273] Program not yet evaluated, assume default SO of 0%.

Heat Pump Water Heater (HPWHM, HPWHD, HPWHI)		
Last Revised Date	7/1/2023	
MEASURE OVERVIEW		
Description	ENERGY STAR®-certified Heat Pump Water Heaters (HPWH). This measure involves the purchase and installation of a new ENERGY STAR® certified HPWH in place of a new code-compliant or standard efficiency electric water heater or as an early replacement of an operational water heater. Savings are counted only for the improved water heater efficiency.[274] A list of certified ENERGY STAR® heat pump water heaters is available at: http://downloads.energystar.gov/bi/qplist/Water_Heaters_Product_List.xls	
Primary Energy Impact	Electric	
Sector	Residential, Commercial	
Program(s)	Appliance Rebate Program, Distributor Initiatives	
End-Use	Domestic Hot Water	
Decision Type	New Construction, Replace on Burnout, Retrofit	
DEEMED GROSS ENERGY SAVINGS (UNIT SAVINGS)		
Demand Savings[275]	ΔkW_{SP} = 0.072 ΔkW_{WP} = 0.116	
Annual Energy Savings[276]	Electric = 659 ΔkWh/y Natural Gas = 0.22 MMBtu Propane = 0.75 MMBtu	Oil = 4.34 MMBtu Kerosene = 0.13 MMBtu
GROSS ENERGY SAVINGS ALGORITHMS (UNIT SAVINGS)		
Demand Savings	Electric Baseline $\Delta kW_{SP} = \Delta kWh/y * LSF_{SP}$ $\Delta kW_{WP} = \Delta kWh/y * LSF_{WP}$	Non-electric Baseline[277] ΔkW_{SP} = -0.103 ΔkW_{WP} = -0.119
Annual Energy Savings	Electric Baseline $\Delta kWh/y = kWh/y_{HWL} * (1/Eff_{BASE} - 1/(COP_{EE} \times EAF))$ Non-electric Baseline $\Delta kWh/y = kWh/y_{HWL} * (-1/(COP_{EE} \times EAF))$ $MMBtu = kWh/y_{HWL} * 0.003412 / Eff_{BASE}$	

Definitions

Unit	= 1 heat pump water heater
kWh/y_{HWL}	= Annual energy required to provide the annual hot water demand[278]
LSF_{SP}	= Summer peak load shape factor (kW/kWh/yr)
LSF_{WP}	= Winter peak load shape factor (kW/kWh/yr)
EF_{BASE}	= Energy factor of electric resistance water heater
COP_{EE}	= coefficient of performance of heat pump water heater
EAF	= efficiency adjustment factor
0.003412	= Conversion factor: 0.003412 MMBtu per kWh
Eff_{BASE}	= efficiency factor for non-electric water heater baseline

[274] Interactive impacts on cooling, heating and humidification energy are assumed to be negligible due to the short cooling season in Maine and the expectation that most water heaters are not located in conditioned spaces. EMT will re-evaluate this assumption as more data and evaluation results are available.
[275] Blended savings calculated with 19% retrofit and 81% LO based on the "more restrictive" decision type analysis Michaels Energy Efficiency Maine HPWH Free-ridership and Baseline Assessment Results Memo., 2020
[276] Fuel mix derived from existing equipment from all combined survey responses; non-electric inferred respondents added to oil baseline (Electric 56.4%, Oil 34.1%, Kerosene 1.0%, Propane 6.6%, Natural Gas 1.9%). 19% retrofit and 81% LO based on the "more restrictive" decision type analysis. Michaels Energy HPWH Free-ridership and Baseline Assessment Results Memo, 2020.
[277] Average of direct measurement of HPWH demand during ISO NE peak hours recorded during West Hill Energy and Computing 2017 HPWH Evaluation.
[278] kWh/y_{HWL} = annual hot water used in gallons x Density of water (8.33 lb/gallon water) x Specific heat of water (1 Btu/lb-°F) / 1,000,000 Btu/MMBtu x (Temperature of the hot water – Temperature of the inlet water)

Heat Pump Water Heater (HPWHM, HPWHD, HPWHI)

EFFICIENCY ASSUMPTIONS

Baseline Efficiency	Blend of pre-existing water heaters and new water heaters that meet federal minimum standards (see Table 5).
Efficient Measure	ENERGY STAR®-certified model

PARAMETER VALUES (DEEMED)

	$\Delta kWh/y_{HWL}$	LSF_{SP}	LSF_{SP}	COP_{EE}	Life (yrs)	Cost ($)
ENERGY STAR® HPWH	2,821[279]	0.000109[280]	0.000157[281]	3.39[282]	13[283]	$1,165[284]

	EAF	Eff_{BASE}	%RES	%COMM
ENERGY STAR® HPWH	0.88[285]	Table 5	98%[286]	2%[286]

IMPACT FACTORS

Measure	ISR	RR_E	RR_D	CF_S	CF_W	FR	SO
Instant Rebate	100%[287]	100%[288]	100%[288]	100%[289]	100%[289]	23%[290]	0%[290]
Mail-In Rebate						8%[291]	

Table 5. Water Heater Baseline Assumptions

Baseline Fuel	Eff_{BASE} Retrofit[292]	Eff_{BASE} NC/ROB[293]	Share of Blended Savings[294]
Electric	0.9299	1.007	56.4%
Natural Gas	0.675	0.9	1.9%
Propane	0.675	0.9	6.6%
Oil	0.756	0.756	34.1
Kerosene	0.756	0.756	1.0%

[279] West Hill Energy and Computing, Heat Pump Water Heater Initiatives Impact Evaluation, 2020.
[280] Ibid.
[281] Ibid.
[282] Weighted average coefficient of performance for program participating HPWH 10/1/2022-3/31/2023
[283] NREL, National Residential Efficiency Measure Database.
[284] Incremental cost based on average cost of appliance rebate and distributor heat pump water heaters Oct 2022 – Mar 2023, weighted by 19% retrofit and 81% lost opportunity, and by program measure count. Incremental cost for retrofits includes installation cost assumption of $500.
[285] West Hill Energy and Computing, Heat Pump Water Heater Initiatives Impact Evaluation, 2020.
[286] Program data 10/1/2022-3/31/2023.
[287] Heat Pump Water Heater Initiatives Impact Evaluation, 2020.
[288] Realization rates are 100 percent since savings estimates are based on evaluation results.
[289] Peak coincidence factors for this measure are embedded in the evaluated peak demand impacts.
[290] Michaels Energy HPWH Free-ridership and Baseline Assessment Results Memo, 2020.
[291] Michaels Energy HPWH Free-ridership and Baseline Assessment Results Memo, 2020.
[292] US DOE energy efficiency standard (10 CFR Part 430). Electric retrofit assumes 50-gallon, high use.
[293] US DOE energy efficiency standard (10 CFR Part 430) for all but Natural Gas and Propane. Tankless, on-demand water heater with efficiency of 0.9 assumed for Natural Gas and Propane new construction/replace on burnout replacements. Electric lost opportunity assumes 93% 50-gallon, high use and 7% 80-gallon, medium use.
[294] Fuel mix derived from existing equipment from all combined survey responses; non-electric inferred respondents added to oil baseline. Michaels Energy HPWH Free-ridership and Baseline Assessment Results Memo, 2020.

Heat Pump Water Heater Direct Install (LIHPWH)		
Last Revised Date	7/1/2023	
MEASURE OVERVIEW		
Description	ENERGY STAR®-certified Heat Pump Water Heaters (HPWH) with a COP => 3.3 replacing a standard efficiency electric water heater.	
Primary Energy Impact	Electric	
Sector	Residential	
Program(s)	Low-income Direct Install, Arrearage Management Program	
End-Use	Domestic Hot Water	
Decision Type	Retrofit	
DEEMED GROSS ENERGY SAVINGS (UNIT SAVINGS)		
Demand Savings	Electric Baseline ΔkW_{SP} = 0.186 ΔkW_{WP} = 0. 268	Non-electric Baseline ΔkW_{SP} = -0.103 ΔkW_{WP} = -0.119
Annual Energy Savings	Electric Baseline $\Delta kWh/y$ = 1,705	Non-electric Baseline Electric (all baselines) $\Delta kWh/y$ = -838 Natural Gas/Propane $\Delta MMBtu/y$ = 11.95 Oil/Kerosene Indirect $\Delta MMBtu/y$ = 10.67 Oil/Kerosene Tankless Coil $\Delta MMBtu/y$ = 20.37
GROSS ENERGY SAVINGS ALGORITHMS (UNIT SAVINGS)		
Demand Savings	Electric Baseline $\Delta kW_{SP} = \Delta kWh/y * LSF_{SP}$ $\Delta kW_{WP} = \Delta kWh/y * LSF_{WP}$	Non-electric Baseline[295] ΔkW_{SP} = -0.103 ΔkW_{WP} = -0.119
Annual Energy Savings	Electric Baseline $\Delta kWh/y = kWh/y_{HWL} * (1/EF_{BASE} - 1/(COP_{EE} \times EAF))$ Non-electric Baseline $\Delta kWh/y = kWh/y_{HWL} * (- 1/(COP_{EE} \times EAF))$ $MMBtu = kWh/y_{HWL} * 0.003412 / Eff_{BASE}$	
Definition	Unit = 1 heat pump water heater kWh/y_{HWL} = Annual energy required to provide the annual hot water demand[296] LSF_{SP} = Summer peak load shape factor (kW/kWh/yr) LSF_{WP} = Winter peak load shape factor (kW/kWh/yr) EF_{BASE} = Energy factor of electric resistance water heater COP_{EE} = coefficient of performance of heat pump water heater EAF = efficiency adjustment factor 0.003412 = Conversion factor: 0.003412 MMBtu per kWh Eff_{BASE} = efficiency factor for non-electric water heater baseline	
EFFICIENCY ASSUMPTIONS		
Baseline Efficiency	Standard 50-gallon residential water heater with an AHRI Energy Factor = 0.945[297]	
Efficient Measure	ENERGY STAR®-certified model (EF = 3.5)	

[295] Average of direct measurement of HPWH demand during ISO NE peak hours recorded during West Hill Energy and Computing 2017 HPWH Evaluation.
[296] kWh/y_{HWL} = annual hot water used in gallons x Density of water (8.33 lb/gallon water) x Specific heat of water (1 Btu/lb-°F) / 1,000,000 Btu/MMBtu x (Temperature of the hot water – Temperature of the inlet water)
[297] Federal Standard, Code of Federal Regulations, Title 10, Part 430, Subpart C. EF = 0.945 value is calculated for 50-gallon water heater.

Heat Pump Water Heater Direct Install (LIHPWH)

PARAMETER VALUES (DEEMED)

	$\Delta kWh/y_{HWL}$	LSF_{SP}	LSF_{SP}	COP_{EE}	Life (yrs)	Cost ($)
ENERGY STAR® HPWH	2,364[298]	0.000109[299]	0.000157[300]	3.4[301]	13[302]	Actual[303]

	EAF	Eff_{BASE}						
ENERGY STAR® HPWH	0.83[304]	Table 5						

IMPACT FACTORS

Measure	ISR	RR_E	RR_D	CF_S	CF_W	FR	SO
ENERGY STAR® HPWH	100%[305]	100%[306]	100%[306]	100%[307]	100%[307]	0%[308]	0%[309]

[298] West Hill Energy and Computing, Heat Pump Water Heater Initiatives Impact Evaluation, 2020.
[299] Ibid.
[300] Ibid.
[301] Weighted average coefficient of performance of program participating heat pump water heater equipment models Oct 2022 – Mar 2023.
[302] NREL, National Residential Efficiency Measure Database.
[303] Total cost to program which covers 100 percent of water heater material cost and installation cost of water heater, bulbs and low flow devices installed = 1800*{Measure:Quantity}+{Bulb Qty Installed}*5+{Kitchen Aerator Qty Installed}*25+{Bathroom Aerator Qty Installed}*10+{Showerhead Qty Installed}*35.
[304] West Hill Energy and Computing, Heat Pump Water Heater Initiatives Impact Evaluation, 2020.
[305] NMR Group, Inc., Efficiency Maine Appliance Rebate Program Evaluation Overall Report – FINAL, July 18, 2014, p. 60.
[306] Realization rates are 100 percent since savings estimates are based on evaluation results.
[307] Peak coincidence factors for this measure are embedded in the evaluated peak demand impacts.
[308] EMT assumes 0 percent free ridership and 0 percent spillover (i.e. NTG = 100%) for all measures implemented through the low-income program.
[309] Program not yet evaluated, assume default SO of 0%.

Domestic Water Heater Temperature Turn-Down (Inactive)

Last Revised Date	4/1/2020
MEASURE OVERVIEW	
Description	The hot water set-point temperature of the existing electric domestic water heater (DWH) is reduced by at least 10°F.[310] Savings derive primarily from reducing the energy lost to leaks, dishwashers and standby losses. The savings assume measures are implemented on electric water heaters.
Primary Energy Impact	Electric
Sector	Residential
Program(s)	Low-income Program
End-Use	Domestic Hot Water
Decision Type	Retrofit
DEEMED GROSS ENERGY SAVINGS (UNIT SAVINGS)	
Demand Savings	$\Delta kW_{SP} = 0.010$ $\Delta kW_{WP} = 0.011$
Annual Energy Savings	$\Delta kWh/yr = 87$
GROSS ENERGY SAVINGS ALGORITHMS (UNIT SAVINGS)	
Demand Savings	$\Delta kW_{SP} = \Delta kWh/y \times F_{ED,SP}$ $\Delta kW_{WP} = \Delta kWh/y \times F_{ED,WP}$
Annual Energy Savings	$\Delta kWh/yr = \Delta kWh_{EWHTD}$

Definitions		
	Unit	= 10°F temperature turndown for 1 electric DHW
	ΔkWh_{EWHTD}	= Average annual energy savings for 10°F turndown on electric water heater (kWh/yr)
	$F_{ED,WP}$	= Energy to Winter Peak Demand factor
	$F_{ED,SP}$	= Energy to Summer Peak Demand ratio (kW/kWh)

EFFICIENCY ASSUMPTIONS	
Baseline Efficiency	Electric DWH at original set-point temperature of 130°F or greater.
Efficient Measure	Electric DWH at set-point temperature 10°F below the original set-point temperature. If the original temperature is reduced by less than 10°F, no savings should be claimed. The temperature should not be reduced below 120°F.[311]

PARAMETER VALUES (DEEMED)

Measure	ΔkWh_{EWHTD}	$F_{ED,SP}$	$F_{ED,WP}$	Life (yrs)	Cost ($)
DWH Turn-Down	87[312]	0.00011[313]	0.00013[314]	4[315]	0[316]

IMPACT FACTORS

Measure	ISR	RR_E	RR_D	CF_S	CF_W	FR	SO
DWH Turn-Down	100%[317]	100%[318]	100%[318]	9.6%[319]	13.3%[319]	0%[320]	0%[321]

[310] Engineering assumption, conservative compared to Illinois 2012 TRM which claims 15°F setback.
[311] The risk of bacteria growing in the stored hot water increases when the set-point temperature is reduced below 120°F: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2094925/#B5
[312] Savings are captured by calculating energy savings from reducing the temperature of the water consumed by the following end uses: leaks, clothes washers and the use categorized by "other." No savings are claimed from hot water end uses such as showering or faucet use because it is assumed that the user will continue to operate the end use at the same temperature as prior to implementing this measure. By operating at the same temperature, the user uses water with the same amount of energy as before (thereby not reducing energy use directly). Daily water usages are based on EPA's WaterSense guide: http://www.epa.gov/WaterSense/docs/home_suppstat508.pdf. Savings include reduced standby losses.
[313] State of Pennsylvania, Technical Reference Manual, Rev date: March 2015, p. 126.
[314] State of Pennsylvania, Technical Reference Manual, Rev date: March 2015, p. 126.
[315] GDS Associates, Inc., Measure Life Report – Residential and Commercial/Industrial Lighting and HVAC Measures, June 2007, Table 1.
[316] Assumes temperature turn-down is performed as part of an audit or direct install program.
[317] EMT assumes that all purchased units are installed (i.e. ISR = 100%). This is consistent with the MA 2013-2015 TRM.
[318] This measure has not yet been evaluated. Until the next program impact evaluation, EMT assumes 100 percent realization rate.
[319] Appendix B: Coincidence and Energy Period Factors.
[320] EMT assumes 0 percent free ridership for all measures implemented through the low-income program.
[321] Program not yet evaluated, assume default SO of 0%.

Domestic Water Heater Pipe Insulation (Inactive)	
Last Revised Date	7/1/2013
MEASURE OVERVIEW	
Description	Savings are captured by installing 10 feet of pipe insulation on uninsulated water pipes serving the electric domestic hot water heater (DWH). The savings assume measures are implemented on electric water heaters and that the temperature turn-down measure has been implemented.
Primary Energy Impact	Electric
Sector	Residential
Program(s)	Low-income Program
End-Use	Domestic Hot Water
Decision Type	Retrofit
DEEMED GROSS ENERGY SAVINGS (UNIT SAVINGS)	
Demand Savings	$\Delta kW = 0.012$
Annual Energy Savings	$\Delta kWh/yr = 103$
GROSS ENERGY SAVINGS ALGORITHMS (UNIT SAVINGS)	
Demand Savings	$\Delta kW = \Delta kWh/yr \,/\, Hours$
Annual Energy Savings	$\Delta kWh/yr = [GPD \times 365 \times \rho_{H2O} \times C_{H2O} \times (T_{WH} - T_{in}) / 3{,}412 / RE_{EWH}] \times SF_{PI}$
Definitions	Unit = 1 water heater GPD = Average daily hot water consumption (gallons/day) ρ_{H2O} = Density of water (8.33 lb/gallon) C_{H20} = Specific heat of water (1 Btu/lb-°F) T_{WH} = Water heater temperature set point (°F) T_{in} = Temperature of water mains (water into the water heater) (°F) RE_{EWH} = Recovery Efficiency for baseline electric water heater SF_{PI} = Savings factor for adding pipe insulation Hours = Annual operating hours for water heater (hrs/yr) 365 = Conversion: 365 days per year 3,412 = Conversion: 3,412 Btu per kWh
EFFICIENCY ASSUMPTIONS	
Baseline Efficiency	Uninsulated DHW heater pipes (both hot and cold). The DWH must have no heat trap installed.
Efficient Measure	DHW heater pipes with 10 feet of pipe insulation installed. Insulation must be R-3 or greater.[322]

[322] Complies with International Residential Code 2009 section N1103.3: mechanical system piping insulation.

Domestic Water Heater Pipe Insulation (Inactive)								
PARAMETER VALUES (DEEMED)								
Measure	GPD	T_{WH}	T_{in}	RE_{EWH}	SF_{PI}	Hours	Life (yrs)	Cost ($)
DWH Pipe Insulation	51.1[323]	125[324]	50.8[325]	0.98[326]	0.03[327]	8,760[328]	15[329]	$70[330]

IMPACT FACTORS							
Measure	ISR	RR_E	RR_D	CF_S	CF_W	FR	SO
DWH Pipe Insulation	100%[331]	100%[332]	100%[332]	100%[333]	100%[333]	0%[334]	0%[335]

[323] Daily household consumption of hot water calculated based on average number of people per household (Nppl): 16.286 x Nppl + 13. The relationship is used in NY and Indiana TRMs and is based on: Lutz, James D., Liu, Xiaomin, McMahon, James E., Dunham, Camilla, Shown, Leslie J.McCure, Quandra T; "Modeling patterns of hot water use in households;" LBL-37805 Rev., Lawrence Berkeley Laboratory, 1996.

[324] The set-point temperature is 10 degrees below the typical set-point temperature of 135°F, assuming that the temperature turn-down measure is implemented.

[325] Standard Building America DHW Schedules, weighted average by population of all Maine water main sources.

[326] NREL, Building America Research Benchmark Definition, 2009, p.12, http://www.nrel.gov/docs/fy10osti/47246.pdf

[327] ACEEE Report Number E093, p. 117, April 2009, Potential for Energy Efficiency, Demand Response, and Onsite Solar Energy in Pennsylvania: "Insulating 10 feet of exposed pipe in unconditioned space, ¾" thick".

[328] EMT assumes the water heater operates continuously to maintain the water heater set-point temperature.

[329] GDS Associates, Inc., Measure Life Report – Residential and Commercial/Industrial Lighting and HVAC Measures, June 2007, Table 1.

[330] NREL, National Residential Efficiency Measures Database, assuming R-5 insulation. The costs range from $44 to $92, with an average of $70.

[331] EMT assumes that all purchased units are installed (i.e. ISR = 100%). This is consistent with the MA 2013-2015 TRM.

[332] This measure has not yet been evaluated. Until the next program impact evaluation, EMT assumes 100 percent realization rate.

[333] See Appendix B: Coincidence and Energy Period Factors.

[334] EMT assumes 0 percent free ridership for all measures implemented through the low-income program.

[335] Program not yet evaluated, assume default SO of 0%.

Domestic Water Heater Wrap (Inactive)	
Last Revised Date	7/1/2013
MEASURE OVERVIEW	
Description	Savings are captured by installing an insulating blanket (wrap) on an existing electric domestic water heater (DWH) in an unconditioned space. For savings to be captured, the DWH must be an inefficient model that does not meet the National Appliance Energy Conservation Act that went into effect in 1991. The savings assume measures are implemented on electric water heaters and that the temperature turn-down measure has been implemented.
Primary Energy Impact	Electric
Sector	Residential
Program(s)	Low-income Program
End-Use	Domestic Hot Water
Decision Type	Retrofit
DEEMED GROSS ENERGY SAVINGS (UNIT SAVINGS)	
Demand Savings	ΔkW = 0.010
Annual Energy Savings	ΔkWh/yr = 89
GROSS ENERGY SAVINGS ALGORITHMS (UNIT SAVINGS)	
Demand Savings	$\Delta kW = \Delta kWh/yr / Hours$
Annual Energy Savings	$\Delta kWh/yr = [GPD \times 365 \times \rho_{H2O} \times Cp_{H2O} \times (T_{WH} - T_{in}) / 3{,}412\ ] \times (1/EF_{BASE} - 1 / EF_{EE})$
Definitions	Unit = 1 water heater with tank wrap GPD = Average daily hot water consumption (gallons/day) 365 = Conversion: 365 days per year ρ_{H2O} = Density of water (8.33 lb/gallon) Cp_{H20} = Specific heat of water (1 Btu/lb-°F) T_{WH} = Water heater temperature set point (°F) T_{in} = Temperature of water mains (water into the water heater) (°F) 3,412 = Conversion: 3,412 Btu per kWh EF_{BASE} = Energy factor for baseline electric water heater EF_{EE} = Energy factor for baseline electric water heater with wrap Hours = Annual operating hours for water heater (hrs/yr)
EFFICIENCY ASSUMPTIONS	
Baseline Efficiency	Inefficient DWH manufactured before 1991 with no insulating wrap in an unconditioned space.
Efficient Measure	Inefficient DWH manufactured before 1991 with an insulating wrap installed in an unconditioned space.

Domestic Water Heater Wrap (Inactive)							
PARAMETER VALUES (DEEMED)							
Measure	GPD	T_{WH}	T_{in}	EF_{BASE}	EF_{EE}	Hours	Life (yrs)	Cost ($)
EWH with tank wrap	51.1[336]	125[337]	50.8[338]	0.86[339]	0.88[339]	8,760[340]	7[341]	$30[342]

Measure	ISR	RR_E	RR_D	CF_S	CF_W	FR	SO
IMPACT FACTORS							
EWH with tank wrap	100%[343]	100%[344]	100%[344]	100%[345]	100%[345]	0%[346]	0%[347]

[336] Daily household consumption of hot water calculated based on average number of people per household (Nppl): 16.286 x Nppl + 13. The relationship is used in NY and Indiana TRMs and is based on: Lutz, James D., Liu, Xiaomin, McMahon, James E., Dunham, Camilla, Shown, Leslie J.McCure, Quandra T; "Modeling patterns of hot water use in households;" LBL-37805 Rev., Lawrence Berkeley Laboratory, 1996.

[337] The set-point temperature is 10 degrees below the typical set-point temperature of 135°F, assuming that the temperature turn-down measure is implemented.

[338] Standard Building America DHW Schedules, weighted average by population of all Maine water main sources.

[339] The Oak Ridge study predicted that wrapping a 40-gal water heater would increase Energy Factor of a 0.86 electric DHW tank by 0.02 (to 0.88). "Meeting the Challenge: The Prospect of Achieving 30 percent Energy Savings Through the Weatherization Assistance Program" by the Oak Ridge National Laboratory - May 2002. https://library.cee1.org/sites/default/files/library/1143/309.pdf

[340] EMT assumes the water heater operates continuously to maintain the water heater set-point temperature.

[341] DEER 2008

[342] http://energy.gov/energysaver/projects/savings-project-insulate-your-water-heater-tank

[343] EMT assumes that all purchased units are installed (i.e. ISR = 100%). This is consistent with the MA 2013-2015 TRM.

[344] This measure has not yet been evaluated. Until the next program impact evaluation, EMT assumes 100 percent realization rate.

[345] See Appendix B: Coincidence and Energy Period Factors.

[346] EMT assumes 0 percent free ridership for all measures implemented through the low-income program.

[347] Program not yet evaluated, assume default SO of 0%.

