Retail/Residential

Technical Reference Manual

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Introduction

PURPOSE

The Efficiency Maine Trust Residential/Retail, Commercial 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 (ΔkWh/yr (electricity) and ΔMMBtu/yr (natural gas and other fuels)) and gross max demand (ΔkW) 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:

Adjusted Gross Annual kWh = ΔkWh/yr × ISR × RR_E

Adjusted Gross Lifetime kWh = ΔkWh/yr × ISR × RR_E × Measure Life

Adjusted Gross Annual MMBtu[4] = ΔMMBtu/yr × ISR × RR_E

Adjusted Gross Lifetime MMBtu[4] = ΔMMBtu/yr × ISR × RR_E × Measure Life

Adjusted Gross Summer On-Peak kW = ΔkW × ISR × RR_D × CF_S

Adjusted Gross Winter On-Peak kW = ΔkW × ISR × RR_D × 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.

Net Annual kWh = ΔkWh/yr × ISR × RR_E × (1 – FR + SO)

Net Lifetime kWh = ΔkWh/yr × ISR × RR_E × (1 – FR + SO) × Measure Life

Net Summer On-Peak kW = ΔkW × ISR × RR_D × CF_S × (1 – FR + SO)

Net Winter On-Peak kW = ΔkW × ISR × RR_D × CF_W × (1 – FR + 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
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

Change Type	TRM Section	Description	Effective Date	effRT update
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
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

Change Type	TRM Section	Description	Effective Date	effRT update
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
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

Change Type	TRM Section	Description	Effective Date	effRT update
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
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

Change Type	TRM Section	Description	Effective Date	effRT update
Revision	Insulation measures	Separate free-ridership rate added for Low-income Home Energy Savings Program (LIHESP)	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
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

Change Type	TRM Section	Description	Effective Date	effRT update
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
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

Change Type	TRM Section	Description	Effective Date	effRT update
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
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

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.

Consumer Products

CFL Bulb – Food Pantry & Appliance Packs (Inactive) (CFLFP, CFLAPP)	
Last Revised Date	3/1/2016 (retroactive to 1/1/2016)
MEASURE OVERVIEW	
Description	ENERGY STAR® Compact Fluorescent Lamps (CFLs). This measure involves giving away CFL bulbs to participants at food pantries and appliance rebate participants that opt-in. Bulbs distributed offset future purchase of inefficient bulbs (incandescent or halogen). ENERGY STAR® key efficiency criteria require that CFLs provide three times more lumens per watt than incandescent bulbs.[5]
Primary Energy Impact	Electric
Sector	Residential
Program(s)	Food Pantry Lighting Program, Appliance Rebate Program
End-Use	Lighting
Decision Type	New Construction, Replace on Burnout
DEEMED GROSS ENERGY SAVINGS (UNIT SAVINGS)	
Electric Demand savings	Δ kW = 0.038 ΔkW_{WP} = 0.00588 ΔkW_{SP} = 0.00446
Annual Energy Savings	ΔkWh/yr = 26 $\Delta MMBtu/yr_{GAS}$ = -0.004 $\Delta MMBtu/yr_{OIL}$ = -0.032 $\Delta MMBtu/yr_{WOOD}$ = -0.006 $\Delta MMBtu/yr_{PROP}$ = -0.003 $\Delta MMBtu/yr_{KERO}$ =-0.003 $\Delta MMBtu/yr_{ELEC}$ = -0.0004 = -0.114 kWh/yr $\Delta MMBtu/yr_{net}$ = 0.041
GROSS ENERGY SAVINGS ALGORITHMS (UNIT SAVINGS)	
Demand savings	$\Delta kW = \Delta Watt_{CFL} / 1{,}000 \times IE_{COOL\_D}$ $\Delta kW_{SP} = \Delta Watt_{CFL} / 1{,}000 \times CF_S \times IE_{COOL\_D}$ $\Delta kW_{WP} = \Delta Watt_{CFL} / 1{,}000 \times CF_W$
Annual energy savings	$\Delta kWh/yr = \Delta Watt_{CFL} / 1{,}000 \times [365 \times HPD_{RES} \times \%RES + HPY_{COMM} \times \%COMM] \times IE_{COOL\_E}$ $\Delta MMBtu/yr = -\Delta Watt_{CFL} / 1{,}000 \times [365 \times HPD_{RES} \times \%RES + HPY_{COMM} \times \%COMM] \times IE_{HEAT\_E}$ $\Delta MMBtu/yr_{FUEL} = \Delta MMBtu/yr \times \%FUEL$
Definitions	Unit = 1 bulb $\Delta Watt_{CFL}$ = Average wattage difference between baseline bulbs and program CFLs (W) 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 sockets (%) HPY_{COMM} = Average annual operating hours in commercial setting (hrs/yr) %COMM = Share of bulb purchases that are installed in commercial sockets (%) 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 excluding coal and other[6]
EFFICIENCY ASSUMPTIONS	
Baseline Efficiency	Incandescent/Halogen bulb
Efficient Measure	CFL

[5] ENERGY STAR® CFL Key Performance Requirements: http://www.energystar.gov/index.cfm?c=cfls.pr_crit_cfls

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

<table>
<tr><th colspan="9">CFL Bulb – Food Pantry & Appliance Packs (Inactive) (CFLFP, CFLAPP)</th></tr>
<tr><td colspan="9">PARAMETER VALUES (DEEMED)</td></tr>
<tr><td>Measure</td><td>$\Delta Watt_{CFL}$</td><td>HPD_{RES}</td><td>HPY_{COMM}</td><td>%RES</td><td>%COMM</td><td>Life (yrs)</td><td colspan="2">Cost ($)</td></tr>
<tr><td>CFL Bulb</td><td>35[7]</td><td>2[8]</td><td>3,772[9]</td><td>100%[10]</td><td>0%[10]</td><td>7[11]</td><td colspan="2">1.25[12]</td></tr>
<tr><td></td><td>IE_{COOL_D}</td><td>IE_{COOL_E}</td><td>IE_{HEAT_E}</td><td>%FUEL</td><td colspan="2">Avoided O&M ($)</td><td colspan="2"></td></tr>
<tr><td>CFL Bulb</td><td>1.08[13]</td><td>1.03[13]</td><td>0.0019[14]</td><td>Table E-1</td><td colspan="2">5.39[15]</td><td colspan="2"></td></tr>
<tr><td colspan="9">IMPACT FACTORS</td></tr>
<tr><td>Measure</td><td>ISR</td><td>RR_E</td><td>RR_D</td><td>CF_S</td><td>CF_W</td><td colspan="2">FR</td><td>SO</td></tr>
<tr><td>Food Pantry</td><td rowspan="2">99%[16]</td><td rowspan="2">100%[17]</td><td rowspan="2">100%[18]</td><td rowspan="2">11.8%[19]</td><td rowspan="2">16.8%[20]</td><td colspan="2">0%[21]</td><td rowspan="2">0%[21]</td></tr>
<tr><td>Appliance Pack</td><td colspan="2">21%[22]</td></tr>
</table>

[7] CLEAResult Wattage Report 7/1/2014-3/31/2015, weighted average for 13 and 23 watt standard bulbs distributed to food pantry and appliance packs.

[8] NMR Group, Efficiency Maine Retail Lighting Program Overall Evaluation Report, April 16, 2015, p. 16.

[9] Average annual hours of use for commercial spaces. Efficiency Maine Commercial Technical Reference Manual Version 2015.1 Table 33.

[10] Food pantry participants assumed to be residential consumers installing bulbs in homes. Commercial participation in Appliance Rebate Program is less than 3%; assume that only residential participants opt for bulb packs.