Tankless Water Heater (NGWH, TLWH) (Inactive)	
Last Revised Date	7/1/2023
MEASURE OVERVIEW	
Description	This measure involves purchase and installation of new on-demand (instantaneous) natural gas-fired, or propane water heater rather than standard industry practice. Energy savings are achieved by reducing the standby losses from the tank water heater.
Energy Impacts	Natural Gas, Propane
Sector	Residential, Commercial
Program(s)	Home Energy Savings Program, Distributor HVAC, Distributor Domestic Water Heating
End-Use	Domestic Hot Water
Decision Type	New Construction, Replacement
DEEMED GROSS ENERGY SAVINGS (UNIT SAVINGS)	
Demand savings	ΔkW = NA
Annual energy savings	ΔkWh/yr = 0 ΔMMBtu/yr = 0.9
GROSS ENERGY SAVINGS ALGORITHMS (UNIT SAVINGS)	
Demand savings	ΔkW = NA
Annual Energy savings	ΔkWh/yr = 0 $\Delta MMBtu/yr = GAL \times 8.33 \times 1 \times (T_{WH} - T_{in}) \times (1/EF_{BASE} - 1/EF_{EE}) / 1{,}000{,}000$
Definitions	Unit = New on-demand natural gas water heater GAL = Average amount of hot water consumed annually per water heater (gal/yr) T_{WH} = Water heater set-point temperature (°F) T_{in} = Average water at the main (°F) EF_{BASE} = Energy factor for baseline stand alone tank water heater (%) EF_{EE} = Energy factor for on-demand water heater (%)= Days per year 365 = Conversion: days/year 8.33 = Density of water: 8.33 lb/gallon water 1 = Specific heat of water: 1 Btu/lb-°F 1,000,000 = Conversion: 1,000,000 Btu/MMBtu
EFFICIENCY ASSUMPTIONS	
Baseline Efficiency	The baseline case is industry standard practice.
Efficient Measure	The high-efficiency case is a new on-demand (instantaneous) natural gas fired water heater that meets Energy Star certification.

Tankless Water Heater (NGWH, TLWH) (Inactive)							
PARAMETER VALUES							
Measure/Input	GAL	T_{WH}	T_{in}	EF_{BASE}	EF_{EE}	Life (yrs)	Cost ($)
Residential: On-Demand Natural Gas Water Heater	18,664[348]	126.2[349]	50.8[350]	0.89[351]	0.93[352]	25[353]	200[354]
Commercial	72,018[355]						
IMPACT FACTORS							
Measure	ISR	RR_E	RR_D	CF_S	CF_W	FR	SO
On-Demand Natural Gas Water Heater	100%[356]	100%[356]	NA	NA	NA	25%[357]	0%[358]

[349] NMR Group, Inc., Efficiency Maine Appliance Rebate Program Evaluation Overall Report – FINAL, July 18, 2014.
[350] Standard Building America DHW Schedules, weighted average by population of all Maine water main sources.
[351] Average efficiency of new water heaters in Maine based on distributor interview, May 2023.
[352] Average Energy Star on-demand water heater efficiency based on distributor interview, May 2023.
[353] GDS Measure Life Report, Residential and Commercial/Industrial Lighting and HVAC Measures, prepared for the New England State Program Working Group, June 2007, Table 1; value for new construction.
[354] Based on distributor interview, May 2023.
[355] Weighted average hot water use for commercial buildings derived from CBEC 2021 water use by building type, Maine facility type distribution from EMT Commercial Building Interval Meter Data Analytics Study and hot water usage informed by NY Standard Approach for Estimating Energy Savings from Energy Efficiency Programs.
[356] EMT assumes that all purchased units are installed (i.e. ISR = 100%).
[357] Program not yet evaluated, assume default FR of 25%.
[358] Program not yet evaluated, assume default SO of 0%.

Space Heating and Cooling and Related Equipment

Ductless Heat Pump Residential Lost Opportunity (CH, HPSING1T1, HPSING2T1, HPSING1T2, HPSING2T2, HPMULT2T1, HPMULT1T1, HPMULT1T2, HPMULT2T2)

Last Revised Date	7/1/2021
MEASURE OVERVIEW	
Description	This measure involves the purchase and installation of a high-efficiency ductless heat pump (DHP) system, instead of a standard efficiency DHP system, as a supplemental heating system.
Energy Impacts	Primary: Electric, Secondary: Heating Oil, Propane, Kerosene, Wood
Sector	Residential
Program(s)	Home Energy Savings Program
End-Use	Heating, Cooling
Decision Type	New Construction, Replace on Burnout

DEEMED GROSS ENERGY SAVINGS (UNIT SAVINGS) for Tier 1 (>=HSPF 12 (single), >=HSPF 10 (multi)[359])

Demand savings

Non-electric central heating system

	Δ kW_{WP}	Δ kW_{SP}
1st Unit	0.037	0.116
Additional Units (each)	0.015	0.064

Electric central heating system

	Δ kW_{WP}	Δ kW_{SP}
1st Unit	0.051	0.116
Additional Units (each)	0.024	0.064

Annual energy savings

Non-electric central heating system

	Δ kWh/y	Δ MMBtu/y
1st Unit	291	0.77
Additional Units (each)	142	1.12

Electric central heating system

	Δ kWh/y	Δ MMBtu/y
1st Unit	525	0.00
Additional Units (each)	406	0.00

DEEMED GROSS ENERGY SAVINGS (UNIT SAVINGS) for Tier 2 (>=HSPF 12.5)[360,361]

Demand savings

Non-electric central heating system

	Δ kW_{WP}	Δ kW_{SP}
1st Unit	0.058	0.127
Additional Units (each)	0.028	0.070

Electric central heating system

	Δ kW_{WP}	Δ kW_{SP}
1st Unit	0.085	0.127
Additional Units (each)	0.044	0.070

Annual energy savings

Non-electric central heating system

	Δ kWh/y	Δ MMBtu/y
1st Unit	410	2.92
Additional Units (each)	316	1.46

Electric central heating system

	Δ kWh/y	Δ MMBtu/y
1st Unit	1140	0.00
Additional Units (each)	671	0.00

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359 For multizone systems the savings are equal to the sum of "1st Unit" plus only one "Additional Unit" except in the special case where the 1st unit is a single zone unit and the second unit is a multizone unit. In this special case, the single zone unit is assigned the "1st Unit" savings and the multizone unit is assigned savings for one "Additional Unit."

360 For multizone systems the savings are equal to the sum of "1st Unit" plus only one "Additional Unit" except in the special case where the 1st unit is a single zone unit and the second unit is a multizone unit. In this special case, the single zone unit is assigned the "1st Unit" savings and the multizone unit is assigned savings for one "Additional Unit."

361 Enhanced incentives starting in FY2020 will drive some level of retrofit within the market-based program. Savings for Tier 2 units are assigned a blend of lost opportunity and retrofit in effRT. The ratio of the blend is set at 77% retrofit for the 1st tier 2 unit and 0% retrofit for the 2nd tier 2 unit based on FY22 program activity.

Ductless Heat Pump Residential Lost Opportunity (CH, HPSING1T1, HPSING2T1, HPSING1T2, HPSING2T2, HPMULT2T1, HPMULT1T1, HPMULT1T2, HPMULT2T2)	
GROSS ENERGY SAVINGS ALGORITHMS (UNIT SAVINGS)	
Demand Savings	Modeled[362]
Annual Energy Savings	Modeled[363] Heating and cooling savings are modeled using TMY3 data for Portland, Bangor and Caribou. Results are weighted based on population (71.2% Portland, 23.4% Bangor, 5.4% Caribou). [364] Savings were calculated based on a model employing the following key assumptions: • Heating and cooling are temperature and season dependent. A behavior model is applied to the TMY3 data to avoid out of season heating and cooling.[365] • Heating is called for when outside air temperature is less than or equal to 60°F (heating balance point).[366] Cooling is called for when outside temperature is more than 70F (cooling balance point). • Outdoor Heating design temperatures are -2F for Bangor, -10 for Caribou and 2 for Portland. Outdoor Cooling design temperatures are 86F for Bangor, 81F for Caribou and 83F for Portland.[367] • EE Heat pump capacity by temperature is weighted average based on program saturation and rated performance. Baseline heat pump capacity by temperature is weighted average of corresponding standard efficiency. • Design load is proportional to the design capacity of the heat pump as defined by the sizing factor. • Heating and cooling loads are linearly dependent on temperature between the balance point and design temperature. • Tier 1 EE Heat pump coefficient of performance by temperature is based on in-situ evaluated performance and varies linearly with temperature.[368] • Tier 2 EE heat pump COP is based on weighted average of rated performance of qualifying units adjusted by the same factor found between rated performance and evaluated performance. • Baseline heat pump COP is based on weighted average of rated performance adjusted by the same factor found between rated performance and evaluated performance for EE Heat Pump. • There is an interaction between the heat pump and the central system based on occupant behavior, building characteristics and capacity differences. This interaction is modeled through a load factor and a capacity ratio. When the existing heating system is electric resistance baseboard, heat is only called for when the heat pump capacity falls below the heat loss (i.e. perfect gap filling). • Energy savings are measured against the baseline heat pump up to its capacity. Above the baseline heat pump's capacity, energy savings are measured against the central heating system. • EE heat pump is used in the same manner as the baseline heat pump would have been for both heating and cooling.

[362] DHP_Model developed by Efficiency Maine Trust and Bruce Harley Energy Consulting.
[363] Ibid.
[364] Calculated based on population of each region; U.S. Census Bureau Census 2010 Summary File 1 population by census tract
[365] Annex G, section 3 of the *CSA EXP07 Public Review Draft / September, 2017*
[366] *BHEC Letter re SNOPR 2016-18993 HLL-Final*
[367] ASHRAE
[368] West Hill Energy and Computing, Home Energy Savings Impact Evaluation, WHEC_DHP_COPbyTemp.

Ductless Heat Pump Residential Lost Opportunity (CH, HPSING1T1, HPSING2T1, HPSING1T2, HPSING2T2, HPMULT2T1, HPMULT1T1, HPMULT1T2, HPMULT2T2)		
Definitions	Unit	= 1 outdoor unit attached to 1 indoor unit. Additional indoor units (whether attached to the same outdoor unit or additional units) are assessed as “Additional Units.” For residential applications, no more than 2 units can be claimed per dwelling.
	SF	= sizing factor - ratio of the heat pump capacity at design temperature to heat loss at design temperature
	LF	= load factor - ratio of heat pump capacity to heat loss above which heat is called for from the central system
	Eff_{CS}	= overall system efficiency of the central heating system
	Cap_{CS}	= capacity of central heating system (kBtu/h)

EFFICIENCY ASSUMPTIONS

Baseline Efficiency	The baseline case assumes the home retains its existing heating system and adds a new ductless heat pump that meets Federal minimum efficiency requirement for units manufactured on or after January 1, 2015: HSPF=8.2 and SEER=14.0.
Efficient Measure	The high-efficiency case assumes a new *high-efficiency* ductless heat pump that meets minimum efficiency requirements for program rebate: Tier 1: HSPF>=12.0 (single-zone), 10.0 (multi-zone); Tier 2: HSPF>=12.5.

PARAMETER VALUES (DEEMED)

Measure	SF	LF	Eff_{CS}	Cap_{CS}	Life (yrs)	Cost ($)
1st Tier 1	1[369]	3.5[370]	80.5[371]	27[372]	18[373]	$682[374]
2nd Tier 1	1.8[375]	3.6[376]				
1st Tier 2	1[377]	2.8[378]		27.8[379]		
2nd Tier 2	1.8[380]	3.6[381]				

IMPACT FACTORS

Measure	ISR	RR_E	RR_D	CF_S	CF_W	FR	SO
Ductless Heat Pump	100%[382]	100%[383]	100%[383]	100%[384]	100%[384]	42%[385]	11%[386]

[369] A sizing factor of 1 indicates that the heat pump capacity at the design temperature is perfectly matched to the heat loss of the area it serves, alternately, the area served by the heat pump is matched to the heat pump’s capacity at the design temperature.

[370] A load factor of 3.5 indicates that heat is called for from the central system when the temperature specific heat pump capacity falls below 3.5 times the heat loss of the area being served. The value is based on empirical data.

[371] NMR, 2015 Maine Residential Baseline Study

[372] Capacity of central heating system is set at 1.5 times the design load of the area served by the heat pump for non-electric resistance heating systems.

[373] GDS Associates, Inc., Measure Life Report – Residential and Commercial/Industrial Lighting and HVAC Measures, June 2007; Table 1.

[374] The incremental cost is the difference in cost between a typical high-efficiency unit ($1,645 based on Fujitsu model 12RLS2, ecomfort.com) and a typical baseline unit ($963 based on LG model LS093HE, ecomfort.com). Enhanced incentives starting in FY2020 will drive some level of retrofit within the market-based program. Measure costs for Tier 2 units are assigned a blend of lost opportunity and retrofit in effRT. The ratio of the blend is set at 100% retrofit for HPSING1T2 and 36% retrofit for HPSING2T2 based on FY2021 program activity and assumed volume growth without the enhanced incentives.

[375] A sizing factor of 1.8 indicates that the heat pump is oversized for the area it serves. Represents a 2nd heat pump being located in a less than ideal location.

[376] A load factor of 3.6 indicates that heat is called for from the central system more often. Represents a 2nd heat pump that is only heating a small portion of a central heating system zone.

[377] A sizing factor of 1 indicates that the heat pump capacity at the design temperature is perfectly matched to the heat loss of the area it serves, alternately, the area served by the heat pump is matched to the heat pump’s capacity at the design temperature.

[378] A load factor of 2.8 indicates that heat is called for from the central system when the temperature specific heat pump capacity falls below 2.8 times the heat loss of the area being served. The value is based on empirical data.

[379] Capacity of central heating system is set at 1.5 times the design load of the area served by the heat pump for non-electric resistance heating systems.

[380] A sizing factor of 1.8 indicates that the heat pump is oversized for the area it serves. Represents a 2nd heat pump being located in a less than ideal location.

[381] A load factor of 3.6 indicates that heat is called for from the central system more often. Represents a 2nd heat pump that is only heating a small portion of a central heating system zone.

[382] EMT assumes that all purchased units are installed (i.e. ISR = 100%). This is consistent with the MA 2013-2015 TRM.

[383] Modeled results informed by evaluation findings.

[384] The on-peak summer and winter kW savings are calculated directly from the modeling.

[385] West Hill Energy, Efficiency Maine Trust Home Energy Savings Program Impact Evaluation, 2019.

[386] West Hill Energy, Efficiency Maine Trust Home Energy Savings Program Impact Evaluation, 2019.

Ductless Heat Pump Residential Retrofit (HPSING1T2, HPSING2T2, HPMULT1T2, HPMULT2T2)

Last Revised Date	5/1/2022 (retroactive to 3/1/2022)

MEASURE OVERVIEW

Description	This measure involves the purchase and installation of a high-efficiency ductless heat pump (DHP) system as a supplemental heating system to offset the central heating system and to replace existing window air conditioning units.
Energy Impacts	Electric, Heating Oil, Propane, Kerosene, Wood
Sector	Residential
Program(s)	Home Energy Savings Program
End-Use	Heating, Cooling
Decision Type	Retrofit

DEEMED GROSS ENERGY SAVINGS (UNIT SAVINGS)[387,388]

Demand savings

Non-electric central heating system

	Δ kW$_{WP}$	Δ kW$_{SP}$
1st Unit	-0.622	0.031
Additional Units (each)	-0.448	0.017

Electric central heating system

	Δ kW$_{WP}$	Δ kW$_{SP}$
1st Unit	1.090	0.031
Additional Units (each)	0.755	0.017

Annual energy savings

Non-electric central heating system

	Δ kWh/y	Δ MMBtu/y
1st Unit	-2992	34.88
Additional Units (each)	-2049	23.96

Electric central heating system

	Δ kWh/y	Δ MMBtu/y
1st Unit	5785	0
Additional Units (each)	3783	0

GROSS ENERGY SAVINGS ALGORITHMS (UNIT SAVINGS)

Demand Savings: Modeled[389]

Annual Energy Savings: Modeled[390]

Heating and cooling savings are modeled using TMY3 data for Portland, Bangor and Caribou. Results are weighted based on population (71.2% Portland, 23.4% Bangor, 5.4% Caribou).[391]

Savings were calculated based on a model employing the following key assumptions:

- Heating and cooling are temperature and season dependent. A behavior model is applied to the TMY3 data to avoid out of season heating and cooling.[392]
- Heating is called for when outside air temperature is less than or equal to 60°F (heating balance point).[393] Cooling is called for when outside temperature is more than 70F (cooling balance point).
- Outdoor Heating design temperatures are -2F for Bangor, -10 for Caribou and 2 for Portland. Outdoor Cooling design temperatures are 86F for Bangor, 81F for Caribou and 83F for Portland.[394]
- EE Heat pump capacity by temperature is weighted average based on program saturation and rated performance.
- Design load is proportional to the design capacity of the heat pump as defined by the

[387] For multizone systems the savings are equal to the sum of "1st Unit" plus only one "Additional Unit" except in the special case where the 1st unit is a single zone unit and the second unit is a multizone unit. In this special case, the single zone unit is assigned the "1st Unit" savings and the multizone unit is assigned savings for one "Additional Unit."
[388] Enhanced incentives starting in FY2020 will drive some level of retrofit within the market-based program. Savings for Tier 2 units are assigned a blend of lost opportunity and retrofit. The ratio of the blend is set at 77% retrofit for the 1st tier 2 unit and 0% retrofit for the 2nd tier 2 unit based on FY22 program activity.
[389] DHP_Model developed by Efficiency Maine Trust and Bruce Harley Energy Consulting.
[390] Ibid.
[391] Calculated based on population of each region; U.S. Census Bureau Census 2010 Summary File 1 population by census tract
[392] Annex G, section 3 of the *CSA EXP07 Public Review Draft / September, 2017*
[393] *BHEC Letter re SNOPR 2016-18993 HLL-Final*
[394] ASHRAE

Ductless Heat Pump Residential Retrofit (HPSING1T2, HPSING2T2, HPMULT1T2, HPMULT2T2)	
	sizing factor. • Heating and cooling loads are linearly dependent on temperature between the balance point and design temperature. • Tier 1 EE Heat pump coefficient of performance by temperature is based on in-situ evaluated performance and varies linearly with temperature.[395] • Tier 2 EE heat pump COP is based on weighted average of rated performance of qualifying units adjusted by the same factor found between rated performance and evaluated performance. • There is an interaction between the heat pump and the central system based on occupant behavior, building characteristics and capacity differences. This interaction is modeled through a load factor and a capacity ratio. When the existing heating system is electric resistance baseboard, heat is only called for when the heat pump capacity falls below the heat loss (i.e. perfect gap filling). • Each btu provided by the heat pump offsets a btu produced by the central system. • 40% of homes have installed cooling equivalent to the cooling provided by the heat pump. 21% of homes do not have installed any cooling. The balance of the homes has partial cooling.
Definitions	Unit = 1 outdoor unit attached to 1 indoor unit. Additional indoor units (whether attached to the same outdoor unit or additional units) are assessed as "Additional Units." For residential applications, no more than 2 units can be claimed per dwelling. SF = sizing factor - ratio of the heat pump capacity at design temperature to heat loss at design temperature LF = load factor - ratio of heat pump capacity to heat loss above which heat is called for from the central system Eff_{CS} = overall system efficiency of the central heating system Cap_{CS} = capacity of central heating system (kBtu/h)
EFFICIENCY ASSUMPTIONS	
Baseline Efficiency	Existing central heating system
Efficient Measure	The high-efficiency case assumes a new *high-efficiency* ductless heat pump that meets minimum efficiency requirements for program rebate: Tier 2: HSPF>=12.5.

PARAMETER VALUES (DEEMED)

Measure	SF	LF	Eff_{CS}	Cap_{CS}	Life (yrs)	Cost ($)
1st Tier 2	1[396]	2.8[397]	80.5[398]	27.8[399]	18[400]	$4,600[401]
2nd Tier 2	1.8[402]	3.6[403]				

[395] West Hill Energy and Computing, Home Energy Savings Impact Evaluation, WHEC_DHP_COPbyTemp.
[396] A sizing factor of 1 indicates that the heat pump capacity at the design temperature is perfectly matched to the heat loss of the area it serves, alternately, the area served by the heat pump is matched to the heat pump's capacity at the design temperature.
[397] A load factor of 2.8 indicates that heat is called for from the central system when the temperature specific heat pump capacity falls below 2.8 times the heat loss of the area being served. The value is based on empirical data.
[398] NMR, 2015 Maine Residential Baseline Study
[399] Capacity of central heating system is set at 1.5 times the design load of the area served by the heat pump for non-electric resistance heating systems.
[400] GDS Associates, Inc., Measure Life Report – Residential and Commercial/Industrial Lighting and HVAC Measures, June 2007; Table 1.
[401] Average installed project cost for completed projects of single zone systems from a sample of program invoices. Enhanced incentives starting in FY2020 will drive some level of retrofit within the market-based program. Measure costs for Tier 2 units are assigned a blend of lost opportunity and retrofit in effRT. The ratio of the blend is set at 100% retrofit for HPSING1T2 and 36% retrofit for HPSING2T2 based on FY2021 program activity and assumed volume growth without the enhanced incentives.
[402] A sizing factor of 1.8 indicates that the heat pump is oversized for the area it serves. Represents a 2nd heat pump being located in a less than ideal location.
[403] A load factor of 3.6 indicates that heat is called for from the central system more often. Represents a 2nd heat pump that is only heating a small portion of a central heating system zone.

Ductless Heat Pump Residential Retrofit (HPSING1T2, HPSING2T2, HPMULT1T2, HPMULT2T2)							
IMPACT FACTORS							
Measure	ISR	RR_E	RR_D	CF_S	CF_W	FR	SO
Ductless Heat Pump	100%[404]	100%[405]	100%[383]	100%[406]	100%[384]	0%[407]	0%[408]

[404] EMT assumes that all purchased units are installed (i.e. ISR = 100%). This is consistent with the MA 2013-2015 TRM.
[405] Modeled results informed by evaluation findings.
[406] The on-peak summer and winter kW savings are calculated directly from the modeling.
[407] Because the program share allocated to retrofits is directly related to the growth in additional projects driven by enhanced incentives, retrofit projects can not be free riders. Free riders on the program are captured in the lost opportunity share.
[408] Assumed to be 0%.

Ductless Heat Pump Low Income Retrofit (LCHA, LCHL, LCHD)

Last Revised Date	7/1/2022 (retroactive to 7/1/2020)
MEASURE OVERVIEW	
Description	This measure involves the purchase and installation of a high-efficiency ductless heat pump (DHP) system to supplement the existing heating system in electric-, gas-, oil-, kerosene-, and propane-heated homes and to replace existing window air-conditioning units.
Energy Impacts	Electric, Heating Oil, Propane, Kerosene, Wood
Sector	Residential
Program(s)	Low Income Initiatives
End-Use	Heating, Cooling
Decision Type	Retrofit

DEEMED GROSS ENERGY SAVINGS (UNIT SAVINGS)

Demand savings

Non-electric central heating system		Electric central heating system	
Δ kW_{WP}	Δ kW_{SP}	Δ kW_{WP}	Δ kW_{SP}
-0.595	0.031	1.046	0.031

Annual energy savings

Non-electric central heating system		Electric central heating system	
Δ kWh/y	Δ MMBtu/y	Δ kWh/y	Δ MMBtu/y
-2744	31.72	5379	0

GROSS ENERGY SAVINGS ALGORITHMS (UNIT SAVINGS)

Demand Savings: Modeled[409]

Annual Energy Savings: Modeled[410]

Heating and cooling savings are modeled using TMY3 data for Portland, Bangor and Caribou. Results are weighted based on population (71.2% Portland, 23.4% Bangor, 5.4% Caribou). [411]

Savings were calculated based on a model employing the following key assumptions:

- Heating and cooling are temperature and season dependent. A behavior model is applied to the TMY3 data to avoid out of season heating and cooling.[412]
- Heating is called for when outside air temperature is less than or equal to 60°F (heating balance point).[413] Cooling is called for when outside temperature is more than 70F (cooling balance point).
- Outdoor Heating design temperatures are -2F for Bangor, -10 for Caribou and 2 for Portland. Outdoor Cooling design temperatures are 86F for Bangor, 81F for Caribou and 83F for Portland.[414]
- EE Heat pump capacity by temperature is weighted average based on program saturation and rated performance.
- Design load is proportional to the design capacity of the heat pump as defined by the sizing factor.
- Heating and cooling loads are linearly dependent on temperature between the balance point and design temperature.
- Tier 1 EE Heat pump coefficient of performance by temperature is based on in-situ evaluated performance and varies linearly with temperature.[415]
- Tier 2 EE heat pump COP is based on weighted average of rated performance of qualifying units adjusted by the same factor found between rated performance and evaluated

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409 DHP_Model developed by Efficiency Maine Trust and Bruce Harley Energy Consulting.
410 Ibid.
411 Calculated based on population of each region; U.S. Census Bureau Census 2010 Summary File 1 population by census tract
412 Annex G, section 3 of the *CSA EXP07 Public Review Draft / September, 2017*
413 *BHEC Letter re SNOPR 2016-18993 HLL-Final*
414 ASHRAE
415 West Hill Energy and Computing, Home Energy Savings Impact Evaluation, WHEC_DHP_COPbyTemp.

Ductless Heat Pump Low Income Retrofit (LCHA, LCHL, LCHD)	
	performance. • There is an interaction between the heat pump and the central system based on occupant behavior, building characteristics and capacity differences. This interaction is modeled through a load factor and a capacity ratio. When the existing heating system is electric resistance baseboard, heat is only called for when the heat pump capacity falls below the heat loss (i.e. perfect gap filling). • Each btu provided by the heat pump offsets a btu produced by the central system. • 40% of homes have the equivalent of full-home cooling. 21% of homes have no cooling. • For homes that have equivalent of whole home A/C already installed, DHP will replace the cooling load equivalent to the DHP's rated capacity. • For homes that have existing partial cooling (i.e. 1 or 2 existing window A/C units), it is unknown if the DHP will be installed in the same areas served by the existing window A/C units. If installed in the same area, the DHP will replace the existing cooling load and result in positive savings due to increased efficiency. However, if installed in a different area, DHP may result in additional cooling load and hence increased energy use. Without any in-situ data, zero-net savings is assumed for homes with existing partial cooling. • For homes with no existing cooling equipment, it is assumed that the DHP will be used to its full cooling capacity.
Definitions	Unit = 1 outdoor unit attached to 1 indoor unit. SF = sizing factor - ratio of the heat pump capacity at design temperature to heat loss at design temperature LF = load factor - ratio of heat pump capacity to heat loss above which heat is called for from the central system Eff_{CS} = overall system efficiency of the central heating system Cap_{CS} = capacity of central heating system (kBtu/h)

EFFICIENCY ASSUMPTIONS

Baseline Efficiency	Average existing central heating system with a system efficiency of 80.5%.
Efficient Measure	The high-efficiency case assumes a new *high-efficiency* ductless heat pump that meets minimum efficiency requirements for program rebate: HSPF=13.0

PARAMETER VALUES (DEEMED)

Measure	SF	LF	Eff_{CS}	Cap_{CS}	Life (yrs)	Cost ($)
Ductless Heat Pump	1[416]	3.5[417]	80.5[418]	27.8[419]	18[420]	Actual

IMPACT FACTORS

Measure	ISR	RR_E	RR_D	CF_S	CF_W	FR	SO
Ductless Heat Pump	100%[421]	100%[422]	100%[383]	100%[423]	100%[384]	0%[424]	0%[425]

[416] A sizing factor of 1 indicates that the heat pump capacity is perfectly sized for the heat loss of the area it serves.
[417] A load factor of 3.5 indicates that heat is called for from the central system when the temperature specific heat pump capacity falls below 3.5 times the heat loss of the area being served. The value is based on empirical data.
[418] NMR, 2015 Maine Residential Baseline Study
[419] Capacity of central heating system is set at 1.5 times the design load of the area served by the heat pump for non-electric resistance heating systems.
[420] GDS Associates, Inc., Measure Life Report – Residential and Commercial/Industrial Lighting and HVAC Measures, June 2007; Table 1.
[421] EMT assumes that all purchased units are installed (i.e. ISR = 100%). This is consistent with the MA 2013-2015 TRM.
[422] Modeled results informed by evaluation findings.
[423] The on-peak summer and winter kW savings are calculated directly from the modeling.
[424] Free ridership of 0% assumed for low income programs.
[425] Spillover of 0% assumed for low income programs.

Table 6. Parameters for Existing Heating Systems

Fuel	Baseline: Main Heating Equipment	Efficiency Measure	Share	Efficiency
Heating Baseline Assumptions				
Electric	Electric Baseboard	HSPF	Calculated Separately	3.4
Oil	Oil-Fired Forced hot water boiler	AFUE	67.5%	83.0%
Oil	Oil-Fired Ducted Furnace	AFUE * Duct Efficiency	20.0%	72.9%
Wood	Wood Stove	AFUE	10.0%	74.0%
Propane	Propane-Fired Forced hot water boiler	AFUE	2.5%	86.0%
Blended	Blended MMBtu Baseline	Blended Efficiency	100%	80.5%
		Duct Efficiency		*90%*
Cooling Baseline Assumptions				
Electric	Single-Package Air Conditioner	SEER	40%	14
Electric	Single-Package Air Conditioner	EER	40%	12

Sources

DOE standards for furnaces manufactured on or after May 1, 2013 (http://www1.eere.energy.gov/buildings/appliance_standards/product.aspx/productid/72)

NMR, 2015 Maine Residential Baseline Study

Whole Home Heat Pump (AIWHHPR, LIWHHPR, MIWHHPR)						
Last Revised Date	1/1/2024 (retroactive to 9/18/2023)					
MEASURE OVERVIEW						
Description	This measure involves the installation of high-efficiency heat pumps instead of industry standard heating systems and retrofit of high-efficiency heat pumps that replace existing heating systems.					
Energy Impacts	Heating Oil, Kerosene, Propane, Wood, Electricity, Natural Gas					
Sectors	Residential					
Program(s)	Home Energy Savings Program, Low & Moderate Income Program					
End-Use	Heating					
Decision Type	Retrofit					
GROSS ENERGY SAVINGS ALGORITHMS (UNIT SAVINGS)						
Demand Savings	For non-electric baseline: $kW_{WP} = DSF_{WPFF} \times AHL$; For electric baseline: $kW_{WP} = DSF_{WPER} \times AHL$ $kW_{SP} = DSF_{SP} \times AHL$					
Annual Energy Savings	For non-electric baseline: $\Delta MMBtu/y = AHL / AFUE_{BASE}$ $\Delta kWh/y = - AHL \times ESF_{FF}$ For electric baseline: $\Delta kWh/y = AHL \times ESF_{ER}$ $AHL = 186{,}648 \times DL / (T_i - T_o) / 1{,}000{,}000 = 0.002666 \times DL$					
Definitions	Unit	= One home heated by heat pumps				
	DSF_{WPFF}	= Demand Savings Factor Winter Peak for fuel displacement (kW/MMBtu of provided heat)				
	DSF_{WPER}	= Demand Savings Factor Winter Peak for electric resistance displacement (kW/MMBtu of provided heat)				
	DSF_{SP}	= Demand Savings Factor Summer Peak (kW/MMBtu of provided heat)				
	AHL	= Annual heat load served by the newly installed heat pumps (MMBtu/y)[426]				
	$AFUE_{BASE}$	= Rated efficiency of the baseline code-compliant unit (AFUE %)				
	ESF_{FF}	= Energy Savings Factor for fuel displacement (kWh/MMBtu of provided heat)				
	ESF_{ER}	= Energy Savings Factor for electric resistance displacement (kWh/MMBtu of provided heat)				
	186,648	= Population weighted average of TMY3 heating degree hours for Portland, Bangor, and Caribou, ME				
	DL	= Design Load from Manual J or installed Heat Pump Capacity if < DL				
	T_i	= Average Indoor Design Temperature				
	T_o	= Average Outdoor Design Temperature				
	1,000,000	= BTU to MMBTU conversion				
EFFICIENCY ASSUMPTIONS						
Baseline Efficiency	The baseline case is a new or existing heating system.					
Efficient Measure	Heat pump(s) that meet program eligibility requirements.					
PARAMETER VALUES (DEEMED)						
Measure	DSF_{WP}[427]	DSF_{SP}[428]	ESF_{FF}[429]	$AFUE_{BASE}$[430]	Life (yrs)[431]	Cost ($)

[426] For homes with previously installed heat pumps, the heat load is adjusted by the average heat load offset by previously installed heat pumps derived from the 2023 Residential Heat Pump Impact Evaluation (16.4 MMBtu per heat pump * 1.6 heat pump rebates per home). Average heat pump rebates per home derived from FY2023 Program data.

[427] Derived from Efficiency Maine DHP Model December 2023 with Tier 1 performance informed by West Hill Energy and Computing, 2019 Home Energy Savings Impact Evaluation. Model parameters: % full cooling baseline: 60%, % no cooling baseline: 40%, blended combustion heating baseline, sizing factor: based on program averages (1.2 for HESP, 1.27 for LI, 1.22 for MI), load factor: 0.7, backup system capacity set to heat pump capacity at design temperature.

Whole Home Heat Pump (AIWHHPR, LIWHHPR, MIWHHPR)

Whole Home Heat Pump	-0.0316	-0.00038	-125	80.5%	18	Actual
Measure	DL[432]	T_i	T_o	$DSF_{WP,ER}$[433]	ESF_{ER}[434]	
Whole Home Heat Pump	Actual	68	-2	0.0387	168	

IMPACT FACTORS

Measure	ISR	RR_E	RR_D	CF_S	CF_W	FR	SO
All Income and Moderate Income	100%[435]	100%[436]	100%[451]	NA	NA	25%[437]	0%[438]
Low Income						0%[439]	

428 Ibid.
429 Ibid.
430 NMR, 2015 Maine Residential Baseline Study.
431 GDS Associates, Inc., Measure Life Report – Residential and Commercial/Industrial Lighting and HVAC Measures, June 2007; Table 1.
432 In cases where the installed heat pump capacity is less than the design load, the installed heat pump capacity will be used in place of the design load to calculate the annual heat load.
433 Derived from Efficiency Maine DHP Model December 2023 with Tier 1 performance informed by West Hill Energy and Computing, 2019 Home Energy Savings Impact Evaluation. Model parameters: % full cooling baseline: 60%, % no cooling baseline: 40%, electric resistance heating baseline, sizing factor: based on program averages (1.2 for HESP, 1.27 for LI, 1.22 for MI), load factor: 0.7, backup system capacity set to heat pump capacity at design temperature.
434 Ibid.
435 EMT assumes that all purchased units are installed (i.e. ISR = 100%).
436 This measure has not yet been evaluated. Until the next program impact evaluation, EMT assumes 100 percent realization rate.
437 Measure not yet evaluated, assume default FR of 25%.
438 Measure not yet evaluated, assume default SO of 0%.
439 Free ridership of 0% assumed for low income programs.

Furnaces and Boilers (BOILM, FURNM) (Inactive)		
Last Revised Date	7/1/2023	
MEASURE OVERVIEW		
Description	This measure involves the installation of a high-efficiency furnace, boiler or combination boiler plus domestic hot water (Combi) instead of industry standard furnace or boiler of the same fuel type and capacity (i.e. no fuel switching). In the case of combi units, the combi also replaces a standalone water heater.	
Energy Impacts	Natural Gas, Heating Oil, Kerosene, Propane	
Sectors	Residential, Commercial	
Program(s)	Home Energy Savings Program	
End-Use	Heating	
Decision Type	New Construction, Replace on Burnout	
DEEMED GROSS ENERGY SAVINGS (UNIT SAVINGS)		
Demand Savings	ΔkW = 0.000	
Annual Energy Savings	<u>Residential</u> NG Furnace Savings $\Delta MMBtu_{GAS}$ = 7.035 Propane Furnace Savings $\Delta MMBtu_{PROP}$ = 7.351 Heating Oil/Kerosene Furnace Savings $\Delta MMBtu_{OIL/KERO}$ = 5.940	<u>Residential</u> NG Boiler Savings $\Delta MMBtu_{GAS}$ = 6.288 Propane Boiler Savings $\Delta MMBtu_{PROP}$ = 6.609 Heating Oil/Kerosene Boiler Savings $\Delta MMBtu_{OIL/KERO}$ = 4.140 NG Combi Savings $\Delta MMBtu_{GAS}$ = 1.617
	<u>Commercial: project specific calculated savings</u>	
GROSS ENERGY SAVINGS ALGORITHMS (UNIT SAVINGS)		
Demand Savings	ΔkW = 0.0000	
Annual Energy Savings	For Boiler and Furnaces $\Delta MMBtu/yr = AHL \times (1 / AFUE_{BASE} - 1 / AFUE_{EE})$ For Combination Boiler and Domestic Hot Water $\Delta MMBtu/yr = AHL \times (1 / AFUE_{BASE} - 1 / AFUE_{EE}) + GPD \times 365 \times 8.33 \times 1 \times (T_{WH} - T_{in}) \times (1/EF_{BASE} - 1/EF_{EE})$ From Manual J: $AHL = 186{,}648 \times DL / (T_i - T_o) / 1{,}000{,}000$	
Definitions	AHL	= Annual heat load (MMBtu/y)
	$AFUE_{BASE}$	= Rated efficiency of the baseline code-compliant unit (AFUE %)
	$AFUE_{EE}$	= Rated efficiency of the high-efficiency unit (AFUE %)
	GPD	= Average amount of hot water consumed annually per Maine household
	365	= Constant: 365 days per year
	8.33	= Density of water: 8.33 lb/gallon water
	1	= Specific heat of water: 1 Btu/lb-°F
	T_{WH}	= Water heater temperature set point (°F)
	T_{in}	= Temperature of water mains (water into the water heater) (°F)
	EF_{BASE}	= Energy factor for baseline stand alone tank water heater (%)
	EF_{EE}	= Energy factor for high-efficiency unit (%)
	186,648	= Population weighted average of TMY3 heating degree hours for Portland, Bangor, and Caribou, ME

Furnaces and Boilers (BOILM, FURNM) (Inactive)		
	DL	= Design Load from Manual J
	T_i	= Indoor Design Temperature used in Manual J
	T_o	= Outdoor Design Temperature used in Manual J
	1,000,000	= BTU to MMBTU conversion
	OF	= Oversize Factor
	CAP	=Rated Input Capacity of Unit (Btu/hr)
	$EFLH_h$	=Effective full load hours for heating
EFFICIENCY ASSUMPTIONS		
Baseline Efficiency	The baseline case is a new boiler or furnace (and a new water heater in the case of a combi) that meets the efficiency specifications for the industry standard.	
Efficient Measure	The high-efficiency equipment exceeds the federal minimum efficiency.	

PARAMETER VALUES (DEEMED)

Measure	Residential AHL[440]	Commercial AHL	$AFUE_{BASE}$[441]	$AFUE_{EE}$[442]	Life (yrs)[443]	Cost ($)[444]
Oil/Kerosene Furnace	92	Calculated	83%	87.7%	25	668
Natural Gas Furnace			87%	93.2%		1,438
Propane Furnace			87%	93.5%		742
Oil/Kerosene Boiler			84%	87.3%		326
Natural Gas Boiler			87%	92.5%		
Natural Gas Combi			92.6%	93%		500
Propane Boiler			87%	92.8%		2,030

Measure	GPD[445]	T_{in}[446]	T_{WH}[447]	EF_{BASE}[448]	EF_{EE}[449]
Natural Gas Combi Unit	51.1	50.8	126.2	89%	93%

IMPACT FACTORS

Measure	ISR	RR_E	RR_D	CF_S	CF_W	FR	SO
High Eff. Furnaces/Boilers	100%[450]	100%[451]	100%[451]	NA	NA	25%[452]	0%[453]

[440] NMR Group, Maine Single-Family Residential Baseline Study, September 14, 2015.
[441] For NG Combi boiler, Maine standard efficiency for new equipment based on distributor interview, May 2023. For all others, Michaels Energy, Midstream HVAC Potential Study, 9/13/2018.
[442] For NG Combi boiler, Maine average efficiency for Energy Star equipment based on distributor interview, May 2023. For all others, average AFUE for new high-efficiency equipment are based on average EMT program tracking data from November 2014 to April 2016.
[443] GDS, Measure Life Report, Residential and Commercial/Industrial Lighting and HVAC Measures, June 2007; Table 1, value for new construction.
[444] Natural Gas combi cost based on distributor interview, May 2023. Oil/Kerosene and Propane unit costs based on incremental costs reported in Efficiency Vermont Technical Reference User Manual (TRM) 2014-87, 1/1/2014, p. 533. Natural Gas unit costs based on incremental costs reported in Illinois Statewide Technical Reference Manual for Energy Efficiency Version 4.0, 1/23/2015, Boiler AFUE 95% p. 572 and Furnace AFUE 95 percent p. 578.
[445] Daily household consumption of hot water calculated based on average number of people per household (Nppl): 16.286 x Nppl + 13. The relationship is used in NY and Indiana TRMs and is based on: Lutz, James D., Liu, Xiaomin, McMahon, James E., Dunham, Camilla, Shown, Leslie J.McCure, Quandra T; "Modeling patterns of hot water use in households;" LBL-37805 Rev., Lawrence Berkeley Laboratory, 1996.
[446] Standard Building America DHW Schedules, weighted average by population of all Maine water main sources.
[447] NMR Group, Inc., Efficiency Maine Appliance Rebate Program Evaluation Overall Report – FINAL, July 18, 2014.
[448] Average efficiency of new gas water heater based on distributor interview May 2023.
[449] Average AFUE for new high-efficiency equipment are based on average EMT program tracking data from November 2014 to April 2016.
[450] EMT assumes that all purchased units are installed (i.e. ISR = 100%).
[451] This measure has not yet been evaluated. Until the next program impact evaluation, EMT assumes 100 percent realization rate.
[452] Measure not yet evaluated, assume default FR of 25%.
[453] Measure not yet evaluated, assume default SO of 0%.

Furnace and Boiler Retrofit (Prescriptive) (Inactive)							
Last Revised Date	7/1/2016						
MEASURE OVERVIEW							
Description	This measure involves the replacement of an existing furnace or boiler with a high-efficiency furnace or boiler of the same fuel type and capacity (i.e. no fuel switching).						
Energy Impacts	Natural Gas, Heating Oil, Kerosene, Propane, Wood, Pellet						
Sector	Residential, Low Income						
Program(s)	Low-income Program						
End-Use	Heating						
Decision Type	Retrofit						
GROSS ENERGY SAVINGS ALGORITHMS (UNIT SAVINGS)							
Demand savings	$\Delta kW = 0$						
Annual Energy Savings	$\Delta kWh/yr = 0$ $\Delta MMBtu/yr = AHL \times (EF_{EE} / EF_{BASE} - 1)$						
Definitions	Unit = 1 new furnace or boiler AHL = Annual heat load (MMBtu/yr) EF_{BASE} = Rated efficiency of the baseline existing unit (AFUE) EF_{EE} = Rated efficiency of the high-efficiency unit (AFUE)						
EFFICIENCY ASSUMPTIONS							
Baseline Efficiency	The baseline is the existing furnace or boiler.						
Efficient Measure	The high-efficiency case is a new furnace or boiler that exceeds the federal minimum efficiency standards.						
PARAMETER VALUES (DEEMED)							
Measure	AHL[454]	EF_{BASE}	EF_{EE}			Life (yrs)	Cost ($)
Furnace/Boiler Retrofit	92	Actual	Actual			25[455]	Actual [456]
IMPACT FACTORS							
Measure	ISR	RR_E	RR_D	CF_S	CF_W	FR	SO
Furnace/Boiler Retrofit	100%[457]	100%[458]	100%[458]	NA	NA	0%[459]	0%[460]

454 NMR Group, Maine Single-Family Residential Baseline Study, September 14, 2015.
455 GDS, Measure Life Report, Residential and Commercial/Industrial Lighting and HVAC Measures, June 2007, Table 1, value for new construction.
456 Full cost of installation.
457 EMT assumes that all purchased units are installed (i.e. ISR = 100%).
458 This measure has not yet been evaluated. Until the next program impact evaluation, EMT assumes 100 percent realization rate.
459 EMT assumes 100 percent NTG (0 percent free ridership) for the low-income sector.
460 Program not yet evaluated, assume default SO of 0%.

Low-income Gas Heat (Modeled)							
Last Revised Date	10/1/2018						
MEASURE OVERVIEW							
Description	This measure involves the installation of a new natural gas heating system and/or building weatherization measures to replace existing or new standard efficiency natural gas heating equipment and/or augment or replace existing weatherization measures.						
Energy Impacts	Natural Gas						
Sector	Low Income						
Program(s)	Low-income Program						
End-Use	Heating						
Decision Type	Retrofit, Replace on Burnout						
DEEMED GROSS ENERGY SAVINGS (UNIT SAVINGS)							
Demand savings	ΔkW = NA						
Annual energy savings	$\Delta kWh/yr = 0$ $\Delta MMBtu_{GAS}$ = Calculated using project-specific data						
GROSS ENERGY SAVINGS ALGORITHMS (UNIT SAVINGS)							
Demand Savings	The program does not estimate demand savings for these projects.						
Annual Energy Savings	The program estimates annual natural gas savings using project-specific data and building modeling software.						
Definitions	Unit = Low-income gas heat project $\Delta MMBtu_{GAS}$ = Modeled annual natural gas savings for weatherization and heating system upgrade (MMBtu)						
EFFICIENCY ASSUMPTIONS							
Baseline Efficiency	The baseline scenario is the existing low-income building and heating system equipment.						
Efficient Measure	The high-efficiency measures involves weatherizing the building and replacing the existing natural gas heating equipment with new high-efficiency natural gas heating equipment.						
PARAMETER VALUES							
Measure	$\Delta MMBtu_{GAS}$					Life (yrs)	Cost ($)
Multifamily Gas Heat	Model					20[461]	Actual
IMPACT FACTORS							
Measure	ISR	RR_E	RR_D	CF_S	CF_W	FR	SO
Multifamily Gas Heat	100%[462]	100%[463]	100%[463]	NA	NA	0%[464]	0%[465]

461 GDS, Measure Life Report, Residential and Commercial/Industrial Lighting and HVAC Measures, June 2007. Table 1, value for weatherization measures.
462 EMT assumes that all purchased units are installed (i.e. ISR = 100%).
463 This measure has not yet been evaluated. Until the next program impact evaluation, EMT assumes 100 percent realization rate.
464 EMT assumes 100 percent NTG (0 percent free ridership) for the low-income sector.
465 Program not yet evaluated, assume default SO of 0%.

Pellet/Cord Wood Boiler (APB)	
Last Revised Date	10/1/2023
MEASURE OVERVIEW	
Description	This measure involves purchase and installation of a pellet or cord wood boiler as a whole-home heating system rather than a new fossil-fuel boiler.
Energy Impacts	Wood, Oil
Sector	Residential, Commercial
Program(s)	Home Energy Savings Program
End-Use	Heating
Decision Type	New Construction, Replace on Burnout, Retrofit
DEEMED GROSS ENERGY SAVINGS (UNIT SAVINGS)	
Demand savings	ΔkW_{SP} = NA ΔkW_{WP} = NA
Annual energy savings	$\Delta MMBtu_{WOOD}$=-79.302 $\Delta MMBtu_{NG}$ = 0.219 $\Delta MMBtu_{PROPANE}$ = 4.374 $\Delta MMBtu_{OIL}$ = 67.002 ΔkWh = 200
GROSS ENERGY SAVINGS ALGORITHMS (UNIT SAVINGS)	
Demand savings	ΔkW = NA
Annual Energy savings	$\Delta MMBtu_{BASEFUEL}/yr = MMBtu_{HEAT} \times (1 / EFF_{BASENEW} \times (1 - \%Ret) + 1 / EFF_{BASEEX} \times (\%Ret)) \times \%FUEL_{BASE}$ $\Delta kWh_{BASEFUEL}/yr = MMBtu_{HEAT} \times (1 / EFF_{BASENEW} \times (1 - \%Ret) + 1 / EFF_{BASEEX} \times (\%Ret)) \times \%FUEL_{BASE}/0.003412$ $\Delta MMBtu_{NEWFUEL}/yr = - (MMBtu_{HEAT} \times 1 / EFF_{PB}) \times \%FUEL_{EE}$
Definitions	Unit = New pellet boiler AHL = Average annual heating load for Maine home (MMBtu) $EF_{BASENEW}$ = Average baseline heating system efficiency (%) for new systems EF_{BASEEX} = Average baseline heating system efficiency (%) for existing systems %Ret = Precent of projects that are retrofit. Remaining is combination of new construction and replace on burnout EF_{PB} = Average pellet boiler heating system efficiency (%) $\%FUEL_{BASE}$ = Distribution of fuel types for baseline boilers $\%FUEL_{EE}$ = Distribution of fuel types for efficient boilers 0.003412 = kWh to MMBtu conversion
EFFICIENCY ASSUMPTIONS	
Baseline Efficiency	The baseline case is a blend of new wood stoves and new standard efficiency fossil fuel boiler.
Efficient Measure	The high-efficiency case assumes the home replaces its heating system with a new pellet boiler that meets the minimum efficiency requirements for program rebate.

Pellet/Cord Wood Boiler (APB)

PARAMETER VALUES (DEEMED)

Measure	AHL[466]	EFF_{PB}	%Ret	Life (yrs)[467]	Cost ($)[468]
Pellet Boiler	92	71%[469]	71%	25	21,234

Measure	$EFF_{BASENEW}$[470]	EFF_{BASEEX}[471]	$\%FUEL_{BASE}$[472]	$\%FUEL_{EE}$[473]
Pellet Boiler	87% oil 93% propane/NG 73.2% wood 100% electric	100% electric 50% wood 80.5% all others	2% natural gas 61% oil 4% propane 31% wood 2% electric	90% pellets 10% cord wood

IMPACT FACTORS

Measure	ISR	RR_E	RR_D	CF_S	CF_W	FR	SO
Boiler	100%[474]	100%[475]	NA	NA	NA	35%[476]	6%[477]

466 NMR Group, Maine Single-Family Residential Baseline Study, September 14, 2015.
467 GDS Measure Life Report, Residential and Commercial/Industrial Lighting and HVAC Measures, prepared for the New England State Program Working Group, June 2007, Table 1; value for new construction.
468 Average project cost from FY2023 program data minus new oil boiler cost for new construction/replace on burnout projects. New oil boiler cost from 2021 New Construction Heating System Cost Assessment. ($23,597 – ($8,086 * 0.21).
469 Weighted Average efficiency of residential pellet boiler, based on FY2019 projects through May 2019.
470 For wood, average measured efficiency of all NSPS 2020 compliant stoves as of 6/6/2019. For oil and propane, Michaels Energy, Midstream HVAC Potential Study, 9/13/2018.
471 For wood, estimate, comparison against RECS microdata for the New England census division found percentages in a similar range. For others, NMR Group, Maine Single-Family Residential Baseline Study, September 14, 2015.
472 Program data FY2023.
473 Program Assumption
474 EMT assumes that all purchased units are installed (i.e. ISR = 100%).
475 The measure has not yet been evaluated. Until the next program impact evaluation, EMT assumes 100 percent realization rate.
476 West Hill Energy, Efficiency Maine Trust Home Energy Savings Program Impact Evaluation, 2019.
477 West Hill Energy, Efficiency Maine Trust Home Energy Savings Program Impact Evaluation, 2019.