[11] Although CFL bulbs have a predicted useful life of 14 years based on rated lifetime of 10,000, measure life has been defined as 7 years to account for more stringent EISA standards that take effect January 1, 2020. Because savings will be reduced after 2020, the reduced measure life represents an equivalent life that results in the same net present value (NPV) benefits as the full life of the measure with the post-2020 savings reduction.

[12] Cost values based on personal communication with Stan Mertz based on industry estimates.

[13] Derived from the following reports: NMR Group, Inc., "Connecticut Residential Lighting Interactive Effects Memo," submitted to the Connecticut Energy Efficiency Board, October 27, 2014; New York Department of Public Service, *New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs*, October 15, 2010; Efficiency Vermont 2013 Technical Reference User Manual--Measure Savings Algorithms and Cost Assumptions, August 9, 2013, p. 367; Minnesota Department of Commerce, *State of Minnesota Technical Reference Manual for Energy Conservation Improvement Programs, Version 1*, 2014; and analysis performed by Cadmus June 2015, based on 2015 NY TRM, Appendix D--HVAC Interactive Effects Multipliers.

[14] NMR Group, Inc., "Connecticut Residential Lighting Interactive Effects Memo," submitted to the Connecticut Energy Efficiency Board October 27, 2014.

[15] 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 $1.00 avoided replacement cost every 2 years for 13 years starting in year 2 and real discount rate of 2.43%. No labor costs have been included. Replacement cost values based on personal communication with Stan Mertz based on industry estimates. Real discount rate based on Avoided Energy Supply Costs in New England: 2015 Report, April 3, 2015.

[16] ISR equals the evaluated long term in-service rate from NMR Group, Efficiency Maine Retail Lighting Program Overall Evaluation Report, April 16, 2015, p. 14.

[17] Realization rates are 100 percent since savings estimates are based on evaluation results.

[18] Realization rates are 100 percent since savings estimates are based on evaluation results.

[19] NMR Group, Efficiency Maine Retail Lighting Program Overall Evaluation Report, April 16, 2015, p. 19.

[20] Ibid.

[21] NMR Group, Efficiency Maine Retail Lighting Program Overall Evaluation Report, April 16, 2015, p. 24.

[22] Free ridership of appliance pack recipients is assumed to be the same as for retail CFLs. NMR Group, Efficiency Maine Retail Lighting Program Overall Evaluation Report, April 16, 2015, p. 24.

Standard LED (Light Emitting Diode) Bulb – Retail (LEDSTDLL, LEDSTDSL, LEDSTDP)	
Last Revised Date	7/1/2017
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 excluding coal and other[23]
EFFICIENCY ASSUMPTIONS	
Baseline Efficiency	Halogen bulb
Efficient Measure	LED bulb

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

Standard LED (Light Emitting Diode) Bulb – Retail (LEDSTDLL, LEDSTDSL, LEDSTDP)							
PARAMETER VALUES (DEEMED)							
Measure	$\Delta Watts_{LED}$	HPD_{RES}	HPY_{COMM}	%RES	%COMM	Life (yrs)	Cost ($)
LED Bulb	Table 1	2[24]	3,772[25]	96%[26]	4%[27]	≥20,000 hr: 9[28] <20,000 hr: 7[29]	Table 2
	IE_{COOL_D}	IE_{COOL_E}	IE_{HEAT_E}	%FUEL	Avoided O&M ($)		
LED Bulb	1.087[30]	1.023[31]	0.00138[32]	Table E-1	Table 2		

IMPACT FACTORS							
Measure	ISR	RR_E	RR_D	CF_S	CF_W	FR	SO
LED Bulb	99%[33]	100%[34]	100%[35]	14.4%[36]	18.6%[37]	Table 2	0%[38]

[24] NMR Group, Efficiency Maine Retail Lighting Program Overall Evaluation Report, April 16, 2015, p. 16.
[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] Although long-life LEDs have a useful life of 29 years based on rated lifetime of 25,000 hours, an equivalent measure life has been defined to account for dual baselines (full savings prior to 7/1/2020 and reduced savings post 7/1/2020 when more stringent EISA standards that take effect 1 January 2020 assuming a 6 month sell through).
[29] Ibid with useful life of 18 years based on rated lifetime of 15,000 hours.
[30] 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.
[31] Ibid.
[32] Ibid.
[33] ISR is based on long term In-Service Rate from NMR Group, Efficiency Maine Retail Lighting Program Overall Evaluation Report, April 16, 2015, p. 14. It is assumed that storage habits are the same for standard efficiency bulbs as LED therefore the equivalent measure life is based on the long term in-service rate.
[34] Realization rates are 100 percent since savings estimates are based on evaluation results.
[35] Ibid.
[36] Composite summer coincidence factor: 96 percent of bulbs in residential sockets with summer CF at 11.8 percent (NMR Group, Efficiency Maine Retail Lighting Program Overall Evaluation Report, April 16, 2015, p. 19) and 4 percent of bulbs in commercial sockets with summer CF at 76 percent (Efficiency Maine Trust Commercial TRM, July 1, 2013).
[37] Composite winter CF: 96 percent of bulbs in residential sockets with winter CF at 16.8 percent (NMR Group, Efficiency Maine Retail Lighting Program Overall Evaluation Report, April 16, 2015, p. 19) and 4 percent of bulbs in commercial sockets with winter CF at 63 percent (Efficiency Maine Trust Commercial TRM, July 1, 2013).
[38] Ibid.

Specialty LED Bulb – Retail (LEDSPCRFL, LEDSPCRFS, LEDSPCOL, LEDSPCOS, LEDSPCCDL, LEDSPCCDS)							
Last Revised Date	4/1/2017 (effective 5/1/2017)						
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 excluding coal and other[39]						
EFFICIENCY ASSUMPTIONS							
Baseline Efficiency	Incandescent						
Efficient Measure	LED bulb						
PARAMETER VALUES (DEEMED)							
Measure	$\Delta Watts_{LED}$	HPD_{RES}	HPY_{COMM}	%RES	%COMM	Life (yrs)	Cost ($)
LED Bulb	Table 1	2[40]	3,772[41]	96%[42]	4%[43]	≥20,000 hr: 25[44] <20,000 hr: 18[45]	Table 2
	IE_{COOL_D}	IE_{COOL_E}	IE_{HEAT_E}	%FUEL	Avoided O&M ($)		
LED Bulb	1.087[46]	1.023[47]	0.00138[48]	Table E-1	Table 2		

[39] Heating fuel distribution is used to allocate savings to different fuels because the interactive effects impact the home's heating energy consumption.
[40] NMR Group, Efficiency Maine Retail Lighting Program Overall Evaluation Report, April 16, 2015, p.16.
[41] Average annual hours of use for commercial spaces. Efficiency Maine Commercial Technical Reference Manual Version 2015.1, Table 33.
[42] The Cadmus Group, Efficiency Maine Trust Residential Lighting Program Evaluation, November 1, 2012, p. 71.
[43] Ibid.
[44] Although LEDs have a useful life of 29 years based on rated lifetime of 25,000 hours, measure life has been capped at 25 years.
[45] Based on rated lifetime of 15,000 hours.
[46] 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.
[47] Ibid.

Specialty LED Bulb – Retail (LEDSPCRFL, LEDSPCRFS, LEDSPCOL, LEDSPCOS, LEDSPCCDL, LEDSPCCDS)							
IMPACT FACTORS							
Measure	ISR	RR_E	RR_D	CF_S	CF_W	FR	SO
LED Bulb	99%[49]	100%[50]	100%[51]	14.4%[52]	18.6%[53]	Table 2	0%[54]

[48] Ibid.
[49] ISR is based on long term In-Service Rate from NMR Group, Efficiency Maine Retail Lighting Program Overall Evaluation Report, April 16, 2015, p. 14. It is assumed that storage habits are the same for standard efficiency bulbs as LED therefore the equivalent measure life is based on the long-term in-service rate.
[50] Realization rates are 100 percent since savings estimates are based on evaluation results.
[51] Realization rates are 100 percent since savings estimates are based on evaluation results.
[52] Composite summer coincidence factor: 96 percent of bulbs in residential sockets with summer CF at 11.8 percent (NMR Group, Efficiency Maine Retail Lighting Program Overall Evaluation Report, April 16, 2015, p. 19) and 4 percent of bulbs in commercial sockets with summer CF at 76 percent (Efficiency Maine Trust Commercial TRM, July 1, 2013).
[53] NMR Group, Efficiency Maine Retail Lighting Program Overall Evaluation Report, April 16, 2015, p. 24.
[54] Ibid.

Table 1. Wattage and Savings by Bulb Type for Retail Channel[55]

Bulb Type	Measure Codes	Baseline Wattage	Efficient Wattage	$\Delta Watts_{LED}$	Energy and Demand Savings with Interactive Effects							
					Electricity kWh/y	Winter kW	Summer kW	Natural Gas MMBtu	Propane MMBtu	Wood MMBtu	Kerosene MMBtu	Oil MMBtu
Standard LEDs	**LEDSTDLL, LEDSTDSL, LEDSTDP**	42	9	33	30	0.006	0.005	-0.004	-0.002	-0.005	-0.002	-0.026
Specialty LEDs - Reflector	**LEDSPCRFL, LEDSPCRFS, LEDSPCRFP**	61	9	52	45	0.010	0.008	-0.006	-0.004	-0.007	-0.004	-0.040
Specialty LEDs - Other (Globe & 3-Way)	**LEDSPCOL, LEDSPCOS**	48	7	41	36	0.008	0.006	-0.004	-0.003	-0.006	-0.003	-0.032
Specialty LEDs - Candelabra	**LEDSPCCDL, LEDSPCCDS**	42	4	38	32	0.007	0.006	-0.004	-0.003	-0.005	-0.003	-0.029

Table 2. Measure Cost, O&M and Free Ridership Rates by Bulb Type for Retail Channel[56]

Bulb Type	Measure Codes	Baseline Retail Price	Average Efficient Product Retail Price Before Incentive		Incremental First Cost		Avoided O&M[57]		Free Ridership Rate[58]	
			≥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**	$1.38	$3.80	$3.02	$2.42	$1.64	$7.23	$6.06	3%	1%
Specialty LEDs - Reflector	**LEDSPCRFL, LEDSPCRFS**	$3.61	$8.05	N/A	$4.44	N/A*	$18.92	$15.86	21%	N/A*

[55] Weighted average based on January – February 2017 program sales data for LEDs.
[56] Cost values based on weighted average pre-incentivized retail costs from Jan-Mar 2017 program sales data for efficient cost and surveyed baseline cost.
[57] 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 F-2 for baseline bulb replacement schedule.
[58] The free ridership rate is estimated from the retail price before incentive and the anticipated customer facing price and the coefficient of elasticity. A nominal incentive of 90% of incremental cost is assumed for calculating free ridership rates for all bulbs not participating in off-shelf promotion. For standard LED bulbs participating in off-shelf promotion, the anticipated customer facing price is $0.50. For reflector LED promotion bulbs the anticipated customer facing price is $1.50. See Appendix F: Supplementary Information for Retail Products.

Bulb Type	Measure Codes	Baseline Retail Price	Average Efficient Product Retail Price Before Incentive		Incremental First Cost		Avoided O&M[57]		Free Ridership Rate[58]	
			≥20,000 hr	<20,000 hr	≥20,000 hr	<20,000 hr	≥20,000 hr	<20,000 hr	≥20,000 hr	<20,000 hr
Specialty LEDs - Other (Globe & 3-Way)	**LEDSPCOL, LEDSPCOS**	$2.14	$7.08	N/A	$4.94	N/A*	$11.22	$9.40	15%	N/A*
Specialty LEDs - Candelabra	**LEDSPCCDL, LEDSPCCDS**	$1.21	$5.65	$5.35	$4.44	$4.14	$6.34	$5.32	15%	16%

*These bulb categories have not had any program participation and therefore have no program data to analyze. Values for ≥20,000 hr category will be used as placeholders in effRT.

Standard LED Bulb – Food Pantry, Direct Install & DIY Kit (LEDSTDLFP, LEDSTDSFP, LILEDSTANL, LILEDSTANS)		
Last Revised Date	7/1/2017	
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: $\Delta kW = 0.037$ $\Delta kW_{WP} = 0.00571$ $\Delta kW_{SP} = 0.00435$ 100 W Equivalent LED Bulb: $\Delta kW = 0.060$ $\Delta kW_{WP} = 0.00924$ $\Delta kW_{SP} = 0.00704$	
Annual energy savings	60 W Equivalent LED Bulb $\Delta kWh/yr = 25$ $\Delta MMBtu/yr_{GAS} = -0.004$ $\Delta MMBtu/yr_{OIL} = -0.022$ $\Delta MMBtu/yr_{WOOD} = -0.004$ $\Delta MMBtu/yr_{PROP} = -0.002$ $\Delta MMBtu/yr_{KERO} = -0.002$ $\Delta MMBtu/yr_{ELEC} = -0.0003 = -0.081$ kWh $\Delta MMBtu/yr_{NET} = 0.052$	100 W Equivalent LED Bulb $\Delta kWh/yr = 41$ $\Delta MMBtu/yr_{GAS} = -0.005$ $\Delta MMBtu/yr_{OIL} = -0.036$ $\Delta MMBtu/yr_{WOOD} = -0.007$ $\Delta MMBtu/yr_{PROP} = -0.003$ $\Delta MMBtu/yr_{KERO} = -0.003$ $\Delta MMBtu/yr_{ELEC} = -0.0004 = -0.131$ kWh $\Delta MMBtu/yr_{NET} = 0.085$
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 excluding coal and other[59]	
EFFICIENCY ASSUMPTIONS		
Baseline Efficiency	Halogen bulb	
Efficient Measure	ENERGY STAR® certified LED bulb	

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

Standard LED Bulb – Food Pantry, Direct Install & DIY Kit (LEDSTDLFP, LEDSTDSFP, LILEDSTANL, LILEDSTANS)

PARAMETER VALUES (DEEMED)

Measure	$\Delta Watts_{LED}$	HPD_{RES}	HPY_{COMM}	%RES	%COMM	Life (yrs)	Cost ($)
60 W Equivalent	34[60]	2[61]	3,772[62]	100%[63]	0%[64]	≥20,000 hr: 8[65] <20,000 hr: 7[66]	actual[67]
100 W Equivalent	55[68]	2[61]	3,772[62]	100%[63]	0%[64]	≥20,000 hr: 8[65] <20,000 hr: 7[66]	

	IE_{COOL_D}	IE_{COOL_E}	IE_{HEAT_E}	%FUEL	Avoided O&M ($)	
LED Bulb	1.085[69]	1.021[70]	0.00137[71]	Table E-1	≥20,000 hr: 6.46 <20,000 hr: 6.06[72]	