Central Air-source Heat Pump (ducted) (DHA) (Inactive)	
Last Revised Date	4/1/2018
MEASURE OVERVIEW	
Description	This measure involves the purchase and installation of new high-efficiency air-source heat pump for central heating and cooling rather than a new standard-efficiency air-source heat pump. Energy savings are achieved by the improved efficiency of the installed equipment compared to federal standards.
Energy Impacts	Electric
Sector	Residential
Program(s)	Home Energy Savings Program
End-Use	Heating, Cooling
Decision Type	New Construction, Replacement
DEEMED GROSS ENERGY SAVINGS (UNIT SAVINGS)	
Demand savings	$\Delta kW_{SP} = 0.013$ $\Delta kW_{WP} = 0.395$
Annual energy savings	$\Delta kWh/yr = 2{,}062$
GROSS ENERGY SAVINGS ALGORITHMS (UNIT SAVINGS)	
Demand savings	$\Delta kW_{SP} = CAP_C \times (1 / EER_{BASE} - 1 / EER_{EE}) \times CF_{SP}$ $\Delta kW_{WP} = CAP_H \times (1 / HSPF_{BASE} - 1 / HSPF_{EE}) \times CF_{WP}$
Annual Energy savings	$\Delta kWh = \Delta kWh_{COOL} + \Delta kWh_{HEAT}$ $\Delta kWh_{COOL} = ACL \times 1000 \text{ x } (1 / SEER_{BASE} - 1 / SEER_{EE})$ $\Delta kWh_{HEAT} = AHL \times 1000 \text{ x } (1 / HSPF_{BASE} - 1 / HSPF_{EE})$
Definitions	Unit = New ASHP equipment CAP_C = Output cooling capacity of ASHP (kBtu/hr) CAP_H = Output heating capacity of ASHP (kBtu/hr) $SEER_{BASE}$ = SEER of new code-compliant ASHP (Btu/w-hr) (baseline code updates 6/30/16) $SEER_{EE}$ = SEER of new high-efficiency ASHP (Btu/w-hr) $HSPF_{BASE}$ = HSPF of new code-compliant ASHP (Btu/w-hr) (baseline code updates 6/30/16) $HSPF_{EE}$ = HSPF of new high-efficiency ASHP (Btu/w-hr) EER_{BASE} = EER of new code-compliant ASHP (Btu/w-hr) EER_{EE} = EER of new high-efficiency ASHP (Btu/w-hr) CF_{SP} = Summer peak coincidence factor (%) CF_{WP} = Winter peak coincidence factor (%) AHL = Annual heating load (MMBtu) ACL = Annual cooling load (MMBtu) 1000 = Conversion factor MMBtu to kBtu
EFFICIENCY ASSUMPTIONS	
Baseline Efficiency	The baseline case is a new code-compliant air-source heat pump to provide heating and cooling.
Efficient Measure	The high-efficiency case is a new high-efficiency air-source heat pump with a HSPF greater than or equal to 10.0 Btu/W-h to provide heating and cooling.

Central Air-source Heat Pump (ducted) (DHA) (Inactive)								
PARAMETER VALUES								
Measure	CAP_C	CAP_H	$SEER_{BASE}$	$SEER_{EE}$	$HSPF_{BASE}$	$HSPF_{EE}$	Life (yrs)	Cost ($)
Central ASHP	36[478]	36[478]	14[479]	18[480]	8.2[479]	10.0[481]	25[482]	2,000[483]
Measure	EER_{BASE}	EER_{EE}	$EFLH_{HEAT}$	$EFLH_{COOL}$	AHL	ACL		
Central ASHP	11.8[484]	12[485]	2,706[486]	231[486]	92[487]	2.7[488]		
IMPACT FACTORS								
Measure	ISR	RR_E	RR_D	CF_{SP}	CF_{WP}	FR	SO	
Central ASHP	100%[489]	100%[490]	100%[490]	25%[491]	50%[491]	25%[492]	0%[493]	

[478] Assumed capacity.
[479] U.S. DOE Standard, effective in 2015: https://www1.eere.energy.gov/buildings/appliance_standards/product.aspx/productid/75 .
[480] NY TRM 2010 p. 42, ASHP measure, SEER correlated to HSPF of 9.2 (closest HSPF value to 10).
[481] Minimum program requirement.
[482] GDS Measure Life Report, Residential and Commercial/Industrial Lighting and HVAC Measures, Prepared for the New England State Program Working Group, June 2007; Table 1; value for new construction.
[483] Survey of standard and high-efficiency system costs at ecomfort.com.
[484] Converted baseline SEER to EER using the following conversion: $EER = -0.02*SEER^2+1.12*SEER$. U.S. DOE Building America House Simulation Protocols, p. 47, Eq 22, http://www.nrel.gov/docs/fy11osti/49246.pdf.
[485] ENERGY STAR database, EER correlated to HSPF of 10: most common EER associated with split ASHP systems with HSPF of 10, viewed 7/16/14.
[486] Calculated based on 97.4 MMBTU average heating load for Maine household and 36 kBtuh Central GSHP heating capacity. Average heating load for Maine household is a weighted average value based on estimated heating energy and population distribution for Portland (96, 71.2%), Bangor (96, 23.4%), and Caribou (122, 5.4%).
[487] NMR Group, Maine Single-Family Residential Baseline Study, September 14, 2015.
[488] Ibid.
[489] EMT assumes that all purchased units are installed (i.e. ISR = 100%).
[490] The measure has not yet been evaluated. Until the next program impact evaluation, EMT assumes 100% realization rate.
[491] MA TRM 2013 TRM 2010, Air-source heat pump peak coincidence factor.
[492] Program not yet evaluated, assume default FR of 25%.
[493] Program not yet evaluated, assume default SO of 0%.

Central Geothermal (Ground source) Heat Pump (GCL, GOL, GHP)	
Last Revised Date	1/1/2024
MEASURE OVERVIEW	
Description	This measure involves the purchase and installation of new Tier 3 high-efficiency geothermal heat pump instead of a standard efficiency oil boiler
Energy Impacts	Electric, Heating Oil
Sector	Residential
Program(s)	Home Energy Savings Program
End-Use	Heating, Cooling
Decision Type	New Construction, Replace on Burnout
DEEMED GROSS ENERGY SAVINGS (UNIT SAVINGS)	
Demand savings	ΔkW_C = -0.084 ΔkW_{SP} = -0.009 ΔkW_H = -2.931 ΔkW_{WP} = -2.333
Annual energy savings	$\Delta kWh/yr$ = -7496 $\Delta kWh_C/yr$ = -6 $\Delta kWh_H/yr$ = -7490 $\Delta MMBTU_H/yr$ = 109.524
GROSS ENERGY SAVINGS ALGORITHMS (UNIT SAVINGS)	
Demand savings	$\Delta kW_H = CAP_H \times (-1 / COP_{EE}) / 3.412$ $\Delta kW_C = [\%COOL_{FULL} \times CAP_C \times (1/EER_B - 1/EER_E) + \%COOL_{NONE} \times CAP_C \times (-1/EER_E)]$
Annual Energy savings	Heating Savings: $\Delta kWh_H/yr = AHL \times 1000 \times (-1 / COP_{EE}) / 3.412$ $\Delta MMBTU_H/yr = AHL / AFUE_{BASE}$ Cooling Savings: $\Delta kWh_C/yr = ACL \times 1000 \times [\%COOL_{FULL} \times (1/EER_B - 1/EER_E) + \%COOL_{NONE} \times (-1/EER_E)]$ *Key Assumptions* • For homes that have the equivalent of whole home A/C already installed, ground source heat pump (GSHP) will replace the cooling load equivalent to the GSHP's rated capacity. • For homes that have existing partial cooling (i.e. 1 or 2 existing window A/C units), it is unknown if the GHSP will be used differently than the existing window A/C units. If the GHSP is used to cool the same spaces as existing window A/C units, the GHSP will replace the existing cooling load and result in positive savings due to increased efficiency. However, if the GHSP is used to cool the entire house, it may result in additional cooling load and hence negative savings. Without any in-situ data, zero-net savings is assumed for homes with existing partial cooling. • For homes with no existing cooling equipment, it is assumed that the GSHP will be used to its full cooling capacity.
Definitions	Unit = New geothermal heat pump system CAP_H = Output heating capacity of geothermal heat pump at 47°F (kBtu/hr) CAP_C = Output cooling capacity of geothermal heat pump at 95°F (kBtu/hr) COP_{EE} = Coefficient of performance of geothermal heat pump EER_B = Assumed energy-efficiency ratio for existing cooling equipment (Btu/Watt-hr) EER_E = Rated energy-efficiency ratio for GSHP (Btu/Watt-hr) $\%COOL_{FULL}$ = Percentage of homes with existing cooling equipment equivalent of a whole home air conditioner (equivalent of 3 window A/C units) (%) $\%COOL_{NONE}$ = Percentage of homes with no existing cooling equipment (%) AHL = Annual heating load (MMBtu) ACL = Annual cooling load (MMBtu) 1000 = Conversion factor MMBtu to kBtu $AFUE_{BASE}$ = Annual fuel utilization efficiency of the existing heating system (%)

Central Geothermal (Ground source) Heat Pump (GCL, GOL, GHP)							
EFFICIENCY ASSUMPTIONS							
Baseline Efficiency	The baseline case is a standard efficiency oil boiler and a mix of standard efficiency air conditioners and no air conditioners.						
Efficient Measure	The high-efficiency case is a new Energy Star® certified geothermal heat pump system to provide heating and cooling.						
PARAMETER VALUES							
Measure	CAP_H	CAP_C	COP_{EE}	EER_B	EER_E	Life (yrs)	Cost ($)
GSHP	36[494]	36[495]	3.6[496]	12[497]	17.1[498]	25[499]	40,775[500]
Measure	$\%COOL_{FULL}$	$\%COOL_{NONE}$	$EFLH_H$	$EFLH_C$	$AFUE_{BASE}$	AHL	ACL
GSHP	40%[501]	21%[501]	2,706[502]	231[503]	84%[504]	92[505]	2.7[506]
IMPACT FACTORS							
Measure	ISR	RR_E	RR_D	CF_S	CF_W	FR	SO
GSHP	100%[507]	100%[508]	100%[508]	10.2%[509]	79.6%[509]	35%[510]	6%[511]

[494] As referenced in MA 2013 TRM: ADM Associates, Inc. (2009). Residential Central AC Regional Evaluation. Prepared for NSTAR, National Grid, Connecticut Light & Power and United Illuminating; p. 4-12, Table 4-9.
[495] As referenced in MA 2013 TRM: ADM Associates, Inc. (2009). Residential Central AC Regional Evaluation. Prepared for NSTAR, National Grid, Connecticut Light & Power and United Illuminating; p. 4-12, Table 4-9.
[496] ENERGY STAR® Geothermal Heat Pumps Key Product Criteria Closed Loop Water-to-air.
[497] ASHRAE 90.1-2019 <65,000 Btu/h single package.
[498] ENERGY STAR® Geothermal Heat Pumps Key Product Criteria Closed Loop Water-to-air Tier 3.
[499] GDS Measure Life Report, Residential and Commercial/Industrial Lighting and HVAC Measures, Prepared for the New England State Program Working Group, June 2007; Table 1; value for new construction.
[500] Average project cost from FY2023 program data minus new oil boiler cost. New oil boiler cost from 2021 New Construction Heating System Cost Assessment. ($48,861 – $8,086).
[501] Portland Press Herald, http://www.pressherald.com/2014/05/26/put_power_rates_on_ice__that_s_a_cool_idea_/. In 2010, an estimated 79 percent of customers in ISO-New England region had room air conditioners. Of the 79 percent, 40 percent of homes have equivalent of whole home A/C (3 window A/Cs); 39 percent of homes have total cooling capacity equivalent of 1 or 2 window A/C units. The remaining 21 percent have no cooling equipment installed.
[502] Calculated based on 97.4 MMBTU average heating load for Maine household and 36 kBtuh Central GSHP heating capacity. Average heating load for Maine household is a weighted average value based on estimated heating energy and population distribution for Portland (96, 71.2%), Bangor (96, 23.4%), and Caribou (122, 5.4%).
[503] NY TRM 2010, average EFLH for the New York cities of Binghamton and Massena. The hours for these cities were mapped to the Maine cities of Portland, Bangor (Binghamton) and Caribou (Massena). Hours were scaled by degree days for each city. Final hours represent an average weighted by city population.
[504] Code of Federal Regulations: http://www.ecfr.gov/cgi-bin/text-idx?c=ecfr&sid=61b33caa9460da7b2e875b478972dfdc&rgn=div6&view=text&node=10:3.0.1.4.18.3&idno=10.
[505] NMR Group, Maine Single-Family Residential Baseline Study, September 14, 2015
[506] Ibid.
[507] EMT assumes that all purchased units are installed (i.e. ISR = 100%).
[508] The measure has not yet been evaluated. Until the next program impact evaluation, EMT assumes 100 percent realization rate.
[509] Factors for the Central GSHP measure were assumed to be identical to the factors of the Ductless Heat Pump Retrofit measure because of the similarity between the two measures.
[510] West Hill Energy, Efficiency Maine Trust Home Energy Savings Program Impact Evaluation, 2019.
[511] West Hill Energy, Efficiency Maine Trust Home Energy Savings Program Impact Evaluation, 2019.

Electronically Commutated Motor: Hydronic Heating Smart Circulation Pump (ECMHW)

Last Revised Date	7/1/2021
MEASURE OVERVIEW	
Description	This measure involves the installation of a ECM circulator pump with brushless permanent magnet motor and variable speed controls for the circulation of hot water that is used for heating[512]. Typical applications include baseboard and/or radiant heating systems.
Primary Energy Impact	Electric
Sector	Residential, Commercial
Program(s)	Distributor Program
End-Use	Heating
Decision Type	New Construction, Replace on Burnout
GROSS ENERGY SAVINGS (UNIT SAVINGS)	
Demand Savings	Residential: $\Delta kW_{max} = 0.0733$ $\Delta kW_{wp} = 0.0363$ ΔkW_{sp} = N/A Commercial: Calculated
Annual Energy Savings	Residential: Δkwh/year = 100.7 Commercial: See Table 7
GROSS ENERGY SAVINGS ALGORITHMS (UNIT SAVINGS)	
Demand savings	Residential: $\Delta kW_{max} = (Watts_{Base} - Watts_{EE})/1{,}000$ $\Delta kW_{wp} = CF_w \times (Watts_{Base} - Watts_{EE})/1{,}000$ $\Delta kW_{sp} = CF_s \times (Watts_{Base} - Watts_{EE})/1{,}000$ Commercial: $\Delta kW = (\Delta kWh/yr)/Hours$
Annual energy savings	$\Delta kWh = Hours \times (Watts_{Base} - Watts_{EE})/1{,}000 \times ISR$
Annual water savings	0
Definitions	Unit = 1 circulation pump motor Hours = Assumed hours per year pump operates $Watts_{Base}$ = Average electrical demand of baseline circulation pump motor $Watts_{EE}$ = Average electrical demand of efficient circulation pump motor 1,000 = Conversion factor, Watts to kilowatts
EFFICIENCY ASSUMPTIONS	
Baseline Efficiency	The baseline circulation pump motor is a shaded pole motor
Efficient Measure	Brushless permanent magnet circulation pump motor with variable speed control
PARAMETER VALUES (DEEMED)	

Measure	Hours	$Watts_{Base}$	$Watts_{EE}$		Life (yrs)	Cost ($)
Residential: Hydronic Heating Smart Circulation Pump	1374[513]	87.7[514]	14.4[514]		20[514]	57[515]
Commercial: Hydronic	4,858[516]					Table 7

[512] Brushless permanent magnet motors (BPLMs) are more efficient than permanent split capacitor motors and shaded pole motors because they lack brushes that add friction to the motor, and have the ability to modulate speed to match the required load by sensing the difference between the magnetic field of the rotating rotor and the rotating magnetic field of the windings in the motor stator, and automatically adjusting its speed by altering the frequency to the motor.

[513] Efficiency Vermont TRM dated 12/31/2016, page 362. Adjusted by ratio of annual heating hours below 55° F from ME to VT (4858 to 4684)

[514] Efficiency Vermont Technical Reference User Manual (TRM) dated 12/31/2016, page 362.

[515] Shelf study performed by CLEAResult May 2021, weighted by four most popular models.

[516] Annual hours per year from October 1 through April 30 where the dry bulb temperature is less than 55°F. Weighted average of Portland, Bangor, and Caribou.

Electronically Commutated Motor: Hydronic Heating Smart Circulation Pump (ECMHW)							
Heating Smart Circulation Pump							
IMPACT FACTORS							
Measure	ISR	RR_E	RR_D	CF_S	CF_W	FR	SO
Hydronic Heating Smart Circulation Pump	100%[517]	100%[518]	100%[518]	0%	49.5%[519]	25%[520]	0%[521]

Table 7 - Savings and Measure Cost for Commercial EC Circulator Pump Motors

Rated Watts	Energy Savings[522] (kWh/yr)	Measure Cost[523] ($)
< 150	426	$368
150 – 600	804	$758
> 600	2,586	$1,018

[517] EMT assumes that all purchased units are installed (i.e. ISR = 100%).
[518] This measure has not yet been evaluated. Until the next program impact evaluation, EMT assumes 100 percent realization rate.
[519] Ratio of average heating degrees during winter on peak hours to maximum heating degrees using TMY3 data weighted for Portland, Caribou, and Bangor.
[520] Measure not yet evaluated, assume default FR of 25%
[521] Measure not yet evaluated, assume default SO of 0%
[522] Efficiency Vermont TRM User Manual No. 2014-87 (3/16/2015), page 29. Adjusted by ratio of hours from ME to VT (4858 to 4684).
[523] From Efficiency Vermont TRM User Manual No. 2014-87 (3/16/2015), page 29.

Room Air Conditioner (RAC) (Inactive)	
Last Revised Date	7/1/2015
MEASURE OVERVIEW	
Description	ENERGY STAR® Room AC (RAC). This measure involves the purchase and installation of a new ENERGY STAR®-certified room air conditioner in place of a new code-compliant or standard efficiency room air conditioner. The ENERGY STAR® key efficiency criteria require that room air conditioners be at least 10 percent more energy efficient than the minimum federal standards.[524] A list of certified ENERGY STAR® room air conditioners is available at: *http://downloads.energystar.gov/bi/qplist/Room%20Air%20Conditioners%20Product%20List.xls*
Primary Energy Impact	Electric
Sector	Residential
Program(s)	Appliance Rebate Program
End-Use	Cooling
Decision Type	New Construction, Replace on Burnout
DEEMED GROSS ENERGY SAVINGS (UNIT SAVINGS)	
Demand savings	$\Delta kW = 0.094$ $\Delta kW_{WP} = 0$ $\Delta kW_{SP} = 0.01$
Annual energy savings	$\Delta kWh/yr = 10$
GROSS ENERGY SAVINGS ALGORITHMS (UNIT SAVINGS)	
Demand savings	$\Delta kW = CAP_{EE} \times (1 / EER_{BASE} - 1 / EER_{EE}) / 1000$
Annual energy savings	$\Delta kWh/yr = CAP_{EE} \times (1 / EER_{BASE} - 1 / EER_{EE}) / 1000 \times EFLH$
Definitions	Unit = 1 room air conditioner CAP_{EE} = Average capacity of installed room air conditioner (Btu/h) EER_{BASE} = Energy-efficiency ratio of code-compliant room air conditioner (Btu/h/Watt) EER_{EE} = Energy-efficiency ratio of ENERGY STAR®-certified room air conditioner (Btu/h/Watt) EFLH = Equivalent full load hours for room air conditioner (hrs/yr) 1000 = Conversion: 1000 Watts per kW
EFFICIENCY ASSUMPTIONS	
Baseline Efficiency	Standard room air conditioner that meets the current federal minimum efficiency requirement effective June 1, 2014[525]
Efficient Measure	ENERGY STAR®-certified room air conditioner

PARAMETER VALUES (DEEMED)

Measure	CAP_{EE}	EER_{BASE}	EER_{EE}	EFLH	Life (yrs)	Cost ($)
ENERGY STAR® RAC	10,000[526]	9.8[527]	10.8[528]	102[529]	9[526]	50[526]

IMPACT FACTORS

Measure	ISR	RR_E	RR_D	CF_S	CF_W	FR	SO
ENERGY STAR® RAC	100%[530]	100.0%[531]	100.0%[531]	11.1%[532]	0.0%[532]	65.5%[533]	3.3%[533]

[524] ENERGY STAR® Room Air Conditioners Key Product Criteria: http://www.energystar.gov/index.cfm?c=roomac.pr_crit_room_ac
[525] Federal Standard, Code of Federal Regulations, Title 10, Part 430, Subpart C.
[526] Typical room air conditioner size, April 2009 according to ENERGY STAR® Room Air Conditioner calculator.
[527] Minimum EER for code-compliant room air conditioner effective June 1, 2014.
[528] ENERGY STAR® requirement for room air conditioner as of October 2013.
[529] Final Report Coincidence Factor Study Residential Room Air Conditioners, June 23, 2008, Table 22, full load equivalent hours for Portland, ME.
[530] EMT assumes that all purchased units are installed (i.e. ISR = 100%). This is consistent with evaluation findings for other appliance measures.
[531] This measure has not yet been evaluated. Until the next program impact evaluation, EMT assumes 100 percent realization rate.
[532] See Appendix B: Coincidence and Energy Period Factors.
[533] NMR Group, Inc., Efficiency Maine Appliance Rebate Program Evaluation Overall Report – FINAL, July 18, 2014, Table 2-41.

Smart Thermostat (STSTAT, LTSTAT)		
Last Revised Date	2/1/2020	
MEASURE OVERVIEW		
Description	This measure involves the purchase and installation of a new Wi-Fi Enabled Thermostat in place of an existing non-programmable thermostat.	
Primary Energy Impact	Electric, Heating Oil, Propane, Natural Gas	
Sector	Residential, Commercial	
Program(s)	Appliance Rebate Program, Low Income Initiatives	
End-Use	Heating and Cooling	
Decision Type	Retrofit	
DEEMED GROSS ENERGY SAVINGS (UNIT SAVINGS)		
Demand Savings	$\Delta kW = 0$	
Annual Energy Savings	For electric heat: Electric Savings: $\Delta kWh/y = 2{,}674$ For non-electric heat: Electric Savings: $\Delta kWh/y = 2$ Fuel Savings: $\Delta MMBtu/y = 9.12$	For unknown heating fuel: Electric Savings: $\Delta kWh/y = 100$ Fuel Savings by Type: $\Delta MMBtu_{GAS}/y = 1.59$ $\Delta MMBtu_{PROP}/y = 1.08$ $\Delta MMBtu_{OIL}/y = 5.96$ $\Delta MMBtu_{KERO}/y = 0.15$
GROSS ENERGY SAVINGS ALGORITHMS (UNIT SAVINGS)		
Demand Savings	$\Delta kW = 0$	
Annual Energy Savings	Electric: $\Delta kWh/y = CSF \times \%COOL \times SEER \times CL + HSF \times HC / 0.003412$ (electric heat) $\Delta kWh/y = CSF \times \%COOL \times SEER \times CL$ (non-electric heat) $\Delta kWh/y = CSF \times \%COOL \times SEER \times CL + HSF \times HC / 0.003412 \times \%FUEL$ (unknown heat) Fuel: $\Delta MMBtu/y = HSF \times HC$ $\Delta MMBtu_{FUEL}/y = \Delta MMBtu/y \times \%FUEL$	
Definitions	Unit = 1 Wi-Fi enabled thermostat CSF = Cooling Savings Factor (%) %COOL = % of homes that have central air conditioners SEER = Seasonal energy-efficiency ratio for central air conditioner (Btu/Watt-hr) CL = Annual Cooling Load (MMBtu) HSF = Heating Savings Factor (%) HC = Annual Heating Consumption (MMBtu) 3,412 = Conversion: 3,412 Btu per kWh %FUEL = Home heating fuel distribution	
EFFICIENCY ASSUMPTIONS		
Baseline Efficiency	Standard non-programmable thermostat	
Efficient Measure	Wi-Fi enabled thermostat	

Smart Thermostat (STSTAT, LTSTAT)								
PARAMETER VALUES (DEEMED)								
Measure	CSF	%COOL	CL	HSF	HC	%FUEL	Life (yrs)	Cost ($)
Retail	10%[534]	2.4%[535]	6.4[535]	8%[536]	114[535]	Table 15	10[537]	$249[538]
Low Income								Actual[539]

IMPACT FACTORS							
Measure	ISR	RR_E	RR_D	CF_S	CF_W	FR	SO
ENERGY STAR® HPWH	100%[540]	100%[541]	100%[541]	100%[542]	100%[542]	25%[543]	0%[544]

534 Lower 95% confidence limit of weighted national average per Energy Star https://www.energystar.gov/products/heating_cooling/smart_thermostats/key_product_criteria
535 NMR Group, Maine Single-Family Residential Baseline Study, September 14, 2015.
536 Lower 95% confidence limit of weighted national average per Energy Star https://www.energystar.gov/products/heating_cooling/smart_thermostats/key_product_criteria .
537 GDS Measure Life Report, Residential and Commercial/Industrial Lighting and HVAC Measures, Prepared for the New England State Program Working Group, June 2007. Table 1.
538 Based on online pricing from multiple retailers as of February 2016.
539 Total cost. For direct install it includes installation cost.
540 This measure has not yet been evaluated. Until the next program impact evaluation, EMT assumes 100 percent ISR.
541 This measure has not yet been evaluated. Until the next program impact evaluation, EMT assumes 100 percent Realization Rate.
542 Peak coincidence factors for this measure are embedded in the evaluated peak demand impacts.
543 Program not yet evaluated, assume default FR of 25%.
544 Program not yet evaluated, assume default SO of 0%.