IMPACT FACTORS

Measure	ISR	RR_E	RR_D	CF_S	CF_W	FR	SO
Low-Income	99%[73]	100%[74]	100%[75]	11.8%[76]	16.8%[77]	0%[78]	0%[79]
Non-Low-Income	99%[73]	100%[74]	100%[75]	11.8%[76]	16.8%[77]	23%[80]	0%[79]

[60] 9 watt A-line standard bulb replacing a 43 W halogen.
[61] NMR Group, Efficiency Maine Retail Lighting Program Overall Evaluation Report, April 16, 2015, p. 16.
[62] Average annual hours of use for commercial spaces. Efficiency Maine Commercial Technical Reference Manual Version 2015.1 Table 33.
[63] Assume residential only for food pantry and appliance packs.
[64] Ibid.
[65] Although long-life LEDs have a useful life of 34 years based on rated lifetime of 25,000 hours, an equivalent measure life has been defined to account for dual baselines (full savings prior to 7/1/2020 and reduced savings post 7/1/2020 when more stringent EISA standards that take effect 1 January 2020 assuming a 6 month sell through).
[66] Ibid with rated lifetime of 15,000 hours.
[67] Actual cost paid by program.
[68] 17 watt A-line standard bulb replacing a 72 W halogen.
[69] 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.
[70] Ibid.
[71] Ibid.
[72] 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 F-2 for baseline bulb replacement schedule.
[73] ISR is based on long-term ISR from NMR Group, Efficiency Maine Retail Lighting Program Overall Evaluation Report, April 16, 2015, p. 14. It is assumed that storage habits are the same for standard efficiency bulbs as LED therefore the equivalent measure life is based on the long-term ISR.
[74] Realization rates are 100 percent since savings estimates are based on evaluation results.
[75] Ibid.
[76] NMR Group, Efficiency Maine Retail Lighting Program Overall Evaluation Report, April 16, 2015, p. 19.
[77] Ibid.
[78] Assume same free ridership as Food Pantry CFL bulbs: NMR Group, Efficiency Maine Retail Lighting Program Overall Evaluation Report, April 16, 2015, p. 24.
[79] Assume same free ridership as Appliance Pack CFL bulbs NMR Group, Efficiency Maine Retail Lighting Program Overall Evaluation Report, April 16, 2015, p. 24.
[80] Ibid.

Specialty LED Bulb – Food Pantry, Direct Install & DIY Kit (LEDSPCLFP, LEDSPCSFP, LILEDSPECL, LILEDSPECS)	
Last Revised Date	4/1/2017
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	New Construction, Replace on Burnout
DEEMED GROSS ENERGY SAVINGS (UNIT SAVINGS)	
Demand savings	$\Delta kW = 0.059$ $\Delta kW_{WP} = 0.00907$ $\Delta kW_{SP} = 0.00691$
Annual energy savings	$\Delta kWh/yr = 40$ $\Delta MMBtu/yr_{GAS} = -0.005$ $\Delta MMBtu/yr_{OIL} = -0.036$ $\Delta MMBtu/yr_{WOOD} = -0.007$ $\Delta MMBtu/yr_{PROP} = -0.003$ $\Delta MMBtu/yr_{KERO} = -0.003$ $\Delta MMBtu/yr_{ELEC} = -0.0004 = -0.128$ kWh $\Delta MMBtu/yr_{NET} = 0.083$
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 excluding coal and other[81]
EFFICIENCY ASSUMPTIONS	
Baseline Efficiency	Incandescent bulb
Efficient Measure	ENERGY STAR® certified LED bulb

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

Specialty LED Bulb – Food Pantry, Direct Install & DIY Kit (LEDSPCLFP, LEDSPCSFP, LILEDSPECL, LILEDSPECS)							
PARAMETER VALUES (DEEMED)							
Measure	$\Delta Watts_{LED}$	HPD_{RES}	HPY_{COMM}	%RES	%COMM	Life (yrs)	Cost ($)
LED Bulb	54[82]	2[83]	3,772[84]	100%[85]	0%[86]	≥20,000 hr: 25[87] <20,000 hr: 21[88]	actual[89]
	IE_{COOL_D}	IE_{COOL_E}	IE_{HEAT_E}	%FUEL	Avoided O&M ($)		
LED Bulb	1.085[90]	1.021[91]	0.00137[92]	Table E-1	≥20,000 hr: 16.90 <20,000 hr: 15.86[93]		

IMPACT FACTORS							
Measure	ISR	RR_E	RR_D	CF_S	CF_W	FR	SO
Low-Income	99%[94]	100%[95]	100%[96]	11.8%[97]	16.8%[98]	0%[99]	0%[100]
Non-Low-Income						23%[101]	

[82] 10 watt reflector bulb replacing a 64 W incandescent bulb (based on weighted average of retail program).
[83] NMR Group, Efficiency Maine Retail Lighting Program Overall Evaluation Report, April 16, 2015, p. 16.
[84] Average annual hours of use for commercial spaces. Efficiency Maine Commercial Technical Reference Manual Version 2015.1 Table 33.
[85] Assume residential only for food pantry and appliance packs.
[86] Ibid.
[87] Although long-life LEDs have a useful life of 34 years based on rated lifetime of 25,000 hours, effective useful life is capped at 25 years.
[88] Based on rated lifetime of 15,000 hours.
[89] Actual cost paid by program.
[90] 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.
[91] Ibid.
[92] Ibid.
[93] 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 F-2 for baseline bulb replacement schedule.
[94] ISR is based on long-term ISR from NMR Group, Efficiency Maine Retail Lighting Program Overall Evaluation Report, April 16, 2015, p. 14. It is assumed that storage habits are the same for standard efficiency bulbs as LED therefore the equivalent measure life is based on the long-term ISR.
[95] Realization rates are 100 percent since savings estimates are based on evaluation results.
[96] Ibid.
[97] NMR Group, Efficiency Maine Retail Lighting Program Overall Evaluation Report, April 16, 2015, p. 19.
[98] Ibid.
[99] Assume same free ridership as Food Pantry CFL bulbs: NMR Group, Efficiency Maine Retail Lighting Program Overall Evaluation Report, April 16, 2015, p. 24.
[100] Assume same free ridership as Appliance Pack CFL bulbs NMR Group, Efficiency Maine Retail Lighting Program Overall Evaluation Report, April 16, 2015, p. 24.
[101] Ibid.

Standard LED Bulb – Distributor (LEDSTDLLD, LEDSTDSLD)	
Last Revised Date	4/1/2017 (effective 5/1/2017)
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 (incandescent or halogen).
Primary Energy Impact	Electric
Sector	Residential, Commercial
Program(s)	Consumer Products Program – Lighting - Distributor
End-Use	Lighting
Decision Type	New Construction, Replace on Burnout
DEEMED GROSS ENERGY SAVINGS (UNIT SAVINGS)	
Demand savings	See Table 3
Annual energy savings	See Table 3
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 excluding coal and other[102]
EFFICIENCY ASSUMPTIONS	
Baseline Efficiency	Halogen bulb
Efficient Measure	LED bulb

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

Standard LED Bulb – Distributor (LEDSTDLLD, LEDSTDSLD)							
PARAMETER VALUES (DEEMED)							
Measure	$\Delta Watts_{LED}$	HPD_{RES}	HPY_{COMM}	%RES	%COMM	Life (yrs)	Cost ($)
LED Bulb	Table 3	2[103]	3,772[104]	31%[105]	69%[105]	≥20,000 hr: 5[106] <20,000 hr: 3[107]	Table 4
	IE_{COOL_D}	IE_{COOL_E}	IE_{HEAT_E}	%FUEL	Avoided O&M ($)		
LED Bulb	1.126[108]	1.048[109]	0.00152[110]	Table E-1	Table 4		