Pellet/Wood Stove (CPS, CWS)	
Last Revised Date	4/1/2020
MEASURE OVERVIEW	
Description	This measure involves purchase and installation of an eligible pellet/wood stove to provide supplemental heat for the existing heating system. Energy savings are achieved due to the improved efficiency of eligible pellet/wood stove.
Energy Impacts	Wood
Sector	Residential
Program(s)	Retail Initiatives
End-Use	Heating
Decision Type	New Construction, Replace on Burnout
DEEMED GROSS ENERGY SAVINGS (UNIT SAVINGS)	
Demand savings	ΔkW_{SP} = NA ΔkW_{WP} = NA
Annual energy savings	$\Delta MMBtu_{WOOD}$ = 1.508
GROSS ENERGY SAVINGS ALGORITHMS (UNIT SAVINGS)	
Demand savings	ΔkW = NA
Annual Energy savings	$\Delta MMBtu = MMBtu_{HEAT} \times \%STOVE \times (1/EFF_{BASE} - 1/EFF_{EE})$
Definitions	Unit = New pellet/wood stove AHL = Average heating energy load for Maine household (MMBtu) %STOVE = Percentage of heat load served by new pellet/wood stove (%) EFF_{BASE} = Baseline heating equipment efficiency (%) EFF_{EE} = Pellet/wood stove heating efficiency (%)
EFFICIENCY ASSUMPTIONS	
Baseline Efficiency	The baseline case is an average EPA certified pellet/wood stove to provide supplemental heat.
Efficient Measure	The high-efficiency case is a program eligible stove that meets measured efficiency requirement.

PARAMETER VALUES

Measure	AHL[545]	%STOVE	EFF_{BASE}	EFF_{EE}		Life (yrs)	Cost ($)
Pellet/Wood Stove	92	50%[546]	73.2%[547]	75%[548]		25[549]	N/A[550]

IMPACT FACTORS

Measure	ISR	RR_E	RR_D	CF_S	CF_W	FR	SO
Pellet/Wood Stove	100%[551]	100%[552]	100%[552]	NA	NA	25%[553]	0%[554]

[545] NMR Group, Maine Single-Family Residential Baseline Study, September 14, 2015.
[546] Estimate, comparison against RECS microdata for the New England census division found percentages in a similar range, though these data were not directly comparable. Primary data collection is the best method for refining this input.
[547] Average measured efficiency of all NSPS 2020 compliant stoves as of 6/6/2019.
[548] Program eligibility requirement.
[549] GDS Measure Life Report, Residential and Commercial/Industrial Lighting and HVAC Measures, prepared for the New England State Program Working Group, June 2007, Table 1; value for new construction.
[550] Shelf survey performed March 2018 showed no correlation between measured efficiency and retail price.
[551] EMT assumes that all purchased units are installed (i.e. ISR = 100%).
[552] The measure has not yet been evaluated. Until the next program impact evaluation, EMT assumes 100 percent realization rate.
[553] Program not yet evaluated, assume default FR of 25%.
[554] Program not yet evaluated, assume default SO of 0%.

Duct Insulation (DDI, Component of LUB) (Inactive)				
Last Revised Date	7/1/2016			
MEASURE OVERVIEW				
Description	This measure involves the installation of insulation with an R-value greater than or equal to 6 on uninsulated heating or cooling ducts in unconditioned space (i.e. attic, unconditioned basement) in order to reduce heating and cooling losses.			
Energy Impacts	Electric, Natural Gas, Oil, Propane, Wood, Kerosene			
Sector	Residential			
Program(s)	Home Energy Savings Program (HESP), Affordable Heating Initiative (AHI)			
End-Use	Heating, Cooling			
Decision Type	Retrofit			
DEEMED GROSS ENERGY SAVINGS (UNIT SAVINGS)				
Demand savings	Basement Supply	Basement Return	Attic Supply	Attic Return
	For homes with non-electric heating			
	ΔkW_{WP} = 0.0 ΔkW_{SP} = 0.006	ΔkW_{WP} = 0.0 ΔkW_{SP} = 0.002	ΔkW_{WP} = 0.0 ΔkW_{SP} = 0.012	ΔkW_{WP} = 0.0 ΔkW_{SP} = 0.007
	For homes with electric resistance heating			
	ΔkW_{WP} = 1.310 ΔkW_{SP} = 0.006	ΔkW_{WP} = 0.316 ΔkW_{SP} = 0.002	ΔkW_{WP} = 1.453 ΔkW_{SP} = 0.012	ΔkW_{WP} = 0.421 ΔkW_{SP} = 0.007
Annual energy savings[555]	Basement Supply	Basement Return	Attic Supply	Attic Return
	For homes with non-electric heating			
	ΔMMBtu = 9.743 ΔkWh = 0	ΔMMBtu = 2.352 ΔkWh = 0	ΔMMBtu = 10.802 ΔkWh = 1	ΔMMBtu = 3.132 ΔkWh = 0
	For homes with electric resistance heating			
	ΔkWh = 2299	ΔkWh = 555	ΔkWh = 2549	ΔkWh = 739
GROSS ENERGY SAVINGS ALGORITHMS (UNIT SAVINGS)				
Demand savings	$\Delta kW_{WP} = \Delta kWh_{H} \times LSF_{WP}$ $\Delta kW_{SP} = \Delta kWh_{C} \times LSF_{SP}$			
Annual Energy savings	$\Delta kWh_{H} = SQFT \times F_{H} / 0.003412 \times \% FUEL$ $\Delta kWh_{C} = AKW_{C} \times SQFT \times \%COOL$ $\Delta kWh = \Delta kWh_{H} + \Delta kWh_{C}$ $\Delta MMBtu = SQFT \times F_{H} / EFF \times \% FUEL$			

[555] If fuel type is unknown, savings are to be allocated across fuel types using the home heating fuel distribution excluding coal and others found in

.

Duct Insulation (DDI, Component of LUB) (Inactive)		
Definitions	Unit	= Duct insulation project
	ΔkWh_H	= Annual energy savings for residences with electric heat (kWh)
	ΔkWh_C	= Annual energy savings for electric cooling (kWh)
	SQFT	= Surface area of ducts being insulated (ft^2)
	F_H	= Annual heating fuel savings per square foot of duct insulation for residences with fuel heating ($MMBtu/ft^2$)
	EFF	= Efficiency factor of representative heating system (Btu/Btu)
	%COOL	= Equivalent percentage of homes with full electric cooling equipment (%)
	AKW_C	= Annual electric savings per square foot for residences with electric cooling (kWh/ft^2)
	%FUEL	= Home heating fuel distribution for duct insulation/sealing[556]
	LSF_{SP}	= Summer Peak electric load shape factor, for residences with electric cooling (W/kWh)
	LSF_{WP}	= Winter peak electric load shape factor, for residences with all electric heating (W/kWh)
	0.003412	= Conversion factor (kWh/MMBtu)
EFFICIENCY ASSUMPTIONS		
Baseline Efficiency	The baseline is the existing uninsulated ducts	
Efficient Measure	The high-efficiency case is the existing ducts with insulation installed	

PARAMETER VALUES (DEEMED)

Measure	SQFT[557]	F_H[558]	AKW_C[559]	%COOL[560]	EFF[561]	LSF_{SP}[562]	LSF_{WP}[563]	Life (yrs)[564]	Cost ($)
Basement Supply	50	0.1569	0.3016	2%	80.5%	0.017	0.00057	25	Actual
Basement Return		0.0379	0.0909						
Attic Supply		0.1739	0.5566						
Attic Return		0.0504	0.3206						

Measure	%FUEL
All	Table 15

IMPACT FACTORS

Measure	ISR[565]	RR_E[566]	RR_D[566]	CF_S[567]	CF_W[567]	FR[568]	SO[569]
Duct Insulation	100%	100%	100%	100%	100%	25%	0%

556 Heating fuel distribution is used to allocate savings to different fuels when fuel type is unknown.
557 Program assumption.
558 Adapted from UI/CL&P C&LM Program Savings Documentation – 2015 p. 156, 4.2.15 Duct Insulation, Table 2. Provided value multiplied by ratio of HDD of Maine and Connecticut, 7,777/5,885. Maine HDD based on a population-weighted average of Caribou, Bangor, and Portland from TMY3 dataset and base temperature of 65 degree F.
559 Adapted from UI/CL&P C&LM Program Savings Documentation – 2015 p. 156, 4.2.15 Duct Insulation, Table 1. Provided value multiplied by ratio of CDD of Maine and Connecticut, 207/530. Degree day data from the National Climactic Data Center, State Data, ME state & CT state, Jan 1979 to Dec 2008, yearly average. http://www7.ncdc.noaa.gov/CDO/CDODivisionalSelect.jsp
560 NMR Group, Maine Single-Family Residential Baseline Study, September 14, 2015. One out of 41 homes had a central, ducted cooling system.
561 Representative heating system efficiency based on NMR Group, Maine Single-Family Residential Baseline Study, September 14, 2015.
562 Evaluation of the Weatherization Residential Assistance Partnership (WRAP) and Helps Programs, conducted by KEMA, September 2010, table ES-9 p. 1-11.
563 Evaluation of WRAP and Helps Program, KEMA, 2010, Table ES-8, p. 1-10 divided by 1000 W/kW.
564 GDS Measure Life Report, Residential and Commercial/Industrial Lighting and HVAC Measures, Prepared for the New England State Program Working Group, June 2007; Table 1.
565 EMT assumes that all purchased units are installed (i.e. ISR = 100%).
566 The measure has not yet been evaluated. Until the next program impact evaluation, EMT assumes 100 percent realization rate.
567 Peak coincidence factors for this measure are embedded in the calculated peak demand impacts.
568 Program not yet evaluated, assume default FR of 25%.
569 Program not yet evaluated, assume default SO of 0%.

Duct Sealing (DDS, Component of LUB) (Inactive)	
Last Revised Date	7/1/2016
MEASURE OVERVIEW	
Description	This measure involves duct sealing to improve air distribution from HVAC systems.
Energy Impacts	Electric, Natural Gas, Oil, Propane, Wood, Kerosene
Sector	Residential
Program(s)	Home Energy Savings Program (HESP), Affordable Heating Initiative (AHI)
End-Use	Heating, Cooling
Decision Type	Retrofit
DEEMED GROSS ENERGY SAVINGS (UNIT SAVINGS)	
Demand savings	$\Delta kW_{SP} = 0.006$ For homes with electric resistance heating: $\Delta kW_{WP} = 1.817$
Annual energy savings[570]	For homes with non-electric heating $\Delta MMBtu = 6.607$ $\Delta kWh = 168$ For homes with electric resistance heating $\Delta kWh = 1{,}170$
GROSS ENERGY SAVINGS ALGORITHMS (UNIT SAVINGS)	
Demand savings	$\Delta kW_{SP} = REM_{SP} \times (CFM_{PRE} - CFM_{POST}) \times \%COOL$ For homes with electric resistance heating $\Delta kW_{WP} = REM_{WP} \times (CFM_{PRE} - CFM_{POST})$
Annual Energy savings	For homes with non-electric heating $\Delta MMBtu = REM_{HEAT} \times (CFM_{PRE} - CFM_{POST}) / EFF$ $\Delta kWh = REM_{COOL} \times (CFM_{PRE} - CFM_{POST}) \times \%COOL + REM_{FAN} \times (CFM_{PRE} - CFM_{POST})$ For homes with electric resistance heating $\Delta kWh = REM_{COOL} \times (CFM_{PRE} - CFM_{POST}) \times \%COOL + REM_{ER} \times (CFM_{PRE} - CFM_{POST})$ For homes with unknown heating fuel type $\Delta MMBtu = REM_{HEAT} \times (CFM_{PRE} - CFM_{POST}) / EFF \times \%FUEL$ $\Delta kWh = REM_{COOL} \times (CFM_{PRE} - CFM_{POST}) \times \%COOL + REM_{FAN} \times (CFM_{PRE} - CFM_{POST}) + REM_{ER} \times (CFM_{PRE} - CFM_{POST}) \times \%FUEL$
Definitions	Unit = Duct sealing project REM_{HEAT} = Heat loss reduction per CFM reduction in duct leakage (MMBtu/CFM) CFM_{PRE} = Air leakage rate before duct sealing at 25 Pa (CFM)[571] CFM_{POST} = Air leakage rate after duct sealing at 25 Pa (CFM)[572] EFF = Efficiency factor of representative heating system (Btu/Btu) %FUEL = Home heating fuel distribution for duct insulation/sealing[573]

[570] If fuel type is unknown, savings are to be allocated across fuel types using the home heating fuel distribution excluding coal and other found in

.

[571] From UI/CL&P C&LM Program Savings Documentation – 2015 p. 140, 4.2.9 Duct Sealing measure, Note 1, actual pre-case CFM leakage measured with duct blaster test should be used, otherwise estimated pre-case leakage rate of 0.195 CFM/SQFT can be used.

[572] From UI/CL&P C&LM Program Savings Documentation – 2015 p. 140, 4.2.9 Duct Sealing measure, Note 2, actual post-case CFM leakage measured with duct blaster test should be used, otherwise estimated post-case leakage rate of 0.080 CFM/SQFT can be used.

[573] Heating fuel distribution is used to allocate savings to different fuels when fuel type is unknown.

Duct Sealing (DDS, Component of LUB) (Inactive)		
	REM_{COOL}	= Cooling savings per CFM reduction in duct leakage (kWh/CFM)
	%COOL	= Equivalent percentage of homes with full electric cooling equipment (%)
	REM_{FAN}	= Fan energy savings per CFM reduction in duct leakage (kWh/CFM)
	REM_{ER}	= Energy savings per CFM reduction in duct leakage (kWh/CFM)
	REM_{SP}	= Summer peak electric demand savings factor (kW/CFM)
	REM_{WP}	= Winter peak electric demand savings factor (kW/CFM)

EFFICIENCY ASSUMPTIONS

Baseline Efficiency	The baseline is the existing (pre-upgrade) ducts
Efficient Measure	The high-efficiency case is the existing ducts with sealing applied

PARAMETER VALUES (DEEMED)

Measure	REM_{HEAT}[574]	CFM_{PRE}[575]	CFM_{POST}[576]	EFF[577]	REM_{COOL}[578]	%COOL[579]	Life (yrs)[580]	Cost ($)[581]
Duct Sealing	0.046	195	80	80.5%	0.414	2%	25	Actual

Measure	REM_{FAN}[582]	REM_{ER}[583]	REM_{WP}[584]	REM_{SP}[584]	%FUEL
Duct Sealing	1.454	10.166	0.0158	0.0023	Table 15

IMPACT FACTORS

Measure	ISR[585]	RR_E[586]	RR_D[586]	CF_S[587]	CF_W[587]	FR[588]	SO[589]
Duct Sealing	100%	100%	100%	100%	100%	25%	0%

574 Adapted from UI/CL&P C&LM Program Savings Documentation – 2015 p. 138, 4.2.9 Duct Sealing measure, Table 2. Provided value multiplied by ratio of HDD of Maine and Connecticut, 7,777/5,885. Maine HDD based on a population-weighted average of Caribou, Bangor, and Portland from TMY3 dataset and base temperature of 65 degree F.
575 UI/CL&P C&LM Program Savings Documentation – 2015 p. 140, 4.2.9 Duct Sealing measure, Note 1.
576 UI/CL&P C&LM Program Savings Documentation – 2015 p. 140, 4.2.9 Duct Sealing measure, Note 2.
577 Representative heating system efficiency based on NMR Group, Maine Single-Family Residential Baseline Study, September 14, 2015.
578 Adapted from UI/CL&P C&LM Program Savings Documentation – 2015 p. 138, 4.2.9 Duct Sealing measure, Table 1. Provided value multiplied by ratio of CDD of Maine and Connecticut, 207/530. Degree day data from the National Climactic Data Center, State Data, ME state & CT state, Jan 1979 to Dec 2008, yearly average. http://www7.ncdc.noaa.gov/CDO/CDODivisionalSelect.jsp
579 NMR Group, Maine Single-Family Residential Baseline Study, September 14, 2015. One out of 41 homes had a central, ducted cooling system.
580 GDS Measure Life Report, Residential and Commercial/Industrial Lighting and HVAC Measures, Prepared for the New England State Program Working Group, June 2007; Table 1.
581 Cost of service where duct sealing was the sole service performed.
582 Adapted from UI/CL&P C&LM Program Savings Documentation – 2015 p. 138, 4.2.9 Duct Sealing measure, Table 1. Provided value multiplied by ratio of HDD of Maine and Connecticut, 7,777/5,885. Maine HDD based on a population-weighted average of Caribou, Bangor, and Portland from TMY3 dataset and base temperature of 65 degree F.
583 Adapted from UI/CL&P C&LM Program Savings Documentation – 2015 p. 138, 4.2.9 Duct Sealing measure, Table 1. Provided value multiplied by ratio of HDD of Maine and Connecticut, 7,777/5,885. Maine HDD based on a population-weighted average of Caribou, Bangor, and Portland from TMY3 dataset and base temperature of 65 degree F.
584 UI/CL&P C&LM Program Savings Documentation – 2015 p. 139, 4.2.9 Duct Sealing measure, Table 3.
585 EMT assumes that all purchased units are installed (i.e. ISR = 100%).
586 The measure has not yet been evaluated. Until the next program impact evaluation, EMT assumes 100 percent realization rate.
587 Peak coincidence factors for this measure are embedded in the calculated peak demand impacts.
588 Program not yet evaluated, assume default FR of 25%.
589 Program not yet evaluated, assume default SO of 0%.

Hydronic Heating Pipe Insulation (DPI, Component of LUB) (Inactive)							
Last Revised Date	7/1/2016						
MEASURE OVERVIEW							
Description	This measure involves insulation of heating pipes to reduce heat loss. This measure does not include pipe insulation for electric hydronic heating systems.						
Energy Impacts	Natural Gas, Oil, Propane, Wood, Kerosene						
Sector	Residential						
Program(s)	Home Energy Savings Program (HESP), Affordable Heating Initiative (AHI)						
End-Use	Heating						
Decision Type	Retrofit						
DEEMED GROSS ENERGY SAVINGS (UNIT SAVINGS)							
Demand savings	N/A						
Annual energy savings	ΔMMBtu = 4.807						
GROSS ENERGY SAVINGS ALGORITHMS (UNIT SAVINGS)							
Demand savings	N/A						
Annual Energy savings	$\Delta MMBtu = AF_H \times L / EFF \times \%FUEL$						
Definitions	Unit = Pipe insulation project AF_H = Annual fuel savings for residences with fossil fuel hot water heating L = Length of pipe insulated EFF = Efficiency factor of representative heating system (Btu/Btu) %FUEL = Home heating fuel distribution for hydronic pipe insulation[590]						
EFFICIENCY ASSUMPTIONS							
Baseline Efficiency	The baseline is heating pipes with no insulation.						
Efficient Measure	The high-efficiency case is the existing hot water or heating pipes with insulation installed. Insulation must be R-3 or greater.						
PARAMETER VALUES (DEEMED)							
Measure	L(ft)[591]	EFF[592]	AF_H[593]	%FUEL	Life (yrs)[594]	Cost ($)	
Pipe Insulation	100	80.5%	0.0387	Table 15	25	Actual	
IMPACT FACTORS							
Measure	ISR[595]	RR_E[596]	RR_D[596]	CF_S	CF_W	FR[597]	SO[598]
Duct Sealing	100%	100%	100%	N/A	N/A	25%	0%

[590] Heating fuel distribution is used to allocate savings to different fuels when fuel type is unknown.
[591] Program estimate.
[592] Representative heating system efficiency based on NMR Group, Maine Single-Family Residential Baseline Study, September 14, 2015.
[593] Hot water heating values for 0.75" pipe adapted from UI/CL&P C&LM Program Savings Documentation – 2015 p. 279, 4.5.9 Pipe Insulation measure, Table 4. Provided values in CCF were converted to MMBtu heat loss reduction using 103,200 Btu/CCF and heating system efficiency of 75 percent.
[594] GDS Measure Life Report, Residential and Commercial/Industrial Lighting and HVAC Measures, Prepared for the New England State Program Working Group, June 2007; Table 1.
[595] EMT assumes that all purchased units are installed (i.e. ISR = 100%).
[596] The measure has not yet been evaluated. Until the next program impact evaluation, EMT assumes 100 percent realization rate.
[597] Program not yet evaluated, assume default FR of 25%.
[598] Program not yet evaluated, assume default SO of 0%.

<table>
<tr><th colspan="3">Seal/Insulate Pipes/Ducts (Component of LUB) (Inactive)</th></tr>
<tr><td>Last Revised Date</td><td colspan="2">7/1/2019</td></tr>
<tr><td colspan="3">MEASURE OVERVIEW</td></tr>
<tr><td>Description</td><td colspan="2">This measure involves insulation and/or sealing of heating pipes or ducts to reduce heat loss. This measure does not include pipe insulation for electric hydronic heating systems.</td></tr>
<tr><td>Energy Impacts</td><td colspan="2">Electric, Natural Gas, Oil, Propane, Wood, Kerosene</td></tr>
<tr><td>Sector</td><td colspan="2">Residential</td></tr>
<tr><td>Program(s)</td><td colspan="2">Affordable Heating Initiative (AHI)</td></tr>
<tr><td>End-Use</td><td colspan="2">Heating</td></tr>
<tr><td>Decision Type</td><td colspan="2">Retrofit</td></tr>
<tr><td colspan="3">DEEMED GROSS ENERGY SAVINGS (UNIT SAVINGS)</td></tr>
<tr><td>Demand savings</td><td colspan="2">For homes with non-electric heating
$\Delta kW_{SP} = 0.002$

For homes with electric resistance heating
$\Delta kW_{WP} = 1.614$ $\Delta kW_{SP} = 0.006$</td></tr>
<tr><td>Annual energy savings</td><td>For homes with non-electric heating
$\Delta MMBtu = 5.57$ $\Delta kWh = 25$

For homes with electric resistance heating
$\Delta kWh = 1{,}622$</td><td>For homes with unknown fuel type
$\Delta kWh = 25$
$\Delta MMBtu_{GAS} = 2.39$
$\Delta MMBtu_{OIL} = 0.692$
$\Delta MMBtu_{PROP} = 2.488$
$\Delta MMBtu_{WOOD}$, $\Delta MMBtu_{KERO} = 0.0$</td></tr>
<tr><td colspan="3">GROSS ENERGY SAVINGS ALGORITHMS (UNIT SAVINGS)</td></tr>
<tr><td>Demand savings</td><td colspan="2">For homes with non-electric heating
$\Delta kW_{SP} = W_{DI} \times CDS_{DI} + W_{DS} \times CDS_{DS}$

For homes with electric resistance heating
$\Delta kW_{WP} = W_{DI} \times HDS_{DI} + W_{DS} \times HDS_{DS} /(W_{DI} + W_{DS})$
$\Delta kW_{SP} = W_{DI} \times CDS_{DI} + W_{DS} \times CDS_{DS} /(W_{DI} + W_{DS})$</td></tr>
<tr><td>Annual Energy savings</td><td colspan="2">For homes with non-electric heating
$\Delta MMBtu = W_{DI} \times FS_{DI} + W_{DS} \times FS_{DS} + W_{PI} \times FS_{PI}$
$\Delta kWh = W_{DI} \times ECS_{DI} + W_{DS} \times ECS_{DS}$

For homes with electric resistance heating
$\Delta kWh = W_{DI} \times EHS_{DI} + W_{DS} \times EHS_{DS} /(W_{DI} + W_{DS})$</td></tr>
</table>

Seal/Insulate Pipes/Ducts (Component of LUB) (Inactive)

Definitions	Unit	= Duct/Pipe Sealing/Insulation project
	W_{DI}	= percent of projects performing duct insulation
	W_{DS}	= percent of projects performing duct sealing alone
	W_{PI}	= percent of projects performing pipe insulation
	CDS_{DI}	= cooling demand reduction associated with duct insulation
	CDS_{DS}	= cooling demand reduction associated with duct sealing
	HDS_{DI}	= heating demand reduction associated with duct insulation
	HDS_{DS}	= heating demand reduction associated with duct sealing
	FS_{DI}	= fuel savings associated with duct insulation
	FS_{DS}	= fuel savings associated with duct sealing
	FS_{PI}	= fuel savings associated with pipe insulation
	ECS_{DI}	= electric cooling savings associated with duct insulation
	ECS_{DS}	= electric cooling savings associated with duct sealing alone
	EHS_{DI}	= electric heating savings associated with duct insulation
	EHS_{DS}	= electric heating savings associated with duct sealing alone
	%FUEL	= Home heating fuel distribution for duct insulation/sealing and hydronic pipe insulation[599]

EFFICIENCY ASSUMPTIONS

Baseline Efficiency	See baseline assumptions under Duct Insulation, Duct Sealing and Hydronic Heating Pipe Insulation measures
Efficient Measure	See efficient measure assumptions under Duct Insulation, Duct Sealing and Hydronic Heating Pipe Insulation measures

PARAMETER VALUES (DEEMED)

Measure	W_{DI} [600]	W_{DS} [601]	W_{PI} [602]	Life (yrs) [603]	Cost ($)
Seal/Insulate Pipes/Ducts	10%	15%	75%	25	Actual

Measure	CDS_{DI} [604]	CDS_{DS} [605]	HDS_{DI} [606]	HDS_{DS} [607]	ECS_{DI} [608]	ECS_{DS} [609]
Seal/Insulate Pipes/Ducts	0.136	0.140	1.310	1.817	8	192

Measure	FS_{DI} [610]	FS_{DS} [611]	FS_{PI} [612]	EHS_{DI} [613]	EHS_{DI} [614]	%FUEL
Seal/Insulate Pipes/Ducts	9.743	6.607	4.807	2,307	1,194	Table 15

IMPACT FACTORS

Measure	ISR[615]	RR_E [616]	RR_D [616]	CF_S	CF_W	FR[617]	SO[618]
Duct Sealing	100%	100%	100%	N/A	N/A	25%	0%

599 Heating fuel distribution is used to allocate savings to different fuels when fuel type is unknown.
600 Program estimate.
601 Program estimate.
602 Program estimate.
603 GDS Measure Life Report, Residential and Commercial/Industrial Lighting and HVAC Measures, Prepared for the New England State Program Working Group, June 2007; Table 1.
604 Summer peak demand reduction for duct insulation basement supply. See Duct Insulation.
605 Summer peak demand reduction for duct sealing. See Duct Sealing.
606 Winter peak demand reduction for duct insulation basement supply. See Duct Insulation.
607 Winter peak demand reduction for duct sealing. See Duct Sealing.
608 Electric savings for cooling for duct insulation basement supply. See Duct Insulation.
609 Electric savings for cooling for duct sealing. See Duct Sealing.
610 Fuel savings for heating for duct insulation basement supply. See Duct Insulation.
611 Fuel savings for heating for duct sealing. See Duct Sealing.
612 Fuel savings for heating for pipe insulation. See Hydronic Heating Pipe Insulation.
613 Electric savings for heating for duct insulation basement supply. See Duct Insulation.
614 Electric savings for heating for duct sealing. See Duct Sealing.
615 EMT assumes that all purchased units are installed (i.e. ISR = 100%).
616 The measure has not yet been evaluated. Until the next program impact evaluation, EMT assumes 100 percent realization rate.
617 Program not yet evaluated, assume default FR of 25%.
618 Program not yet evaluated, assume default SO of 0%.

Transportation

Electric Vehicle (BEV, PHEV, LBEV, LPHEV, MBEV, MPHEV, CBEV, CPHEV)		
Last Revised Date	1/1/2023	
MEASURE OVERVIEW		
Description	Purchase of a new electric vehicle (EV) in place of a new internal combustion engine (ICE) vehicle. Electric vehicles can be solely powered by an electric motor with a battery (a Battery Electric Vehicle or BEV) or by a combination of both an electric motor and a gas engine (a Plug-in Hybrid Electric Vehicle or PHEV)	
Primary Energy Impact	Gasoline	
Sector	Commercial, Residential, Low Income	
Program(s)	Electric Vehicle Acceleration	
End-Use	Transportation	
Project Type	New, Replace on Burnout	
DEEMED GROSS ENERGY SAVINGS (UNIT SAVINGS)		
Demand Savings	BEV: ΔkW_{SP} = -0.020, ΔkW_{WP} = -0.135 PHEV: ΔkW_{SP} = -0.059, ΔkW_{WP} = -0.066	
Annual Energy Savings	BEV: ΔkWh/yr = -3,450 ΔMMBtu/yr = 65.04	PHEV: ΔkWh/yr = -2,355 ΔMMBtu/yr = 48.09
GROSS ENERGY SAVINGS ALGORITHMS (UNIT SAVINGS)		
Demand Savings[619]	Deemed	
Annual Energy Savings	BEV: $\Delta kWh/yr = -VMT / 100 \times kWh_{100mi}$ $\Delta MMBtu/yr = VMT / MPG_{ICE} \times 0.120286$	PHEV: $\Delta kWh/yr = -(VMT \times \%Batt) / 100 \times kWh_{100mi}$ $\Delta MMBtu/yr = (VMT / MPG_{ICE} – VMT \times (1-\%Batt)/MPG_{PHEV}) \times 0.120286$
Definitions	Unit = Electric Vehicle VMT = Vehicle Miles Traveled per year (mile/y) 100 = Conversion factor (100 miles) kWh_{100Mi} = Electricity energy consumed per 100 miles traveled (kWh/100 mile) MPG_{ICE} = Miles traveled per gallon of gasoline for baseline vehicle 0.120286 = Conversion factor (MMBtu/gallon of gasoline) %Batt = Percentage of vehicle miles driven using electric motor MPG_{PHEV} = Miles traveled per gallon of gasoline for PHEV when using ICE	
EFFICIENCY ASSUMPTIONS		
Baseline Efficiency	New vehicle powered by internal combustion engine	
Efficient Measure	New vehicle powered by electric motor with battery storage (BEV) or hybrid vehicles equipped with electric motor with battery storage and internal combustion engines (PHEV).	

[619] Derived from data collected from meter chargers. Convergence Data Analytics, Electric Vehicle Charging in Maine Study, 2021.

<table>
<tr><th colspan="10">PARAMETER VALUES</th></tr>
<tr><td>Measure/Type</td><td>VMT</td><td>kWh_{100Mi}</td><td>MPG_{ICE}</td><td>%Batt</td><td>MPG_{PHEV}</td><td>Avoided O&M ($)</td><td>Life (yrs)</td><td>Cost ($)[620]</td></tr>
<tr><td>BEV, LBEV, MBEV</td><td rowspan="4">11,895[621]</td><td rowspan="2">29[622]</td><td rowspan="4">22[623]</td><td rowspan="2">N/A</td><td rowspan="2">N/A</td><td rowspan="2">$3,964[624]</td><td rowspan="4">14[625]</td><td>9,166</td></tr>
<tr><td>CBEV</td><td>13,375</td></tr>
<tr><td>PHEV, LPHEV, MPHEV</td><td rowspan="2">36[626]</td><td rowspan="2">55%[627]</td><td rowspan="2">38[628]</td><td rowspan="2">$3,965[629]</td><td>8,099</td></tr>
<tr><td>CPHEV</td><td>8,000</td></tr>
</table>

<table>
<tr><th colspan="8">IMPACT FACTORS</th></tr>
<tr><td>Program</td><td>ISR</td><td>RR_E</td><td>RR_D</td><td>CF_S</td><td>CF_W</td><td>FR</td><td>SO</td></tr>
<tr><td>EVA</td><td>100%</td><td>100%[630]</td><td>100%[631]</td><td>100%[632]</td><td>100%[633]</td><td>25%[634]</td><td>0%[635]</td></tr>
</table>

[620] USDOE Vehicle Technologies Office incremental cost findings weighted by vehicle class in rebate program data from 7/1/2022 to 11/30/2022. 2022 Incremental Purchase Cost Methodology and Results for Clean Vehicles (energy.gov)

[621] EMT calculation based on 2017 data: MDEP LDV pop inventory; Maine annual passenger car and truck miles traveled (data from MDEP)

[622] Average of kWh/100 miles rate of BEVs on EMT's eligible vehicle list. EMT list of eligible vehicles: https://docs.google.com/spreadsheets/d/1_rb7tliK42e-dvjG8LTvPkUFKGhmR8Wog_SJZJRiAjA/edit#gid=0

[623] EPA Fuel Economy, avg 2019 passenger ICE vehicle

[624] Net present value of estimated savings on maintenance and repairs over assumed 14-year measure life. Maintenance and repair cost estimates from Maintenance-Cost-White-Paper-9.24.20-1.pdf (consumerreports.org).

[625] Based on 11,895 miles driven per year (annual Maine vehicle miles traveled) and average 169,400-mile life (Davis, S. C.; Diegel, S. W.; Boundy, R. G. Transportation Energy)
Data Book Edition 34; Oak Ridge National Laboratory: Oak Ridge,
TN, USA, 2015. http://cta.ornl.gov/data

[626] Average of kWh/100 miles rate of PHEVs on EMT's eligible vehicle list. EMT list of eligible vehicles: https://docs.google.com/spreadsheets/d/1_rb7tliK42e-dvjG8LTvPkUFKGhmR8Wog_SJZJRiAjA/edit#gid=0

[627] https://afdc.energy.gov/vehicles/electric_emissions_sources.html

[628] Ibid.

[629] Net present value of estimated savings on maintenance and repairs over assumed 14-year measure life. Maintenance and repair cost estimates from Maintenance-Cost-White-Paper-9.24.20-1.pdf (consumerreports.org).

[630] New measure offering not yet evaluated.

[631] Ibid.

[632] Peak impacts are estimated directly.

[633] Ibid.

[634] Measure not yet evaluated, assume default FR of 25%.

[635] Measure not yet evaluated, assume default SO of 0%.

Building Thermal Envelope

Air Sealing (IR, LIR, MIR)	
Last Revised Date	7/1/2023
MEASURE OVERVIEW	
Description	This measure involves sealing air leaks in windows, doors, roof, crawl spaces and outside walls as well as improved air sealing from insulation resulting in decreased heating and cooling loads.
Energy Impacts	Electric, Natural Gas, Oil, Propane, Wood, Kerosene
Sector	Residential
Program(s)	Home Energy Savings Program (HESP), Affordable Heating Initiative (AHI)
End-Use	Heating, Cooling
Decision Type	Retrofit
GROSS ENERGY SAVINGS ALGORITHMS (UNIT SAVINGS)	
Demand savings	$\Delta kW_{SP} = \Delta MMBtu_{COOL}$ / EER x 1000 x %COOL x LSF_{SP} $\Delta kW_{WP} = \Delta MMBtu_{HEAT}$ / 0.003412 / EFF x LSF_{WP}
Annual Energy savings	For known fuel and non-electric heat: $\Delta MMBtu_{FUEL} = \Delta MMBtu_{HEAT}$ / EFF $\Delta kWh = \Delta MMBtu_{COOL}$ / EER x 1000 x %COOL For known electric heat: $\Delta kWh = \Delta MMBtu_{HEAT}$ / 0.003412 / EFF + $\Delta MMBtu_{COOL}$ / EER x 1000 x %COOL For unknown fuel: $\Delta MMBtu_{FUEL} = \Delta MMBtu_{HEAT}$ / EFF x %FUEL $\Delta kWh = \Delta MMBtu_{HEAT}$ / 0.003412 / EFF x %FUEL + $\Delta MMBtu_{COOL}$ / EER x 1000 x %COOL $\Delta MMBtu_{COOL} = \Delta CFM50/14.8 \times 60 \times 0.014 \times CDH / 1000000$ $\Delta MMBtu_{HEAT} = \Delta CFM50/14.8 \times 60 \times 0.014 \times HDH / 1000000$
Definitions	Unit = Air sealing project EFF = Efficiency factor of representative heating system (Btu/Btu) EER = Energy-efficiency ratio of representative cooling system (Btu/Wh) %FUEL = Home heating fuel distribution[636] LSF_{SP} = Summer peak load shape factor (kW/kWh/yr) LSF_{WP} = Winter peak load shape factor (kW/kWh/yr) %COOL = Equivalent percentage of homes with full electric cooling equipment (%) 0.003412 = Conversion factor (MMBtu/kWh) 1000 = Conversion factor (kW/MW) ΔCFM50 = Change in air leakage per square foot of insulation resulting from improved air sealing ($ft^3/h/ft^2$) 14.8 = Conversion factor (CFM50 to CFM natural)[637] 60 = Conversion factor (minutes/hour) 0.014 = heat loss reduction factor from improved air sealing (Btu/(ft^3/h)/°F)[638]
EFFICIENCY ASSUMPTIONS	
Baseline Efficiency	The baseline case is the existing home before the air-sealing measures are installed. The program contractor measures the baseline leakage rate ($CFM50_{PRE}$) during the home audit.
Efficient Measure	The high-efficiency case is the home after the air-sealing measures are installed. The program contractor measures the post-upgrade leakage rate ($CFM50_{POST}$) after the air-sealing installation is complete.

[636] Heating fuel distribution is used when heating system fuel is unknown.
[637] Based on LBNL "N" factors Zone 2, 1.5-2 stories.
[638] Btu savings estimated using 0.014 Btu/CFH natural/delta temperature* delta temperature * hours per year for each delta temperature as recommended by the West Hill Energy, Efficiency Maine Trust Home Energy Savings Program Impact Evaluation, 2019.

Air Sealing (IR, LIR, MIR)							
PARAMETER VALUES (DEEMED)							
Measure	ΔCFM50	EFF	EER	%COOL	%FUEL	Life (yrs)	Cost ($)
Air Sealing	Actual[639]	83%[640]	9.8[641]	53%[642]	Table 15	15[643]	Actual
Measure	LSF_{SP}	LSF_{WP}					
Air Sealing	0.00213[644]	0.000248[645]					
IMPACT FACTORS							
Measure	ISR	RR_E	RR_D	CF_S	CF_W	FR	SO
Air Sealing	100%[646]	100%[647]	100%[647]	100%[648]	100%[648]	30%[649]	2.9%[650]
Low Income Air Sealing						0%[651]	0%[652]

[639] Difference in blower door test results before and after weatherization project (Pre CFM50 – Post CFM50).
[640] Recommended assumption from HESP Impact Evaluation. For known electric heat, 100% efficiency is assumed.
[641] Average existing cooling efficiency is set to the federal standard of 9.8 according to DOE Federal Test Procedure 10 CFR 430, Appendix F: http://buildingsdatabook.eere.energy.gov/TableView.aspx?table=7.5.1. The code was effective for products manufactured on or after October 1, 2000. Since the measure life for room air-conditioners is about 9 years, most units will meet this standard.
[642] Portland Press Herald, http://www.pressherald.com/2014/05/26/put_power_rates_on_ice__that_s_a_cool_idea_/. In 2010, an estimated 79 percent of customers in ISO-New England region had room air conditioners. Of the 79 percent, 40 percent of homes have equivalent of whole home A/C (3 window A/Cs); 39 percent of homes have total cooling capacity equivalent of 1 or 2 window A/C units. The remaining 21 percent have no cooling equipment installed. Assuming that the 39 percent of homes with 1 or 2 window units are equivalent to 33% of whole home cooling, the resulting equivalent cooling for all homes is 53 percent (40%*100% + 39%*33%).
[643] GDS Measure Life Report, Residential and Commercial/Industrial Lighting and HVAC Measures, Prepared for the New England State Program Working Group, June 2007, Table 1.
[644] Based on temperature bin analysis of seasonal cooling using TMY3 temperature bins and base temperature of 60 deg F.
[645] Based on temperature bin analysis of seasonal heating using TMY3 temperature bins and base temperature of 60 deg F.
[646] ISR is 100 percent because deemed savings results are based on evaluated results that include installation verification.
[647] Realization rate set to 100% as savings reflect evaluation results.
[648] Peak coincidence factors for this measure are embedded in the evaluated peak demand impacts.
[649] West Hill Energy, Efficiency Maine Trust Home Energy Savings Program Impact Evaluation, 2019.
[650] West Hill Energy, Efficiency Maine Trust Home Energy Savings Program Impact Evaluation, 2019.
[651] Program assumes no free ridership or spillover for the AHI program
[652] Program assumes no free ridership or spillover for the AHI program

Air Sealing Direct Install (LNAS) (Inactive)	
Last Revised Date	7/1/2019
MEASURE OVERVIEW	
Description	This measure involves sealing air leaks in windows, doors, roof, crawl spaces and outside walls resulting in decreased heating and cooling loads.
Energy Impacts	Natural Gas
Sector	Residential
Program(s)	Low-income Direct Install
End-Use	Heating, Cooling
Decision Type	Retrofit
GROSS ENERGY SAVINGS ALGORITHMS (UNIT SAVINGS)	
Demand savings	$\Delta kW = 0$
Annual Energy savings	$\Delta MMBtu = HLF \times (\Delta CFM50) / EFF$
Definitions	Unit = Air-sealing project HLF = Heat loss factor as a function of reduction in CFM50 ΔCFM50 = Reduction in air infiltration EFF = Efficiency factor of representative heating system (Btu/Btu)
EFFICIENCY ASSUMPTIONS	
Baseline Efficiency	The baseline case is the existing home before the air-sealing measures are installed. The program contractor measures the baseline leakage rate ($CFM50_{PRE}$) during the home audit.
Efficient Measure	The high-efficiency case is the home after the air-sealing measures are installed. The program contractor measures the post-upgrade leakage rate ($CFM50_{POST}$) after the air sealing installation is complete.

PARAMETER VALUES (DEEMED)

Measure	HLF[653]	ΔCFM50	EFF[654]		Life (yrs)	Cost ($)
Air Sealing	0.01362	Actual	80.5%		15[655]	$700[656]

IMPACT FACTORS

Measure	ISR	RR_E	RR_D	CF_S	CF_W	FR	SO
Air Sealing	100%[657]	100%[658]	100%[658]	N/A	N/A	0%[659]	0%[660]

653 Based on modeling of TMY3 data.
654 Representative heating system efficiency NMR Group, Maine Single-Family Residential Baseline Study, September 14, 2015.
655 GDS Measure Life Report, Residential and Commercial/Industrial Lighting and HVAC Measures, prepared for the New England State Program Working Group, June 2007, Table 1.
656 Average cost of sampled 2016 projects where attic insulation was itemized separately on contractor invoice (N=51).
657 ISR is 100 percent because deemed savings results are based on evaluated results that include installation verification.
658 The measure has not yet been evaluated. Until the next program impact evaluation, EMT assumes 100 percent realization rate.
659 FR of 0% assumed for low income programs.
660 Program not yet evaluated, assume default SO of 0%.

Insulation (BA, LBA, MBA, BB, LBB, MBA, BW, LBW, MBW, BU, LBU, MBU)	
Last Revised Date	7/1/2023
MEASURE OVERVIEW	
Description	This measure involves the insulation of the attic floor, exterior walls, basement walls or floor exposed to exterior to decrease heating and cooling losses. The participant must also complete a comprehensive air-sealing project. The total savings below reflect savings due to the added insulation and improved air sealing attributable to the insulation.
Energy Impacts	Electric, Oil, Propane, Wood, Kerosene
Sector	Residential
Program(s)	Home Energy Savings Program (HESP), Affordable Heating Initiative (AHI)
End-Use	Heating, Cooling
Decision Type	Retrofit
GROSS ENERGY SAVINGS ALGORITHMS (UNIT SAVINGS)	
Demand savings	$\Delta kW_{SP} = \Delta MMBtu_{COOL} / EER \times 1000 \times \%COOL \times LSF_{SP}$ For known electric heat: $\Delta kW_{WP} = \Delta MMBtu_{HEAT} / 0.003412 / EFF \times LSF_{WP}$
Annual Energy savings	For known fuel and non-electric heat: $\Delta MMBtu_{FUEL} = \Delta MMBtu_{HEAT} / EFF$ $\Delta kWh = \Delta MMBtu_{COOL} / EER \times 1000 \times \%COOL$ For electric heat: $\Delta kWh = \Delta MMBtu_{HEAT} / 0.003412 / EFF + \Delta MMBtu_{COOL} / EER \times 1000 \times \%COOL$ For unknown fuel: $\Delta MMBtu_{FUEL} = \Delta MMBtu_{HEAT} / EFF \times \%FUEL$ $\Delta kWh = \Delta MMBtu_{HEAT} / 0.003412 / EFF \times \%FUEL + \Delta MMBtu_{COOL} / EER \times 1000 \times \%COOL$ Where $\Delta MMBtu_{COOL} = (1/ (RVAL_{PRE} + RAdj) - 1/RVAL_{POST}) \times SQFT \times Aadj \times CDH / 1000000$ $\Delta MMBtu_{HEAT} = (1/ (RVAL_{PRE} + RAdj) - 1/RVAL_{POST}) \times SQFT \times Aadj \times HDH / 1000000$
Definitions	Unit = single zone of insulation (attic, walls, basement) with the same pre and post R values $\Delta MMBtu_{HEAT}$ = Reduction in annual heat loss due to improved insulation and associated air sealing $\Delta MMBtu_{COOL}$ = Reduction in annual heat gain due to improved insulation and associated air sealing EFF = Efficiency factor of representative heating system (Btu/Btu) EER = Energy-efficiency ratio of representative cooling system (Btu/Wh) %FUEL = Home heating fuel distribution[661] LSF_{SP} = Summer peak load shape factor (kW/kWh/y) LSF_{WP} = Winter peak load shape factor (kW/kWh/y) %COOL = Equivalent percentage of homes with full electric cooling equipment (%) 0.003412 = Conversion factor (MMBtu/kWh) 1000 = Conversion factor (W/kW) SQFT = Area of insulation (ft^2) installed $RVAL_{PRE}$ = Pre-upgrade R-value (ft^2-°F-h/Btu) $RVAL_{POST}$ = Post-upgrade R-value (ft^2-°F-h/Btu) RAdj = Adjustment to Pre-upgrade R-value (ft^2-°F-h/Btu) AAdj = Area adjustment (used to adjust the effective insulated area for basement walls due to ground effects) HDH = Heating Degree Hours derived from TMY3 hourly dry bulb temperature (°F-h) CDH = Cooling Degree Hours derived from TMY3 hourly dry bulb temperature (°F-h) $Base_T$ = Base temperature against which HDH and CDH are calculated
EFFICIENCY ASSUMPTIONS	
Baseline Efficiency	The baseline is the existing (pre-upgrade) insulation
Efficient Measure	The high-efficiency case is the upgraded insulation

[661] Heating fuel distribution is used to allocate savings to different fuels when fuel type is unknown because the savings achieved through insulation impact heating energy consumption.

Insulation (BA, LBA, MBA, BB, LBB, MBA, BW, LBW, MBW, BU, LBU, MBU)

PARAMETER VALUES (DEEMED)

Measure	EFF	EER	%FUEL	LSF_{SP}	LSF_{WP}	%COOL	Life (yrs)	Cost ($)
Insulation	83%[662]	9.8[663]	Table 15	0.00213[664]	0.000248[665]	53%[666]	25[667]	Actual

Measure	SQFT	$RVAL_{PRE}$	$RVAL_{POST}$	RAdj	AAdj	HDH	CDH
Insulation	Actual	Actual	Actual	Table 8		Table 9	

IMPACT FACTORS

Program	ISR	RR_E	RR_D	CF_S	CF_W	FR	SO
HESP	100%[668]	100%[669]	100%[670]	100%[671]	100%[672]	30%[673]	2.9%[674]
AHI						0%[675]	0%[676]

Table 8. Insulation Zone Parameters

Zone	Variable	Attic	Wall	Underbelly	Basement
Base temperature cooling[677]	$Base_T$	70	70	70	95
Base temperature heating[678]	$Base_T$	60	60	60	40
Pre-upgrade R-value adjustment[679]	RAdj	2.5	2.5	2.5	0.5
Area adjustment[680]	AAdj	1	1	1	0.31
Cooling Degree Hours[681]	CDH	5,570	5,570	5,570	0
Heating Degree Hours[682]	HDH	152,580	152,580	152,580	51,257

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662 Recommended assumption from HESP Impact Evaluation. For electric heat, 100% efficiency is assumed.

663 Average existing cooling efficiency is set to the federal standard of 9.8 according to DOE Federal Test Procedure 10 CFR 430, Appendix F: http://buildingsdatabook.eere.energy.gov/TableView.aspx?table=7.5.1. The code was effective for products manufactured on or after October 1, 2000. Since the measure life for room air-conditioners is about 9 years, most units will meet this standard.

664 Based on temperature bin analysis of seasonal cooling using TMY3 temperature bins and base temperature of 60 deg F.

665 Based on temperature bin analysis of seasonal heating using TMY3 temperature bins and base temperature of 60 deg F.

666 Portland Press Herald, http://www.pressherald.com/2014/05/26/put_power_rates_on_ice__that_s_a_cool_idea_/. In 2010, an estimated 79 percent of customers in ISO-New England region had room air conditioners. Of the 79 percent, 40 percent of homes have equivalent of whole home A/C (3 window A/C's); 39 percent of homes have total cooling capacity equivalent of 1 or 2 window A/C units. The remaining 21 percent have no cooling equipment installed. Assuming that the 39 percent of homes with 1 or 2 window units are equivalent to 33% of whole home cooling, the resulting equivalent cooling for all homes is 53 percent (40%*100% + 39%*33%).

667 GDS Measure Life Report, Residential and Commercial/Industrial Lighting and HVAC Measures, Prepared for the New England State Program Working Group, June 2007; Table 1.

668 Claim form requires customer and contractor to confirm insulation installation.

669 Savings estimates updated based on West Hill Energy, Efficiency Maine Trust Home Energy Savings Program Impact Evaluation, 2019.

670 Savings estimates updated based on West Hill Energy, Efficiency Maine Trust Home Energy Savings Program Impact Evaluation, 2019.

671 Peak coincidence factors for this measure are embedded in the peak demand impacts formulas.

672 Peak coincidence factors for this measure are embedded in the peak demand impacts formulas.

673 HESP: West Hill Energy, Efficiency Maine Trust Home Energy Savings Program Impact Evaluation, 2019.

674 HESP: West Hill Energy, Efficiency Maine Trust Home Energy Savings Program Impact Evaluation, 2019.

675 AHI: Program assumes no free ridership for the AHI program

676 AHI: Program assumes no spillover for the AHI program

677 Assumed temperature above which cooling is required. Basement cooling base temperature set to avoid cooling savings which are not applicable to basement insulation improvements.

678 Assumed temperature below which heating is required as recommended by West Hill, Efficiency Maine Trust Home Energy Savings Program Impact Evaluation, 2019. Basement heating base temperature set lower than other zones to account for unconditioned basements.

679 Recommended adjustments from West Hill Energy, Efficiency Maine Trust Home Energy Savings Program Impact Evaluation, 2019: Attic: no adjustment, Wall: + R2.5 for framing, Basement: + R-0.50 for cement wall. In addition to the pre R-value adjustments, minimum pre and post R-values are implemented in the effRT formulas to guard against 0 values: Attic: 10 pre/20 post, Wall: 5 pre/10 post, Basement 2 pre/10 post.

680 Area of insulation for basements is adjusted to account for portion of wall exposed to ambient temperature. Recommended value from West Hill Energy, Efficiency Maine Trust Home Energy Savings Program Impact Evaluation, 2019.

681 Population weighted cooling degree hours derived from TMY 3 dry bulb temperatures. See Table 9.

682 Population weighted heating degree hours derived from TMY 3 dry bulb temperatures. See Table 9.

Table 9. Heating and Cooling Degree Hours[683]

Heating/Cooling	Base Temperature ($Base_T$)	Portland	Caribou	Bangor	Population Weighted Average
Heating	60	149366	199010	151623	152580
Heating	40	48718	84495	51297	51257
Cooling	70	5139	3829	7284	5570
Cooling	95	0	0	0	0
	Population Weight	71%	5%	23%	100%

[683] Sum of the differences between the assumed base temperature and the TMY3 hourly dry bulb temperature for each location. Population weights derived from population of each region; U.S. Census Bureau Census 2010 Summary File 1 population by census tract.