IMPACT FACTORS							
Measure	ISR	RR_E	RR_D	CF_S	CF_W	FR	SO
LED Bulb	99%[111]	100%[112]	100%[113]	56.1%[114]	48.7%[115]	26%[116]	1.6%[117]

103 NMR Group, Efficiency Maine Retail Lighting Program Overall Evaluation Report, April 16, 2015, p. 16.
104 Average annual hours of use for commercial spaces. Efficiency Maine Commercial Technical Reference Manual Version 2015.1 Table 33.
105 Percent of bulbs sold through distributor channel installed in commercial setting based on program data collected 7/1/2016-3/31/2017.
106 Although long-life LEDs have a useful life of 18 years based on rated lifetime of 25,000 hours, an equivalent measure life has been defined account for dual baselines (full savings prior to 7/1/2020 and reduced savings post 7/1/2020 when more stringent EISA standards that take effect 1 January 2020 assuming a 6-month sell through).
107 Ibid with rated life of 15,000 hours.
108 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.
109 Ibid.
110 Ibid.
111 ISR is based on long-term ISR from NMR Group, Efficiency Maine Retail Lighting Program Overall Evaluation Report, April 16, 2015, p. 14. It is assumed that storage habits are the same for standard efficiency bulbs as LED therefore the equivalent measure life is based on the long-term ISR.
112 Realization rates are 100 percent since savings estimates are based on evaluation results.
113 Ibid.
114 Composite summer coincidence factor: 31 percent of bulbs in residential sockets with summer CF at 11.8 percent (NMR Group, Efficiency Maine Retail Lighting Program Overall Evaluation Report, April 16, 2015, p.19) and 69 percent of bulbs in commercial sockets with summer CF at 76 percent (Efficiency Maine Trust Commercial TRM, July 1, 2013).
115 Composite winter coincidence factor: 96 percent of bulbs in residential sockets with winter CF at 16.8 percent (NMR Group, Efficiency Maine Retail Lighting Program Overall Evaluation Report, April 16, 2015, p. 19) and 4 percent of bulbs in commercial sockets with winter CF at 63 percent (Efficiency Maine Trust Commercial TRM, July 1, 2013).
116 Nexant, Business Incentive Program Process Evaluation, Published October 31, 2016, page 58.
117 Ibid.

Specialty LED Lamp – Distributor (Codes: LEDSPCCDDL, LEDSPCCDDS, LEDSPCGLDL, LEDSPCGLDS, LEDSPCBRDL, LEDSPCBRDS, LEDSPCPRDL, LEDSPCPRDS, LEDSPCPBDL, LEDSPCPBDS, S110<A/C><2/4><L/S>)	
Last Revised Date	10/1/2017
MEASURE OVERVIEW	
Description	Specialty LED Bulbs (Globe, Reflector, Candelabra, 3-way and Linear). This measure involves the installation of a new 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 - Distributor
End-Use	Lighting
Decision Type	New Construction, Replace on Burnout
DEEMED GROSS ENERGY SAVINGS (UNIT SAVINGS)	
Demand savings	See Table 3
Annual energy savings	See Table 3
GROSS ENERGY SAVINGS ALGORITHMS (UNIT SAVINGS)	
Demand savings	Δ kW = $\Delta Watt_{LED}$ / 1,000 x IE_{COOL_D} Δ kW_{SP} = $\Delta Watt_{LED}$ / 1,000 x CF_S x IE_{COOL_D} Δ kW_{WP} = $\Delta Watt_{LED}$ / 1,000 x CF_W
Annual energy savings	ΔkWh/yr = $\Delta Watts_{LED}$ / 1,000 x [365 x HPD_{RES} x %RES + HPY_{COMM} x %COMM] x IE_{COOL_E} Δ MMBtu = -$\Delta Watts_{LED}$ / 1,000 x [365 x HPD_{RES} x %RES + HPY_{COMM} x %COMM] x IE_{HEAT_E} $\Delta MMBtu_{FUEL}$ = ΔMMBtu x %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 excluding coal and other[118]
EFFICIENCY ASSUMPTIONS	
Baseline Efficiency	Incandescent
Efficient Measure	LED bulb

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

Specialty LED Lamp – Distributor (Codes: LEDSPCCDDL, LEDSPCCDDS, LEDSPCGLDL, LEDSPCGLDS, LEDSPCBRDL, LEDSPCBRDS, LEDSPCPRDL, LEDSPCPRDS, LEDSPCPBDL, LEDSPCPBDS, S110<A/C><2/4><L/S>)

PARAMETER VALUES (DEEMED)

Measure	$\Delta Watts_{LED}$	HPD_{RES}	HPY_{COMM}	%RES	%COMM	Life (yrs)	Cost ($)
LED Bulb	Table 3	2[119]	3,772[120]	31%[121]	69%[122]	≥20,000 hr: 9[123] <20,000 hr: 5[124]	Table 4
	IE_{COOL_D}	IE_{COOL_E}	IE_{HEAT_E}	%FUEL	Avoided O&M ($)		
LED Bulb	1.126[125]	1.048[126]	0.00152[127]	Table E-1	Table 4		

IMPACT FACTORS

Measure	ISR	RR_E	RR_D	CF_S	CF_W	FR	SO
LED Bulb	99%[128]	100%[129]	100%[130]	56.1%[131]	48.7%[132]	26%[133]	1.6%[134]

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119 NMR Group, Efficiency Maine Retail Lighting Program Overall Evaluation Report, April 16, 2015, p. 16.
120 Average annual hours of use for commercial spaces. Efficiency Maine Commercial Technical Reference Manual Version 2015.1 Table 33.
121 Percent of bulbs sold through distributor channel installed in commercial setting based on interviews with distributors in July 2015 in advance of additional data gathering.
122 Ibid.
123 Based on rated lifetime of 25,000 hours.
124 Based on rated lifetime of 15,000 hours.
125 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.
126 Ibid.
127 Ibid.
128 ISR is based on long-term ISR from NMR Group, Efficiency Maine Retail Lighting Program Overall Evaluation Report, April 16, 2015, p. 14. It is assumed that storage habits are the same for standard efficiency bulbs as LED therefore the equivalent measure life is based on the long-term ISR
129 Realization rates are 100 percent since savings estimates are based on evaluation results.
130 Ibid.
131 Composite summer coincidence factor: 31 percent of bulbs in residential sockets with summer CF at 11.8 percent (NMR Group, Efficiency Maine Retail Lighting Program Overall Evaluation Report, April 16, 2015, p.19) and 69 percent of bulbs in commercial sockets with summer CF at 76 percent (Efficiency Maine Trust Commercial TRM, July 1, 2013).
132 Composite winter coincidence factor: 96 percent of bulbs in residential sockets with winter CF at 16.8 percent (NMR Group, Efficiency Maine Retail Lighting Program Overall Evaluation Report, April 16, 2015, p. 19) and 4 percent of bulbs in commercial sockets with winter CF at 63 percent (Efficiency Maine Trust Commercial TRM, July 1, 2013).
133 Nexant, Business Incentive Program Process Evaluation, Published October 31, 2016, page 58.
134 Ibid.