Insulate Attic Openings (Component of LUB) (Inactive)			
Last Revised Date	7/1/2016		
MEASURE OVERVIEW			
Description	This measure involves the installation of a thermal barrier on attic hatches, attic stairs, or whole house fans. The infiltration savings can only be claimed if they are independent of the air sealing measure.		
Energy Impacts	Electric, Natural Gas, Oil, Propane, Wood, Kerosene		
Sector	Residential		
Program(s)	Affordable Heating Initiative (AHI)		
End-Use	Heating		
Decision Type	Retrofit		
DEEMED GROSS ENERGY SAVINGS (UNIT SAVINGS)			
Demand savings	Attic hatch insulation	Attic pull down stairs insulation	Whole house fan insulation
	For homes with non-electric heating		
	$\Delta kW_{WP} = 0.0$	$\Delta kW_{WP} = 0.0$	$\Delta kW_{WP} = 0.0$
	For homes with electric resistance heating		
	With infiltration $\Delta kW_{WP} = 0.087$ Without infiltration $\Delta kW_{WP} = 0.061$	$\Delta kW_{WP} = 0.203$ $\Delta kW_{WP} = 0.114$	$\Delta kW_{WP} = 0.094$ $\Delta kW_{WP} = 0.053$
Annual energy savings[684]	Attic hatch insulation	Attic pull down stairs insulation	Whole house fan insulation
	For homes with non-electric heating		
	With infiltration $\Delta MMBtu = 0.646$ Without infiltration $\Delta MMBtu = 0.453$	$\Delta MMBtu = 1.508$ $\Delta MMBtu = 0.845$	$\Delta MMBtu = 0.699$ $\Delta MMBtu = 0.397$
	For homes with electric resistance heating		
	With infiltration $\Delta kWh = 152$ Without infiltration $\Delta kWh = 107$	$\Delta kWh = 356$ $\Delta kWh = 199$	$\Delta kWh = 165$ $\Delta kWh = 94$
GROSS ENERGY SAVINGS ALGORITHMS (UNIT SAVINGS)			
Demand savings	$\Delta kW_{WP} = \Delta kWh \times LSF_{WP}$		
Annual Energy savings	$\Delta MMBtu_{COND} = SQFT \times (1/RVAL_{PRE} - 1/RVAL_{POST}) \times HDD \times 24 \times F_{ADJ} / 1{,}000{,}000$ $\Delta MMBtu_{INFIL}$ = Deemed value For homes with non-electric heating $\Delta MMBtu = (\Delta MMBtu_{COND} + \Delta MMBtu_{INFIL})/EFF$ For homes with electric resistance heating $\Delta kWh = \Delta MMBtu / 0.003412$ For homes with unknown heating fuel type $\Delta MMBtu = (\Delta MMBtu_{COND} + \Delta MMBtu_{INFIL})/EFF \times \%FUEL$ $\Delta kWh = \Delta MMBtu / 0.003412 \times \%FUEL$		

684 If fuel type is unknown, savings are to be allocated across fuel types using the insulation fuel distribution found in

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Insulate Attic Openings (Component of LUB) (Inactive)		
Definitions	Unit	= Insulation project
	$\Delta MMBtu_{COND}$	= Annual conduction heat loss reduction
	$\Delta MMBtu_{INFIL}$	= Annual infiltration heat loss reduction
	SQFT	= Area of insulation (ft^2)
	$RVAL_{PRE}$	= Pre-upgrade R-value (ft^2-°F-hr/Btu)
	$RVAL_{POST}$	= Post-upgrade R-value (ft^2-°F-hr/Btu)
	HDD	= Heating Degree Days, Maine population-weighted state average[688]
	F_{ADJ}	= ASHRAE adjustment factor[690]
	EFF	= Efficiency factor of representative heating system (Btu/Btu)
	%FUEL	= Home heating fuel distribution for insulation[685]
	LSF_{WP}	= Winter peak load shape factor (W/kWh/yr)[692]
	0.003412	= Conversion factor (kWh/MMBtu)
	1,000,000	= Conversion factor (Btu/MMBtu)
	24	= Conversion factor (hours/day)

EFFICIENCY ASSUMPTIONS

Baseline Efficiency	The baseline is the existing (pre-upgrade) insulation
Efficient Measure	The high-efficiency case is the upgraded insulation

PARAMETER VALUES (DEEMED)

Measure	$\Delta MMBtu_{INFIL}$ [686]	SQFT[687]	$RVAL_{PRE}$[687]	$RVAL_{POST}$[687]	HDD[688]	Life (yrs) [689]	Cost ($)
Attic Hatch Insulation	0.154876	5.6	1.69	21.7	7,777	25	Actual
Attic Pull-Down Stairs Insulation	0.533461	11.25	1.69	11.7			
Whole House Fan Insulation	0.243195	4.00	1.32	11.3			

Measure	F_{ADJ}[690]	EFF[691]	LSF_{WP}	%FUEL
Insulate Attic Openings	0.64	80.5%	0.000248 [692]	Table 15

IMPACT FACTORS

Measure	ISR[693]	RR_E[694]	RR_D[694]	CF_S[695]	CF_W[695]	FR[696]	SO[697]
Insulate Attic Openings	100%	100%	100%	100%	100%	25%	0%

[685] Heating fuel distribution is used to allocate savings to different fuels when fuel type is unknown.
[686] ASHRAE 1997 Handbook – Fundamentals, p. 25.16, was used to calculate infiltration of these measures using data from evaluation of WRAP and Helps Program, KEMA, 2010.
[687] UI/CL&P C&LM Program Savings Documentation – 2015 p. 235, 4.4.11 Insulate Attic Openings measure, Table 1.
[688] Based on a population-weighted average of Caribou, Bangor, and Portland from TMY3 dataset and base temperature of 65 degree F.
[689] GDS Measure Life Report, Residential and Commercial/Industrial Lighting and HVAC Measures, Prepared for the New England State Program Working Group, June 2007; Table 1.
[690] ASHRAE degree-day correction. 1989 ASHRAE Handbook – Fundamentals, 28.2, Fig 1.
[691] Representative heating system efficiency based on NMR Group, Maine Single-Family Residential Baseline Study, September 14, 2015.
[692] Based on temperature bin analysis of seasonal heating using TMY3 temperature bins and base temperature of 60 deg F.
[693] EMT assumes that all purchased units are installed (i.e. ISR = 100%).
[694] The measure has not yet been evaluated. Until the next program impact evaluation, EMT assumes 100 percent realization rate.
[695] Peak coincidence factors for this measure are embedded in the calculated peak demand impacts.
[696] Program not yet evaluated, assume default FR of 25%.
[697] Program not yet evaluated, assume default SO of 0%.

Window Inserts (LWI)			
Last Revised Date	7/1/2020		
MEASURE OVERVIEW			
Description	This measure involves the installation of interior window inserts in single and double pane windows that do not have exterior or interior storm windows installed.		
Energy Impacts	Oil, Propane, Kerosene, Wood.		
Sector	Residential		
Program(s)	Low-income Direct Install		
End-Use	Heating		
Decision Type	Retrofit		
DEEMED GROSS ENERGY SAVINGS (UNIT SAVINGS)			
Demand savings	For electric heat: $\Delta kW_{SP} = 0$ $\Delta kW_{WP} = 0.001872/sqft$	For non-electric heat: $\Delta kW_{SP} = 0$ $\Delta kW_{WP} = 0$	If fuel is unknown: $\Delta kW_{SP} = 0$ $\Delta kW_{WP} = 0.000071/sqft$
Annual energy savings	For electric heat: $\Delta kWh = 7.550/sqft$ For non-electric heat: $\Delta MMBtu = 0.03104/sqft$	If fuel is unknown distribute savings based on % Fuel $\Delta kWh = 0.287/sqft$ $\Delta MMBtu_{GAS} = 0.00279/sqft$ $\Delta MMBtu_{PROP} = 0.00407/sqft$ $\Delta MMBtu_{OIL} = 0.02123/sqft$ $\Delta MMBtu_{KERO} = 0.00043/sqft$ $\Delta MMBtu_{WOOD} = 0.00133/sqft$	
GROSS ENERGY SAVINGS ALGORITHMS (UNIT SAVINGS)			
Demand savings	$\Delta kW_{WP} = \Delta MMBtu_{HEAT} \times SQFT / 0.003412 / EFF \times LSF_{WP}$		
Annual Energy savings	For known fuel and non-electric heat: $\Delta MMBtu_{FUEL} = \Delta MMBtu_{HEAT} \times SQFT / EFF$ For known electric heat: $\Delta kWh = \Delta MMBtu_{HEAT} \times SQFT / 0.003412 / EFF$ For unknown fuel: $\Delta MMBtu_{FUEL} = \Delta MMBtu_{HEAT} \times SQFT / EFF \times \%FUEL$ $\Delta kWh = \Delta MMBtu_{HEAT} / 0.003412 \times SQFT / EFF \times \%FUEL$		
Definitions	Unit = window insert $\Delta MMBtu_{HEAT}$ = Reduction in annual heat loss due to improved insulation and associated air sealing derived from temperature bin analysis using TMY3 per square foot of window insert SQFT = Area per window insert $RVAL_{PRE}$ = R-value (ft^2-°F-hr/Btu) of window assumed in temperature bin analysis $RVAL_{POST}$ = R-value (ft^2-°F-hr/Btu) of window plus an insert assumed in temperature bin analysis $\Delta CFM50$ = Change in air leakage resulting from improved air sealing assumed in temperature bin analysis = Efficiency factor of representative heating system EFF (Btu/Btu) EER = Energy-efficiency ratio of representative cooling system (Btu/Wh) %FUEL = Home heating fuel distribution[698] LSF_{SP} = Summer peak load shape factor (kW/kWh/yr) LSF_{WP} = Winter peak load shape factor (kW/kWh/yr) 0.003412 = Conversion factor (MMBtu/kWh) 1000 = Conversion factor (kW/MW)		

[698] Heating fuel distribution is used to allocate savings to different fuels when fuel type is unknown because the savings achieved through insulation impact heating energy consumption.

Window Inserts (LWI)

EFFICIENCY ASSUMPTIONS

Baseline Efficiency	The baseline is the existing window without inserts
Efficient Measure	The high-efficiency case is the window with insert installed

PARAMETER VALUES (DEEMED)

Measure	$\Delta MMBtu_{HEAT}$	$\Delta MMBtu_{COOL}$	EFF	EER	%FUEL	Life (yrs)	Cost ($)
Window Insert	0.02509[699]	0.0[700]	80.5%[701]	9.8[702]	Table 15	4[703]	3.4867/sqft[704]

Measure	SQFT	$RVAL_{PRE}$	$RVAL_{POST}$	LSF_{SP}	LSF_{WP}	$\Delta CFM50$
Window Insert	actual	2.66[705]	4.73[706]	0.00213[707]	0.000248[708]	0.34[709]

IMPACT FACTORS

Measure	ISR[710]	RR_E[711]	RR_D[712]	CF_S	CF_W	FR[713]	SO[714]
Window Insert	100%	100%	100%	N/A	N/A	0%	0%

[699] Heat loss/gain changes based on weighted temperature bin analysis using TMY3 temperature bins for Portland (71.2%), Bangor (23.4%) and Caribou (5.4%) and the factors defined in this TRM entry. Heat transfer calculated as area insulated * delta temperature * hours per year for the delta temperature * (1/R value_pre – 1/R value_post). Delta temperature defined as 60 degrees F minus ambient temperature for heating season and 70 degrees F minus ambient temperature for cooling season.

[700] Ibid.

[701] Representative heating system efficiency based on NMR, 2015 Maine Residential Baseline Study. For electric resistance heating efficiency is assumed to be 100%.

[702] Average existing cooling efficiency is set to the federal standard of 9.8 according to DOE Federal Test Procedure 10 CFR 430, Appendix F: http://buildingsdatabook.eere.energy.gov/TableView.aspx?table=7.5.1. The code was effective for products manufactured on or after October 1, 2000. Since the measure life for room air-conditioners is about 9 years, most units will meet this standard.

[703] Program assumption based on program design.

[704] Average cost per WindowDressers invoice FY2022 assuming an average of 12 sq ft per window.

[705] Daniel Mistro, Window Inserts and the People Adopting Them: Building Sustainable Communities in Maine, University of Maine, August 2017.

[706] Ibid.

[707] Based on temperature bin analysis of seasonal cooling using TMY3 temperature bins and base temperature of 60 deg F.

[708] Based on temperature bin analysis of seasonal heating using TMY3 temperature bins and base temperature of 60 deg F.

[709] Results from an unpublished study conducted by the University of Maine in collaboration with WindowDressers and Efficiency Maine. Reduction value is for incremental infiltration reduction achieved with window inserts after air sealing has been performed. Reduction without previous air sealing is 1.22 CFM50.

[710] EMT assumes that all purchased units are installed (i.e. ISR = 100%).

[711] The measure has not yet been evaluated. Until the next program impact evaluation, EMT assumes 100% realization rate.

[712] The measure has not yet been evaluated. Until the next program impact evaluation, EMT assumes 100% realization rate.

[713] Program assumes no free ridership for the low-income direct install program.

[714] Program not yet evaluated, assume default SO of 0%.

Appendix A: Glossary

Definitions are based primarily on the ***Northeast Energy Efficiency Partnerships (NEEP), Regional Evaluation, Measurement & Verification (EMV) Forum, Glossary of Terms, Version 2.0 (PAH Associates, March 2011)***, cited at the end of each definition as [NEEP EMV Glossary].

Adjusted Gross Savings: The change in energy consumption and/or demand that results directly from program-related actions taken by participants in an efficiency program, regardless of why they participated, adjusted for evaluation findings. It adjusts for such factors as data errors, installation and persistence rates and hours of use, but does not adjust for free-ridership or spillover. Adjusted Gross Savings can be calculated as an annual or lifetime value. [NEEP EMV Glossary, edited]

Actual: Actual means the project-specific value that is recorded in the Project Application/Documentation for this measure.

Algorithm: An equation or set of equations, more broadly a method, used to calculate a number. In this case, it is an estimate of energy use or energy savings tied to operation of a piece of equipment or a system of interacting pieces of equipment. An algorithm may include certain standard numerical assumptions about some relevant quantities, leaving the user to supply other data to calculate the use or savings for the particular measure or equipment. [NEEP EMV Glossary]

Annual Demand Savings: The maximum reduction in electric demand in a given year within defined boundaries. The demand reduction is typically the result of the installation of higher efficiency equipment, new controls, or behavioral change. The term can be applied at various levels, from individual projects and energy-efficiency programs to overall program portfolios. [NEEP EMV Glossary, edited]

Annual Energy Savings: The reduction in electricity usage (reported as ΔkWh) or in fossil-fuel use (reported as ΔMMBtu) in a given year from the savings associated with an energy-saving measure, project, or program. [NEEP EMV Glossary, edited]

Average Annual Operating Hours: see Hours of Use.

Baseline Efficiency: The assumed efficiency condition of the baseline equipment that is being replaced by the subject energy-efficiency measure. It is used to determine the energy savings obtained by the more efficient measure. [NEEP EMV Glossary, edited]

Btu: A standard measure of heat energy, one Btu is required to raise the temperature of one pound of water one degree Fahrenheit from 58.5 to 59.5 degrees under standard pressure of 30 inches of mercury at or near its point of maximum density. [NEEP EMV Glossary, edited]

Coincident Demand: The demand of a device, circuit or building that occurs at the same time as the peak demand of a system load or some other peak of interest. The peak of interest should be specified. [NEEP EMV Glossary]

Coincidence Factor (CF): The ratio of the average hourly demand of a group of measures during a specified period of time to the sum of their individual maximum demands (or connected loads) within the same period. [NEEP EMV Glossary, edited]

Deemed Savings: An estimate of energy or demand savings for a single unit of an installed energy-efficiency measure that (a) has been developed from data sources and analytical methods that are widely considered acceptable for the measure and purpose, and (b) is applicable to the situation being evaluated. A measure with deemed savings will have the same savings per unit. Individual parameters used to calculate savings and/or savings calculation methods can also be deemed. [NEEP EMV Glossary, edited]

Delta Watts: The difference in the wattage between existing or baseline equipment and its more efficient replacement or installation at a specific time, expressed in watts or kilowatts. [NEEP EMV Glossary]

Demand: The time rate of energy flow. Demand usually refers to the amount of electric energy used by a customer or piece of equipment at a specific time, expressed in kilowatts. [NEEP EMV Glossary]

ENERGY STAR®: A joint program of the U.S. Environmental Protection Agency and the U.S. Department of Energy designed to reduce energy use and its impact on the environment. The ENERGY STAR® label is awarded to products that meet applicable energy-efficiency guidelines as well as to homes and commercial buildings that meet specified energy-efficiency standards. [NEEP EMV Glossary, edited]

Free rider: A program participant who would have implemented the program measure or practice in the absence of the program. A free-rider can be: 1) total, in which the participant's activity would have completely replicated the program measure; 2) partial, in which the participant's activity would have partially replicated the program measure; or 3) deferred, in which the participant's activity would have completely replicated the program measure but at a future time beyond the program's timeframe. [NEEP EMV Glossary, edited]

Free ridership Rate (FR): The percent of energy savings through an energy-efficiency program attributable to free riders. [NEEP EMV Glossary, edited]

Gross Savings: The change in energy consumption and/or demand that results directly from program-related actions taken by participants in an efficiency program, regardless of why they participated and not adjusted for any factors. [NEEP EMV Glossary, edited]

Hours of Use (HOU) or Operating Hours: The average number of hours a measure is in use during a specified time period, typically a day or a year. [NEEP EMV Glossary]

Incremental Cost: The difference between the cost of existing or baseline equipment/service and the cost of energy-efficient equipment/service. [NEEP EMV Glossary]

In-Service Rate (ISR): The percentage of energy-efficiency measures adopted in response to program incentives that are actually installed and operating. The in-service rate is calculated by dividing the number of measures installed and operating by the number of incentives offered by an efficiency program in a defined period of time. [NEEP EMV Glossary, edited]

Interactive Effects (IE) - The influence of one technology's application on the energy required to operate another application. An example is the reduced heat in a facility as a result of replacing incandescent lights with CFLs, and the resulting need to increase space heating from another source, usually oil or gas fired. [NEEP EMV Glossary]

Kilowatt (kW): A measure of the rate of power used during a preset time period (e.g. minutes, hours, days or months) equal to 1,000 watts. [NEEP EMV Glossary]

Kilowatt-Hour (kWh): A common unit of electric energy; one kilowatt-hour is numerically equal to 1,000 watts used for one hour. [NEEP EMV Glossary]

Lifetime Energy Savings: The energy savings over the lifetime of an installed measure, calculated by multiplying the measure's annual energy usage reduction by its expected lifetime. [NEEP EMV Glossary, edited]

Measure Life: The length of time that a measure is expected to be functional. Measure Life is a function of: (1) *equipment life*—meaning the number of years that a measure is installed and will operate until failure; and (2) *measure persistence* which takes into account business turnover, early retirement of installed equipment, and other reasons that measures might be removed or discontinued. Measure Life is sometimes referred to as expected useful life (EUL). [adapted from NEEP EMV Glossary]

Meter-level Savings: Savings from energy-efficiency programs at the customer meter or premise level. [NEEP EMV Glossary, edited]

Net Present Value (NPV): Present value of benefits and costs that occur over the life of the measure taking the time value of money into account.

Net Savings: The savings attributable to an energy-efficiency program (which differs from gross savings because it includes the effects of free ridership and/or spillover rates).

Net-to-Gross Ratio (NTGR or NTG): The ratio of net savings to gross savings. The NTGR may be determined from the free ridership and spillover rates (NTGR=1-FR+SO), if available, or it may be a distinct value relating gross savings to the net effect of the program with no separate specification of FR and SO values. NTGR can be applied separately to either energy or demand savings.

Realization Rate (RR): The ratio of savings adjusted for data errors and for evaluated or verified results (verified) to initial estimates of project savings. RR_E (Energy Realization Rate) is applied to kWh and all fuels, while RR_D (Demand Realization Rate) is applied only to kW.

Seasonal Energy-efficiency Ratio (SEER): The total cooling output of a central AC unit in Btus (during its normal usage period for cooling) divided by the total electrical energy input in watt-hours during the same period, as determined using specified federal test procedures. [NEEP EMV Glossary]

Spillover (SO): Reductions in energy consumption and/or demand caused by the presence of an energy-efficiency program, beyond the program-related gross savings of the participants and without financial or technical assistance from the program. There can be participant and/or non-participant spillover. *Participant spillover* is the additional energy savings that occur when a program participant independently installs energy-efficiency measures or applies energy-saving practices in response to their participation in the efficiency program. *Non-participant spillover* refers to energy savings that occur when someone who did not participate in a program still installs energy-efficiency measures or applies energy savings practices as a result of a program's influence. [NEEP EMV Glossary, edited]

Spillover Rate (SO): Estimate of energy savings attributable to spillover effects expressed as a percent of savings installed by participants through an energy-efficiency program. [NEEP EMV Glossary]

Typical Meteorological Year 3: The TMY3s are data sets of hourly values of solar radiation and meteorological elements for a 1-year period published by the National Renewable Energy Laboratory. Their intended use is for computer simulations of solar energy conversion systems and building systems to facilitate performance comparisons of different system types, configurations, and locations in the United States and its territories. Because they represent typical rather than extreme conditions, they are not suited for designing systems to meet the worst-case conditions occurring at a location.

Waste Heat Factor (WHF): The interaction between a lighting measure's incidental heat output and installed HVAC systems.

Appendix B: Coincidence and Energy Period Factors

Coincidence factors are used to determine the average electric demand savings during the summer and winter on-peak periods as defined by the ISO-NE Forward Capacity Market (FCM). The on-peak demand periods are defined as follows:[715]

- **Summer On-Peak**: 1:00 to 5:00 PM on non-holiday weekdays in June, July and August.
- **Winter On-Peak**: 5:00 to 7:00 PM on non-holiday weekdays in December and January.

Energy period factors are used to allocate the annual energy savings into one of the four energy periods. This allocation is performed in order to apply the appropriate avoided cost values in the calculation of program benefits. The four energy periods are defined as follows:[716]

- **Winter Peak**: 7:00 AM to 11:00 PM on non-holiday weekdays during October through May (8 months).
- **Winter Off Peak**: 11:00 PM to 7:00 AM on non-holiday weekdays and all hours on weekends and holidays during October through May (8 months).
- **Summer Peak**: 7:00 AM to 11:00 PM on non-holiday weekdays during June through September (4 months).
- **Summer Off Peak**: 11:00 PM to 7:00 AM on non-holiday weekdays and all hours on weekends and holidays during June through September (4 months).

Table 10 includes a listing of measure coincidence factors and energy period allocations.

Table 10. Retail and Residential Coincidence Factors and Energy Period Factors

Measure Name	End-Use	Coincidence Factor (CF)		Energy Period Factors (EPF)				Footnote Reference	
		Winter On-Peak	Summer On-Peak	Winter Peak	Winter Off Peak	Summer Peak	Summer Off Peak	CF	EPF
LED Bulb – Retail	Lighting	18.5%	10.9%	37.0%	31.0%	17.1%	14.9%	717	718
LED Bulb – Food Pantry/Direct Install/Appliance Pack	Lighting	17.2%	7.3%	34.9%	33.5%	15.5%	16.1%	719	720
Refrigerator	Refrigeration	100.0%	100.0%	33.1%	33.5%	16.6%	16.8%	721	722

715 http://www.iso-ne.com/markets-operations/markets/demand-resources/about
716 http://www.efficiencymaine.com/docs/2015-AESC-Report-With-Appendices-Attached.pdf, p. 2-71.
717 Composite coincidence factors based on proportion of bulbs installed in residential and commercial settings. Demand Side Analytics, Retail and Distributor Lighting Impact Evaluation, March 2021.
718 Composite Energy Period Factors based on proportion of bulbs installed in residential and commercial settings. Demand Side Analytics, Retail and Distributor Lighting Impact Evaluation, March 2021.
719 Demand Side Analytics, Retail and Distributor Lighting Impact Evaluation, March 2021.
720 Ibid.
721 Peak coincidence factors for this measure are embedded in the evaluated peak demand impacts.