LED Mogul Lamp Interior – Distributor (Codes: S64<A/BCL/BCH><L/H><L/S>)	
Last Revised Date	10/1/2017
MEASURE OVERVIEW	
Description	LED mogul base lamps. This measure involves the installation of a new LED in place of an existing or new inefficient bulb (incandescent or halogen) in an interior fixture.
Primary Energy Impact	Electric
Sector	Residential, Commercial
Program(s)	Consumer Products Program – Lighting - Distributor
End-Use	Lighting
Decision Type	New Construction, Replace on Burnout
DEEMED GROSS ENERGY SAVINGS (UNIT SAVINGS)	
Demand savings	See Table 3
Annual energy savings	See Table 3
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 excluding coal and other[135]
EFFICIENCY ASSUMPTIONS	
Baseline Efficiency	Incandescent
Efficient Measure	LED bulb

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

LED Mogul Lamp Interior – Distributor (Codes: S64<A/BCL/BCH><L/H><L/S>)							
PARAMETER VALUES (DEEMED)							
Measure	$\Delta Watts_{LED}$	HPD_{RES}	HPY_{COMM}	%RES	%COMM	Life (yrs)	Cost ($)
LED Bulb	Table 3	2[136]	3,772[137]	0%[138]	100%[139]	≥20,000 hr: 9[140] <20,000 hr: 5[141]	Table 4
	IE_{COOL_D}	IE_{COOL_E}	IE_{HEAT_E}	%FUEL	Avoided O&M ($)		
LED Bulb	1.144[142]	1.060[143]	0.00159[144]	Table E-1	Table 4		

IMPACT FACTORS							
Measure	ISR	RR_E	RR_D	CF_S	CF_W	FR	SO
LED Bulb	99%[145]	100%[146]	100%[147]	63.0%[148]	76.0%[149]	26%[150]	1.6%[151]

[136] NMR Group, Efficiency Maine Retail Lighting Program Overall Evaluation Report, April 16, 2015, p. 16.
[137] Average annual hours of use for commercial spaces. Efficiency Maine Commercial Technical Reference Manual Version 2015.1 Table 33.
[138] Mogul base lamps are primarily applicable to commercial settings. Percent installed in commercial applications is assumed to be 100%.
[139] Ibid.
[140] Based on rated lifetime of 25,000 hours.
[141] Based on rated lifetime of 15,000 hours.
[142] 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.
[143] Ibid.
[144] Ibid.
[145] ISR is based on long-term ISR from NMR Group, Efficiency Maine Retail Lighting Program Overall Evaluation Report, April 16, 2015, p. 14. It is assumed that storage habits are the same for standard efficiency bulbs as LED therefore the equivalent measure life is based on the long-term ISR
[146] Realization rates are 100 percent since savings estimates are based on evaluation results.
[147] Ibid.
[148] KEMA, C&I Lighting Load Shape Project FINAL Report, July 2011.
[149] Ibid.
[150] Nexant, Business Incentive Program Process Evaluation, Published October 31, 2016, page 58.
[151] Ibid.

LED Mogul Lamp Exterior – Distributor (Codes: S6<B/C><L/M/H><L/S>)	
Last Revised Date	10/1/2017
MEASURE OVERVIEW	
Description	LED mogul base lamp exterior. This measure involves the installation of a new LED in place of an existing or new inefficient bulb (incandescent or halogen) in an exterior fixture.
Primary Energy Impact	Electric
Sector	Residential, Commercial
Program(s)	Consumer Products Program – Lighting - Distributor
End-Use	Lighting
Decision Type	New Construction, Replace on Burnout
DEEMED GROSS ENERGY SAVINGS (UNIT SAVINGS)	
Demand savings	See Table 3
Annual energy savings	See Table 3
GROSS ENERGY SAVINGS ALGORITHMS (UNIT SAVINGS)	
Demand savings	$\Delta\ kW = \Delta Watt_{LED} / 1{,}000$ $\Delta\ kW_{SP} = \Delta Watt_{LED} / 1{,}000 \times CF_S$ $\Delta\ kW_{WP} = \Delta Watt_{LED} / 1{,}000 \times CF_W$
Annual energy savings	$\Delta kWh/yr = \Delta Watts_{LED} / 1{,}000 \times [365 \times HPD_{RES} \times \%RES + HPY_{COMM} \times \%COMM]$
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 (%)
EFFICIENCY ASSUMPTIONS	
Baseline Efficiency	Incandescent
Efficient Measure	LED bulb

PARAMETER VALUES (DEEMED)

Measure	$\Delta Watts_{LED}$	HPD_{RES}	HPY_{COMM}	%RES	%COMM	Life (yrs)	Cost ($)
LED Lamp	Table 3	2[152]	3,772[153]	0%[154]	100%[155]	≥20,000 hr: 9[156] <20,000 hr: 5[157]	Table 4
					Avoided O&M ($)		
LED Lamp					Table 4		

IMPACT FACTORS

Measure	ISR	RR_E	RR_D	CF_S	CF_W	FR	SO
LED Bulb	99%[158]	100%[159]	100%[160]	70.2%[161]	3.7%[162]	26%[163]	1.6%[164]

152 NMR Group, Efficiency Maine Retail Lighting Program Overall Evaluation Report, April 16, 2015, p. 16.
153 Average annual hours of use for commercial spaces. Efficiency Maine Commercial Technical Reference Manual Version 2015.1 Table 33.
154 Mogul base lamps are primarily applicable to commercial settings. Percent installed in commercial applications is assumed to be 100%.
155 Ibid.
156 Based on rated lifetime of 25,000 hours.
157 Based on rated lifetime of 15,000 hours.
158 ISR is based on long-term ISR from NMR Group, Efficiency Maine Retail Lighting Program Overall Evaluation Report, April 16, 2015, p. 14. It is assumed that storage habits are the same for standard efficiency bulbs as LED therefore the equivalent measure life is based on the long-term ISR
159 Realization rates are 100 percent since savings estimates are based on evaluation results.
160 Ibid.
161 Efficiency Vermont TRM 2012, Commercial Outdoor Lighting.
162 Ibid.
163 Nexant, Business Incentive Program Process Evaluation, Published October 31, 2016, page 58.
164 Ibid.

Table 3. Wattage and Savings by Bulb Type for Distributor Channel

Bulb Type	Measure Codes	Baseline Wattage	Efficient Wattage	$\Delta Watts_{LED}$	Energy and Demand Savings with Interactive Effects							
					Electricity kWh/y	Winter kW	Summer kW	Natural Gas MMBtu	Propane MMBtu	Wood MMBtu	Kerosene MMBtu	Oil MMBtu
Standard A-Line LED	**LEDSTDLLD, LEDSTDSLD**	**47**	**10**	**37**	110	0.018	0.023	-0.015	-0.010	-0.019	-0.010	-0.105
Specialty LED - Candelabra	**LEDSPCCDDL, LEDSPCCDDS**	**47**	**5**	**42**	124	0.020	0.026	-0.016	-0.011	-0.022	-0.011	-0.119
Specialty LED - R20, MR16, Globe	**LEDSPCGLDL, LEDSPCGLDS**	**36**	**7**	**29**	87	0.014	0.018	-0.011	-0.008	-0.015	-0.008	-0.083
Specialty LED - BR30, PAR16	**LEDSPCBRDL, LEDSPCBRDS**	**42**	**7**	**36**	105	0.017	0.022	-0.014	-0.009	-0.019	-0.009	-0.101
Specialty LED - PAR20, PAR30	**LEDSPCPRDL, LEDSPCPRDS**	**59**	**9**	**50**	148	0.024	0.031	-0.020	-0.013	-0.026	-0.013	-0.141
Specialty LED - PAR38, BR40	**LEDSPCPBDL, LEDSPCPBDS**	**84**	**15**	**69**	205	0.034	0.044	-0.027	-0.018	-0.036	-0.018	-0.196
Linear LED 2 ft	**S110A2L, S110C2L, S110A2S, S110C2S**	**37**	**11**	**26**	127	0.021	0.027	-0.017	-0.012	-0.023	-0.012	-0.125
Linear LED 4 ft	**S110A4L, S110C4L, S110A4S, S110C4S**	**91**	**12**	**80**	203	0.033	0.043	-0.028	-0.019	-0.037	-0.019	-0.201
LED Low Bay Mogul Screw-Base Low Output	**S64ALL, S64BCLLL, S64ALS, S64BCLLS**	**204**	**57**	**147**	587	0.092	0.128	-0.080	-0.080	-0.107	-0.053	-0.579
LED Low Bay Mogul Screw-Base High Output	**S64AHL, S64BCLHL, S64AHS, S64BCLHS**	**363**	**99**	**264**	1057	0.167	0.230	-0.144	-0.144	-0.193	-0.096	-1.043
LED High Bay Mogul Screw-Base Low Output	**S64BCHLL, S64BCHLS**	**449**	**105**	**344**	1376	0.217	0.299	-0.188	-0.188	-0.251	-0.125	-1.358
LED High Bay Mogul Screw-Base High Output	**S64BCHHL, S64BCHHS**	**447**	**138**	**309**	1237	0.195	0.269	-0.169	-0.113	-0.225	-0.113	-1.221
Outdoor Mogul Screw-Base Low Output	**S6BLL, S6CLL, S6BLS, S6CLS**	**200**	**42**	**158**	598	0.006	0.111	0.000	0.000	0.000	0.000	0.000
Outdoor Mogul Screw-Base Medium Output	**S6BML, S6CML, S6BMS, S6CMS**	**309**	**89**	**220**	831	0.008	0.155	0.000	0.000	0.000	0.000	0.000
Outdoor Mogul Screw-Base High Output	**S6BHL, S6CHL, S6BHS, S6CHS**	**458**	**129**	**329**	1241	0.012	0.231	0.000	0.000	0.000	0.000	0.000

Table 4. Measure Cost, O&M and Free Ridership Rates by Bulb Type for Distributor Channel[165]

Bulb Type	Measure Codes	Baseline Retail Price	Average Efficient Product Retail Price Before Incentive		Incremental First Cost		Avoided O&M[166]	
			≥20,000 hr	<20,000 hr	≥20,000 hr	<20,000 hr	≥20,000 hr	<20,000 hr
Standard A-Line LED	LEDSTDLLD, LEDSTDSLD	$1.38	$4.62	$4.11	$3.24	$2.73	$13.33	$8.10
Specialty LED - Candelabra	LEDSPCCDDL, LEDSPCCDDS	$1.21	$6.69	$4.69	$5.48	$3.48	$11.69	$7.11
Specialty LED - R20, MR16, Globe	LEDSPCGLDL, LEDSPCGLDS	$2.92	$9.29	$6.61	$6.37	$3.69	$28.21	$17.15
Specialty LED - BR30, PAR16	LEDSPCBRDL, LEDSPCBRDS	$2.85	$7.92	N/A	$5.07	N/A*	$27.54	N/A
Specialty LED - PAR20, PAR30	LEDSPCPRDL, LEDSPCPRDS	$6.53	$12.24	N/A	$5.71	N/A*	$63.09	N/A
Specialty LED - PAR38, BR40	LEDSPCPBDL, LEDSPCPBDS	$3.80	$15.46	N/A	$11.66	N/A*	$36.72	N/A
Linear LED 2 ft	S110A2L, S110C2L, S110A2S, S110C2S	$2.96	$12.91	N/A	$9.95	N/A*	$28.62	N/A
Linear LED 4 ft	S110A4L, S110C4L, S110A4S, S110C4S	$2.96	$8.51	N/A	$5.55	N/A*	$28.62	N/A
LED Low Bay Mogul Screw-Base Low Output Type A	S64ALL, S64ALS	$40.00	$120.00	N/A	$80.00	N/A*	$407.67	N/A
LED Low Bay Mogul Screw-Base High Output Type A	S64AHL, S64AHS	$50.00	$240.00	N/A	$190.00	N/A*	$509.59	N/A
LED Low Bay Mogul Screw-Base Low Output Type B&C	S64BCLLL, S64BCLLS	$40.00	$128.54	N/A	$88.54	N/A*	$407.67	N/A
LED Low Bay Mogul Screw-Base High Output Type B&C	S64BCLHL, S64BCLHS	$50.00	$245.15	N/A	$195.15	N/A*	$509.59	N/A
LED High Bay Mogul Screw-Base Low Output	S64BCHLL, S64BCHLS	$60.00	$191.39	N/A	$131.39	N/A*	$611.50	N/A
LED High Bay Mogul Screw-Base High Output	S64BCHHL, S64BCHHS	$50.00	$270.10	N/A	$220.10	N/A*	$509.59	N/A
Outdoor Mogul Screw-Base Low Output	S6BLL, S6CLL, S6BLS, S6CLS	$60.00	$90.81	N/A	$30.81	N/A*	$611.50	N/A
Outdoor Mogul Screw-Base Medium Output	S6BML, S6CML, S6BMS, S6CMS	$80.00	$123.12	N/A	$43.12	N/A*	$815.34	N/A
Outdoor Mogul Screw-Base High Output	S6BHL, S6CHL, S6BHS, S6CHS	$130.00	$305.83	N/A	$175.83	N/A*	$1,324.92	N/A

***These bulb categories have not had any program participation and therefore have no program data to analyze. Values for ≥20,000 hr category will be used as placeholders in effRT.**

[165] Cost values based on weighted average pre-incentivized distributor costs from October-November 2017 program sales data for efficient cost and surveyed baseline cost.

[166] 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 F-2 for baseline bulb replacement schedule.

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.[167] 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	$\Delta kW_{SP} = 0.015$[168] $\Delta kW_{WP} = 0.017$[169]
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[170]
Efficient Measure	ENERGY STAR®-certified refrigerator

PARAMETER VALUES (DEEMED)

Measure	kWh_{BASE}	kWh_{EE}	ISA		Life (yrs)	Cost ($)		
Refrigerator	509.7[171]	460.0[171]	98.8% [172]		12[171]	20[173]		

IMPACT FACTORS

Measure	ISR	RR_E	RR_D	CF_S	CF_W	FR	SO
Refrigerator	100%[174]	100%[175]	100%[175]	100%[176]	100%[176]	67.8%[177]	3.3%[177]

[167] ENERGY STAR® Refrigerators and Freezers Key Product Criteria: http://www.energystar.gov/index.cfm?c=refrig.pr_crit_refrigerators
[168] NMR Group, Inc., Efficiency Maine Appliance Rebate Program Evaluation Overall Report – FINAL, July 18, 2014, p. 30.
[169] Memo provided to supplement NMR Group, Inc., Efficiency Maine Appliance Rebate Program Evaluation Overall Report – FINAL, July 18, 2014.
[170] Federal Standard, Code of Federal Regulations, Title 10, Part 430, Subpart C.
[171] Table F-1. Weighted Average Refrigerator Energy Use.
[172] 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.
[173] ENERGY STAR Appliance Calculator.
[174] NMR Group, Inc., Efficiency Maine Appliance Rebate Program Evaluation Overall Report – FINAL, July 18, 2014, Table 2-41.
[175] Realization rates are 100 percent since savings estimates are based on evaluation results.
[176] Peak coincidence factors for this measure are embedded in the evaluated peak demand impacts.
[177] 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.[178] 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[179]
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[180]	49.1[181]	0.015[181]	0.017[181]	12[180]	0[180]

IMPACT FACTORS

Measure	ISR	RR_E	RR_D	CF_S	CF_W	FR	SO
ENERGY STAR® Freezer	100%[182]	100%[183]	100%[183]	100%[184]	100%[184]	65.5%[185]	3.3%[185]

[178] ENERGY STAR® Refrigerators and Freezers Key Product Criteria: http://www.energystar.gov/index.cfm?c=refrig.pr_crit_refrigerators
[179] Federal Standard, Code of Federal Regulations, Title 10, Part 430, Subpart C.
[180] 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).
[181] See Refrigerator measure entry.
[182] 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.
[183] Realization rates are 100 percent since savings estimates are based on evaluation results.
[184] Peak coincidence factors for this measure are embedded in the evaluated peak demand impacts.