Measure Name	End-Use	Coincidence Factor (CF)		Energy Period Factors (EPF)				Footnote Reference	
		Winter On-Peak	Summer On-Peak	Winter Peak	Winter Off Peak	Summer Peak	Summer Off Peak	CF	EPF
Freezer	Refrigeration	100.0%	100.0%	33.1%	33.5%	16.6%	16.8%	721	723
Room AC	Cooling	0.0%	11.1%	0.7%	2.8%	53.3%	43.2%	724	
Room Air Purifier	Cooling	66.7%	66.7%	30.4%	36.2%	15.6%	17.9%	725	
Dehumidifier	Cooling	0.0%	37.1%	17.9%	15.5%	33.9%	32.7%	721	722
Dishwasher	Process	4.0%	2.2%	39.7%	26.8%	20.3%	13.1%		
Clothes Washer	Process	6.3%	4.8%	40.0%	26.6%	20.1%	13.3%	722	
Electric Water Heater	DHW	13.3%	9.6%	40.9%	25.7%	20.9%	12.5%	734	
Heat Pump Water Heater	DHW	100.0%	100.0%	35.8%	30.8%	17.9%	15.5%	721	722
Custom	Heating/Cooling	100.0%	100.0%	38.6%	54.1%	3.3%	4.0%	721	726
Air Sealing	Heating/Cooling	100.0%	100.0%	38.6%	54.1%	3.3%	4.0%	721	726
Insulation: Attic & Wall	Heating/Cooling	100.0%	100.0%	38.6%	54.1%	3.3%	4.0%	721	726
Insulation: Basement	Heating Only	100.0%	100.0%	39.4%	60.5%	0.0%	0.1%	721	726
Window Inserts	Heating Only	100.0%	100.0%	39.8%	56.1%	1.0%	3.1%	721	726
Air Sealing	Cooling Only*	0.0%	100.0%	2.8%	0.5%	66.6%	30.1%	721	726
Insulation: Attic & Wall	Cooling Only*	0.0%	100.0%	2.8%	0.5%	66.6%	30.1%	721	726
Insulation: Basement	Cooling Only*	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	727	
Air Sealing	H/C & C Only**	100.0%	100.0%	36.5%	51.1%	6.9%	5.5%	721	728
Insulation: Attic & Wall	H/C & C Only**	100.0%	100.0%	36.5%	51.1%	6.9%	5.5%		
Smart Thermostat	Heating/Cooling	100.0%	100.0%	38.6%	54.1%	3.3%	4.0%	729	
ECM: Hydronic Heating Smart Circulator Pump	Heating Only	49.5%	0%	39.8%	56.1%	1.0%	3.1%	730	
Duct Sealing and Insulation	Heating/Cooling	100.0%	100.0%	38.6%	54.1%	3.3%	4.0%	731	
Duct Sealing and Insulation	Cooling Only*	100.0%	100.0%	2.8%	0.5%	66.6%	30.1%		

[722] Memo provided to supplement NMR Group, Inc., Efficiency Maine Appliance Rebate Program Evaluation Overall Report – FINAL, July 18, 2014.
[723] Assumed to be the same as refrigerator measure.
[724] RLW Analytics, Coincidence Factor Study, Residential Room Air Conditioners, June 2008. Values are based on TMY2 weather for Portland, Maine.
[725] Values developed based on annual hours of use and equipment operating assumptions.
[726] Values developed based on the bin analysis calculations for insulation savings using typical annual hours in each weather bin during each energy period.
[727] Basement insulation does not impact cooling and therefore has no electric impact in a non-electrically heated home.
[728] Blend of heating and cooling and cooling only impacts based on the proportion of electric heating in Maine homes.
[729] Assumes same factors as air sealing.
[730] Assumes same factors as window inserts.
[731] Assumes same factors as air sealing.

Measure Name	End-Use	Coincidence Factor (CF)		Energy Period Factors (EPF)				Footnote Reference	
		Winter On-Peak	Summer On-Peak	Winter		Summer		CF	EPF
				Peak	Off Peak	Peak	Off Peak		
Ductless Heat Pump, blended baseline, 1st Unit, Tier 1	Heating/Cooling	100.0%	100.0%	36.7%	51.2%	6.7%	5.3%	732	
Ductless Heat Pump, blended baseline, 2st Unit, Tier 1	Heating/Cooling	100.0%	100.0%	38.1%	52.5%	5.1%	4.2%		
Ductless Heat Pump, blended baseline, 1st Unit, Tier 2	Heating/Cooling	100.0%	100.0%	37.8%	52.9%	4.8%	4.4%		
Ductless Heat Pump, blended baseline, 2st Unit, Tier 2	Heating/Cooling	100.0%	100.0%	38.2%	52.9%	4.8%	4.1%		
Ductless Heat Pump low income retrofit, blended baseline	Heating/Cooling	100.0%	100.0%	37.4%	52.7%	5.2%	4.6%		
Ductless Heat Pump low income retrofit, electric baseline	Heating/Cooling	100.0%	100.0%	39.8%	53.1%	2.9%	4.2%		
Whole Home Heat Pump	Heating/Cooling	100.0%	100.0%	38.3%	56.1%	2.9%	2.7%		
Central Air-source Heat Pump (Ducted)	Heating/Cooling	50.0%	25.0%	38.5%	54.1%	3.3%	4.0%	733	726
Central Geothermal (Ground Source) Heat Pump	Heating/Cooling	79.6%	10.2%	38.5%	54.1%	3.3%	4.0%	721	726
Low-flow Kitchen Aerator	DHW	100%	100%	39.7%	26.8%	20.3%	13.1%	734	
Low-flow Bathroom Aerator	DHW	100%	100%	39.7%	26.8%	20.3%	13.1%	734	
Low-flow Showerhead	DHW	100%	100%	35.5%	31.1%	18.1%	15.3%	734	
Thermostatic Shower Valve	DHW	100%	100%	35.5%	31.1%	18.1%	15.3%	734	
DHW Temperature Turn-Down	DHW	100%	100%	40.9%	25.7%	20.9%	12.5%	734	
DHW Pipe Insulation	DHW	100.0%	100.0%	30.4%	36.2%	15.6%	17.9%	725	
DHW Wrap	DHW	100.0%	100.0%	30.4%	36.2%	15.6%	17.9%	725	

[732] Values developed based on the bin analysis calculations for DHP savings using typical annual hours in each weather bin during each demand and energy period.
[733] MA TRM 2013 TRM 2010, Air-source heat pump peak coincidence factor.
[734] Values developed based on residential hot water usage profiles from: Aquacraft, Inc., The End Uses of Hot Water in Single Family Homes from Flow Trace Analysis. Peak coincidence factors for these measures are embedded in peak demand impacts.

Measure Name	End-Use	Coincidence Factor (CF)		Energy Period Factors (EPF)				Footnote Reference	
		Winter On-Peak	Summer On-Peak	Winter		Summer		CF	EPF
				Peak	Off Peak	Peak	Off Peak		
Low-income Multifamily Gas Heat, Furnaces and Boilers (NC/Retrofit), Pellet/Wood Stove, Pellet Boiler, Hydronic Heating Pipe Insulation, On Demand Natural Gas Water Heater***	Heating, DHW	NA	NA	NA	NA	NA	NA	NA	NA
Electric Vehicle – BEV	Transportation	100%	100%	0.52	0.25	0.05	0.18	735	736
Electric Vehicle – PHEV	Transportation	100%	100%	0.01	0.56	0.04	0.39		

*Cooling only factors apply for insulation and air sealing installed in a non-electrically heated home where only the reductions in cooling load results in electric savings. CF and EPF do not apply to the non-electric fuel savings. AHI factor schedule in effRT assumes cooling only for air sealing, attic insulation and wall insulation as projects are expected to be completed in non-electrically heated homes. Because basement insulation and window inserts have no cooling savings, heating only energy period factors are used in the AHI factor schedule since the only projects that would have electric savings would be for electrically heated homes.

**H/C & C Only is a blend of heating and cooling factors and cooling only factors based on the distribution of heating fuel defined in Table 15 for air sealing and insulation. HESP factor schedule in effRT uses the H/C & C Only factors for air sealing, attic insulation and wall insulation measures. Because basement insulation has no cooling savings, heating only energy period factors are used in the HESP factor schedule as electricity savings are for heating only.

***Coincidence Factor and Energy Period Factors are not applicable for fossil-fuel measures, as avoided costs for fossil fuels do not account for time-of-use.

[735] Peak impacts are estimated directly. See deemed demand values.

[736] Derived from EV charger meter data, Convergence Data Analytics, 2021 Electric Charging in Maine

Appendix C: Carbon Dioxide Emission Factors

Table 11. Carbon Dioxide Emission Factors[737]

Carbon Dioxide (CO_2) Factors:	Pounds CO2 Per Unit of Volume or Mass		Kilograms CO2 Per Unit of Volume or Mass		Pounds CO2 Per Million Btu	Kilograms CO2 Per Million Btu
For homes and businesses						
Propane	12.68	gallon	5.75	gallon	138.63	62.88
Diesel and Home Heating Fuel (Distillate Fuel Oil)	22.46	gallon	10.19	gallon	163.45	74.14
Kerosene	21.78	gallon	9.88	gallon	161.35	73.19
Coal (All types)	4,027.93	short ton	1,827.04	short ton	211.06	95.74
Natural Gas	120.96	thousand cubic feet	54.87	thousand cubic feet	116.65	52.91
Gasoline	19.37	gallon	8.78	gallon	155.77	70.66
Residual Heating Fuel (Businesses only)	24.78	gallon	11.24	gallon	165.55	75.09
Other fuels						
Municipal Solid Waste	5,771.04	short ton	2,617.70	short ton	91.90	41.69
Tire-derived fuel	5,961.03	short ton	2,703.88	short ton	189.54	85.97
Waste oil	22.51	gallon	10.21	gallon	163.14	74.00
Carbon Dioxide (CO2) Factors:					**Pounds CO2 Per kWh**	**Kilograms CO2 Per kWh**
Electricity[738]					0.706	0.32

[737] U.S. Energy Information Administration - EIA - Independent Statistics and Analysis

[738]Table 5-3 Time-Weighted Marginal Emission Rate - All LMUs, Annual Average (All Hours), https://www.iso-ne.com/static-assets/documents/2022/05/2020_air_emissions_report.pdf

Appendix D: Retail Lighting EISA History

Lighting savings changed dramatically between 2011 and 2015 as a result of the Energy Independence and Security Act of 2007 (EISA). The following tables outline key assumptions and calculations that changed during that time. This appendix is for historical reference only and is no longer updated.

Table 12. Retail Lighting Program: Baseline Wattages and CFL Wattages

Bulb Type	Lumen Bin	Proportion of Total Bulb Sales	Average CFL Wattage	Baseline Wattage (2011)
Standard	3301-4815	0.01%	55.00	200
Standard	2601-3300	0.09%	41.59	150
Standard	1490-2600	8.46%	24.51	100
Standard	1050-1489	3.35%	19.52	75
Standard	750-1049	78.72%	13.41	60
Standard	310-749	4.35%	9.51	40
Standard	0-309	0.02%	5.00	25
Specialty	3301-4815	0.01%	65.00	200
Specialty	1490-2600	0.65%	26.47	100
Specialty	1050-1489	0.23%	19.61	75
Specialty	750-1049	2.27%	14.50	60
Specialty	310-749	0.72%	10.08	40
Giveaway	1490-2600	1.13%	23.00	100
Weighted Average	N/A	100%	14.62	63.71

Table 13 describes the adjustments to baseline starting in 2012 due to the changing maximum wattages specified in EISA.

Table 13. EISA Adjustments by Lumen Range (Evaluation, Table 25)[739]

Lumen Range	Assumed Original Baseline	New Maximum Wattage	Effective Date
310-749	40	29	2014
750-1049	60	43	2014
1050-1489	75	53	2013
1490-2600	100	72	2012

Table 14 shows the changes in the weighted average baseline wattage resulting from the EISA requirements becoming effective from 2011 through 2014. Weighted average wattage for CFL and LED bulbs are presented for 2011 and 2014 along with the resulting percentage change in savings compared to 2011 based on EISA impacts.

Table 14. EISA Adjusted Weighted Average Baseline Wattage by Year

Year	Program Year (7/1/(YY-1)-6/30/YY)	EISA Adjusted Weighted Average Baseline Wattage	Weighted Average CFL Wattage	Delta Watts	Weighted Average LED Wattage	Delta Watts
2011	2012	63.71	14.62	49.09	13	50.71
2012	2013	61.03	14.62	46.41	13	48.03
2013	2014	60.29	14.62	45.67	13	47.29
2014	2015	46.43	14.62	31.81	12	34.43

[739] The Cadmus Group, Efficiency Maine Trust Residential Lighting Program Evaluation, November 1, 2012, Table 25.

Appendix E: Standard Assumptions for Maine

Table 15. Distribution of Heating Fuel for Maine Residential Customers

Measure	Fuel Distribution for "Unknown"							Footnote Reference
	Natural Gas	Propane	Oil	Kerosene	Wood	Electric	Heat Pump	
Boiler & Furnace	0%	77.9%	22.1%	0.0%	0.0%	0.0%	0.0%	740
Heat Pumps – Low Income	0%	6%	79%	6%	7%	2%	0%	741
Heat Pumps – non-Low Income	6%	20%	43%	2%	25%	4%	0%	742
Air Sealing, Window Inserts, Insulation	10%	15%	61%	1%	2%	11%[743]	0%	744
Underbelly Insulation	0%	7.6%	83.8%	7.6%	0%	1.0%	0%	745
Smart Thermostat	17.4%	11.9%	65.4%	1.6%	0.0%	3.7%	0.0%	746
Hydronic Pipe Insulation	37.3%	48.3%	14.4%	0.0%	0.0%	0.0%	0.0%	747
Duct Sealing/ Insulation	53.2%	38.0%	8.8%	0.0%	0.0%	0.0%	0.0%	748
Water Heating	5.0%	5.0%	60.0%	0.0%	0.0%	25.0%	5.0%	749
Lighting	7.2%	7.5%	65.9%	1.5%	13.5%	4.4%	Included	750

[740] Weighted average of provided Boiler and Furnace fuel types from HESP projects completed between 7/1/2017 and 4/30/2018 excluding natural gas. Natural gas is excluded because higher incentives drive 100% identification of natural gas projects.
[741] Weighted average of provided fuel types from AHI HP projects completed between 7/1/2020 and 6/31/2021.
[742] Heat Pump Survey data collected May 2020 through April 2021 on what additional heating sources were used in conjunction with the HP.
[743] "Electric" does not distinguish between electric resistant and electrically driven heat pumps.
[744] Weighted average of provided fuel types from HESP air sealing and insulation projects completed between 7/1/2020 and 6/30/2021
[745] Fuel mix from inactive Mobile Home Underbelly (Component of LUB) measure with Natural Gas and Wood removed to represent more accurate fuel distribution of mobile homes in Maine.
[746] Weighted average of provided fuel types from HESP air sealing and insulation projects completed between 7/1/2017 and 4/30/2018 excluding wood. Wood is excluded because most heating systems that rely on wood do not use a central thermostat.
[747] Provided Boiler fuel types from HESP projects completed between 7/1/2017 and 4/30/2018.
[748] Provided Furnace fuel types from HESP projects completed between 7/1/2017 and 4/30/2018.
[749] NMR, 2015 Residential Baseline Study

Interactive Effects - Residential							in Electric	
Lighting Interactive Effects – Retail	9.2%	7.7%	64.1%	1.5%	13.3%	4.2%		

[750] Derived from NMR, 2015 Residential Baseline Study based on primary heating system and Demand Side Analytics, Retail and Distributor Lighting Impact Evaluation, March 2021.

Table 16. Minimum Efficiency Requirements for Furnaces and Boilers[751]

Equipment Category	Equipment Type	Federal Code Minimum (AFUE)
Furnaces	Non-weatherized gas furnaces (not including mobile home furnaces)*	80%
	Mobile home gas furnaces	80%
	Non-weatherized oil-fired furnaces (not including mobile home furnaces)*	83%
	Mobile home oil-fired furnaces	75%
	Weatherized gas furnaces	81%
	Weatherized oil-fired furnaces	78%
	Electric furnaces	78%
Boilers	Gas-fired hot water boiler*	82%
	Gas-fired steam boiler	80%
	Oil-fired hot water boiler*	84%
	Oil-fired steam boiler	82%
	Electric hot water boiler	None
* For the TRM, the highlighted equipment types have been selected as representative of the systems installed under the program. Gas entries are used for Natural Gas and Propane systems, Oil-fired are used for Oil and Kerosene systems.		

[751] Code of Federal Regulations: http://www.ecfr.gov/cgi-bin/text-idx?c=ecfr&sid=61b33caa9460da7b2e875b478972dfdc&rgn=div6&view=text&node=10:3.0.1.4.18.3&idno=10

Appendix F: Supplementary Information for Retail Products

Using the values in the IL TRM v.4.0 2015,[752] and quantities from the FY2014 Efficiency Maine Program by type yields a value of 509.7 kWh for baseline units after the September 2014 federal standard change (as detailed in Table 17 below).

Table 17. Weighted Average Refrigerator Energy Use

IL TRM v.4.0 2015 for refrigerators after September 2014 federal standard change	**FY2014 Maine Quantity**	**Baseline Unit**	**New Efficient ENERGY STAR®**
1. Refrigerators and Refrigerator-freezers with manual defrost	0	368.6	331.6
2. Refrigerator-Freezer--partial automatic defrost	1480	430.9	387.8
3. Refrigerator-Freezers--automatic defrost with top-mounted freezer without through-the-door ice service and all-refrigerators--automatic defrost	3174	441.7	397.4
4. Refrigerator-Freezers--automatic defrost with side-mounted freezer without through-the-door ice service	16	517.1	465.4
5. Refrigerator-Freezers--automatic defrost with bottom-mounted freezer without through-the-door ice service	2357	545.1	490.7
5A Refrigerator-freezer—automatic defrost with bottom-mounted freezer with through-the-door ice service	1214	713.8	651
6. Refrigerator-Freezers--automatic defrost with top-mounted freezer with through-the-door ice service	0	601.9	550.1
7. Refrigerator-Freezers--automatic defrost with side-mounted freezer with through-the-door ice service	9	652.9	596.1
Total	8250		

	Weighted Average.:	**509.7**	**460.0**

[752] Illinois Statewide Technical Reference Manual for Energy Efficiency Version 4.0 Final, February 24, 2015, p. 508.

Table 18. Baseline Bulb Replacement Schedule and Avoided O&M

Commercial Hours/Year	Residential Hours/Year	Real Discount Rate
3771	730	2.80%

	Retail		Residential	
Life Category	>20,000 hr	<20,000 hr	>20,000 hr	< 20,000 hr
Rated Hours	25,000	15,000	25,000	15,000
% Commercial	4%	4%	0%	0%
Hours/Year	851.64	851.64	730	730
Rated Life (Years)	29	18	34	21
Baseline Rated Hours	2000	2000	2000	2000
Baseline Rated Life (Years)	2.35	2.35	2.74	2.74
Baseline bulbs per EE life	11	7	11	7
Check	11	7	11	7
NPV of Bulbs	7.25	5.43	6.99	5.11

Baseline Replacement Schedule: Number of Bulbs Replaced per year				
Year	RetL	RetS	ResL	ResS
1	0	0	0	0
2	1	1	0	0
3	0	0	1	1
4	0	0	0	0
5	1	1	0	0
6	0	0	1	1
7	0	1	0	0
8	1	0	0	0
9	0	1	1	1
10	0	0	0	0
11	1	0	0	0
12	0	1	1	1
13	0	0	0	0
14	1	0	0	0
15	0	1	1	1
16	0	0	0	0
17	1	1	0	0
18	0	0	1	1
19	0		0	0
20	1		1	1
21	0		0	0
22	1		0	
23	0		1	
24	1		0	
25	0		0	
26	1		1	
27	0		0	
28	1		0	
29	0		1	
30			0	
31			0	
32			1	
33			0	
34			0	

Interactive Effects Derivation

More efficient lighting provides the same amount of lumens with fewer watts. Halogen and incandescent bulbs generate a lot of heat in addition to light. The wattage that produces heat rather than light is referred to as waste heat. When cooling is called for, the waste heat generated by inefficient lights requires the cooling system to work harder. By replacing inefficient lights with efficient lights less waste heat is produced which reduces the load on the cooling system. The magnitude of the reduced cooling load is proportional to the magnitude of the wattage reduction of the lights. Conversely, when heating is called for, the reduction in waste heat from the replacement of inefficient lights with efficient lights increases the load on the heating system. To calculate the interactive factors several factors must be considered as define below.

Factors included in the calculation of Interactive Effects Factors:

IGC = Internal Gain Contribution (%) – This factor accounts for some portion of the wattage reduction not contributing to the interactive effects. Some waste heat escapes through ceiling and wall penetrations without contributing to internal gains that affect the load on HVAC systems.

%A = Applicability (%) – Interactive effects are only applicable if the waste heat reduction interacts with a HVAC system. Lights installed in unconditioned spaces do not contribute to interactive effects. Applicability is calculated as the product of % of bulbs installed in interior sockets and the % of buildings with mechanical cooling. (%A = %I*%A/C)

C_{HVAC} = Concurrency with Heating/Cooling – Waste heat only impacts HVAC systems when the lights and the systems are on concurrently. Cooling interactive effects only occur during the cooling season and heating interactive effects only occur during the heating season.

Eff_{HVAC} = Efficiency of the HVAC system – The change in consumption of the HVAC system is determined by the efficiency of the system.

Cooling Demand Interactive Effects Factor

The following formula is used to calculate the cooling demand interactive effects factor. Total demand reduction is calculated by multiplying the demand reduction from the lighting change by the cooling demand factor. The values used in the formula are defined in the table below.

$$IE_{COOL\_D} = 1 + \frac{IGC \times \%A \times C_{HVAC}}{Eff_{HVAC}}$$

Cooling Energy Interactive Effects Factor

The following formula is used to calculate the cooling energy interactive effects factor. Total energy savings is calculated by multiplying the energy savings from the lighting change by the cooling energy factor. The values used in the formula are defined in the table below.

$$IE_{COOL\_E} = 1 + \frac{IGC \times \%A \times C_{HVAC}}{Eff_{HVAC}}$$

Heating Energy Interactive Effects Factor

The following formula is used to calculate the heating energy interactive effects factor. Heating energy increased used (in MMBtu) is calculated by multiplying the energy savings from the lighting change (in kWh) by the heating energy factor. The values used in the formula are defined in the table below.

$$IE_{HEAT\_E} = \frac{IGC \times \%A \times C_{HVAC}}{Eff_{HVAC}} \times 0.003412\ MMBtu/kWh$$

Table 19. Interactive Effects Input Factors and resulting IE Factors

Input Factors		IGC		%A		C_{HVAC}		Eff_{HVAC}		Interactive Effects Factor	
		Value	Note	Value	Note	Value	Note	Value	Note	Term	Value
Residential	Cooling Demand	60%	753	45.6%	754	100.0%	755	400%	756	IE_{COOL_D}	1.068
Residential	Cooling Energy	60%	753	45.6%	754	25.0%	757	400%	756	IE_{COOL_E}	1.017
Residential	Heating	60%	753	86.0%	758	50.0%	759	80.5%	760	IE_{HEAT_E}	0.00109
Commercial Interior Non-Bay	Cooling Demand	60%	753	77.0%	761	100.0%	755	400%	756	IE_{COOL_D}	1.116
Commercial Interior Non-Bay	Cooling Energy	60%	753	77.0%	761	41.7%	762	400%	756	IE_{COOL_E}	1.048
Commercial Interior Non-Bay	Heating	60%	753	100.0%	763	50.0%	759	80.5%	760	IE_{HEAT_E}	0.00127
Commercial Interior Bay	Cooling Demand	40%	753	77.0%	761	100.0%	755	400%	756	IE_{COOL_D}	1.077
Commercial Interior Bay	Cooling Energy	40%	753	77.0%	761	41.7%	762	400%	756	IE_{COOL_E}	1.032
Commercial Interior Bay	Heating	40%	753	100.0%	763	50.0%	759	80.5%	760	IE_{HEAT_E}	0.00085
For Retail and Distributor programs, the interactive effect factors are calculated based on the portion of bulbs installed in residential and commercial settings											
Retail	Cooling Demand	Residential %		96%		Commercial Interior Non-Bay %		4%		IE_{COOL_D}	1.070
Retail	Cooling Energy	Residential %		96%		Commercial Interior Non-Bay %		4%		IE_{COOL_E}	1.018
Retail	Heating	Residential %		96%		Commercial Interior Non-Bay %		4%		IE_{HEAT_E}	0.00110
Distributor	Cooling Demand	Residential %		31%		Commercial Interior Non-Bay %		69%		IE_{COOL_D}	1.101
Distributor	Cooling Energy	Residential %		31%		Commercial Interior Non-Bay %		69%		IE_{COOL_E}	1.039
Distributor	Heating	Residential %		31%		Commercial Interior Non-Bay %		69%		IE_{HEAT_E}	0.00122

[753] Based on engineering judgment informed by findings in Chantrasrisalai, C., and D.E. Fisher. 2007. Lighting heat gain parameters: Experimental results. HVAC&R Research 13(2):305-324.

[754] Per 2015 Maine Residential Baseline Study, 86% of bulbs are installed in locations that are conditioned. According to Portland Press Herald, http://www.pressherald.com/2014/05/26/put_power_rates_on_ice__that_s_a_cool_idea_/, in 2010, an estimated 79 percent of customers in ISO-New England region had room air conditioners. Of the 79 percent, 40 percent of homes have equivalent of whole home A/C (3 window A/Cs); 39 percent of homes have total cooling capacity equivalent of 1 or 2 window A/C units. The remaining 21percent have no cooling equipment installed. Assuming that a window A/C unit cools 1/3 of a home that works out to be 53% of residential homes are mechanical cooled. (%A = 46% = 86%*53%)

[755] Maximum demand reduction occurs when lights and cooling systems are on concurrently. Coincidence factors are then applied to determine coincidence with peak hours.

[756] Cooling equipment efficiency is assumed to be 400% based on a SEER of 14 which is the current federal minimum efficiency standard.

[757] Cooling season is assumed to be 3 months for residential applications. (3/12 = 25%)

[758] Per 2015 Maine Residential Baseline Study 86% of bulbs are installed in locations that are conditioned. 100% of residences are heated. (%A = 86% = 86%*100%)

[759] Heating season is assumed to be 6 months. (6/12=50%)

[760] Per 2015 Maine Residential Baseline Study, the average heating system efficiency is 80.5%. It is assumed that commercial heating systems have a similar average efficiency.

[761] For commercial applications, it is assumed that all bulbs are installed in interior sockets. The C&I Prescriptive program tracks exterior lights separately and interactive effect factors are not applied to those measures. Based on the cooling system type saturation in the 2012 EMT Baseline Opportunities Study and assuming that window unit A/C cools 1/3 of the conditioned space, 77% of commercial space is mechanically cooled in Maine. (%A = 77% = 100%*53%)

[762] Cooling season is assumed to be 5 months for commercial applications due to higher internal gains. (5/12=42%)

[763] For commercial applications, it is assumed that all bulbs are installed in interior sockets. The C&I Prescriptive program tracks exterior lights separately and interactive effect factors are not applied to those measures. It is assumed that 100% of commercial spaces are heated. (%A = 100% = 100%*100%)