Room Air Conditioner (Inactive) (RAC)	
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.[186] 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[187]
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[188]	9.8[189]	10.8[190]	102[191]	9[188]	50[188]

IMPACT FACTORS

Measure	ISR	RR_E	RR_D	CF_S	CF_W	FR	SO
ENERGY STAR® RAC	100%[192]	100.0%[193]	100.0%[193]	11.1%[194]	0.0%[194]	65.5%[195]	3.3%[195]

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

Room Air Purifier (RAP)	
Last Revised Date	11/21/2016
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.[196] 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	$\Delta kW = 0.107$ $\Delta kW_{SP} = 0.071$ $\Delta kW_{WP} = 0.071$
Annual Energy Savings	$\Delta kWh/yr = 624$
GROSS ENERGY SAVINGS ALGORITHMS (UNIT SAVINGS)	
Demand Savings	$\Delta kW = CADR \times (1/EF_{BASE} - 1/EF_{ES}) / 1000$
Annual Energy Savings	$\Delta kWh/yr = [CADR \times (1/EF_{BASE} - 1/EF_{ES}) \times Hours + (SBP_{BASE} - SBP_{ES}) \times (8{,}760 - Hours)] / 1000$
Definitions	Unit = 1 room air purifier CADR = Rated Clear Air Delivery Rate (CADR) EF_{BASE} = Rated efficiency for baseline unit (CADR/Watt) EF_{ES} = Rated efficiency for ENERGY STAR® unit (CADR/Watt) SBP_{BASE} = Rated standby power for baseline unit (Watts) SBP_{ES} = Rated standby for ENERGY STAR® unit (Watts) Hours = Annual operating hours (hrs/yr) 8,760 = Total hours in a year (24 hours/day × 365 days/year) 1,000 = Conversion: 1,000 Watts per kW
EFFICIENCY ASSUMPTIONS	
Baseline Efficiency	Conventional model with CADR = 183, CADR/Watt = 1.0, and standby power = 1.0 Watts
Efficient Measure	Average available ENERGY STAR®-certified model

PARAMETER VALUES (DEEMED)

Measure	CADR	EF_{BASE}	SBP_{BASE}	EF_{ES}	SBP_{ES}	Hours	Life (yrs)	Cost ($)
ENERGY STAR® RAP	153[197]	1.0[198]	1.0[198]	3.3[197]	0.6[197]	5,840[199]	9[200]	55.82[201]

Measure	%RES	%COMM
ENERGY STAR® RAP	99%[202]	1%[202]

IMPACT FACTORS

Measure	ISR	RR_E	RR_D	CF_S	CF_W	FR	SO
ENERGY STAR® RAP	100%[203]	100%[204]	100%[204]	66.7%[205]	66.7%[205]	65.5%[206]	3.3%[206]

194 See Appendix B: Coincidence and Energy Period Factors.
195 NMR Group, Inc., Efficiency Maine Appliance Rebate Program Evaluation Overall Report – FINAL, July 18, 2014, Table 2-41.
196 ENERGY STAR® Room Air Cleaners Key Product Criteria: http://www.energystar.gov/index.cfm?c=room_airclean.pr_crit_room_airclean
197 Average CADR based on PY 2016 sales data as of 4/21/16.
198 EPA Research based on available models, 2011 (from ENERGY STAR® Appliance Savings Calculator, accessed 3/31/2013).
199 Assume average 16 hours per day operating (from ENERGY STAR® Appliance Savings Calculator, accessed 3/31/2013).
200 Appliance Magazine, Portrait of the U.S. Appliance Industry 1998 (from ENERGY STAR® Appliance Savings Calculator, accessed 3/31/2013).
201 Shelf and on-line survey November 2016 of ENERGY STAR® and non-ENERGY STAR® units sold through Home Depot, Walmart, Best Buy, Lowe's and Amazon.
202 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.

Dehumidifier (DH)	
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.[207] 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[208]
Efficient Measure	ENERGY STAR®-certified dehumidifier

PARAMETER VALUES (DEEMED)

Measure	%RES	%COMM	CAP_{EE}	EF_{BASE}	EF_{EE}	Hours	ISA	Life (yrs)	Cost ($)
ENERGY STAR® Dehumidifier	97%[209]	3%[209]	54[210]	1.65[210]	2.0[211]	1,632[212]	81.6%[213]	12[214]	50[215]

[203] EMT assumes that all purchased units are installed (i.e. ISR = 100%). This is consistent with evaluation findings for other appliance measures.
[204] This measure has not yet been evaluated. Until the next program impact evaluation, EMT assumes 100 percent realization rate.
[205] See Appendix B: Coincidence and Energy Period Factors.
[206] NMR Group, Inc., Efficiency Maine Appliance Rebate Program Evaluation Overall Report – FINAL, July 18, 2014, Table 2-41.
[207] ENERGY STAR® Dehumidifiers Key Product Criteria:
https://www.energystar.gov/sites/default/files/ENERGY%20STAR_Dehumidifiers_V4%200_Specification_Final.pdf
[208] Federal Standard, Code of Federal Regulations, Title 10, Part 430, Subpart C.
[209] 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.
[210] Average capacity based on PY16 sales data as of 4/21/16.
[211] https://www.energystar.gov/sites/default/files/ENERGY%20STAR_Dehumidifiers_V4%200_Specification_Final.pdf
[212] NMR Group, Inc., Efficiency Maine Appliance Rebate Program Evaluation Overall Report – FINAL, July 18, 2014, p. 53.

Dehumidifier (DH)							
IMPACT FACTORS							
Measure	ISR	RR_E	RR_D	CF_S	CF_W	FR	SO
ENERGY STAR® Dehumidifier	100%[216]	100%[217]	100%[217]	37.1%[218]	0%[219]	65.3%[220]	3.3%[221]

213 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.
214 https://www.energystar.gov/sites/default/files/asset/document/appliance_calculator.xlsx
215 https://www.energystar.gov/sites/default/files/asset/document/appliance_calculator.xlsx
216 NMR Group, Inc., Efficiency Maine Appliance Rebate Program Evaluation Overall Report – FINAL, July 18, 2014, p. 51.
217 Realization rates are 100 percent since savings estimates are based on evaluation results.
218 Derived from summer peak demand, NMR Group, Inc., Efficiency Maine Appliance Rebate Program Evaluation Overall Report – FINAL, July 18, 2014, p. 55.
219 Assumed that dehumidifiers are not operating in the winter.
220 NMR Group, Inc., Efficiency Maine Appliance Rebate Program Evaluation Overall Report – FINAL, July 18, 2014, Table 2-42.
221 Ibid.

Dishwasher (Inactive) (DW)	
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.[222] 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	$\Delta Gallons/yr = (WC_{BASE} - WC_{EE}) \times Cycles$

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

Dishwasher (Inactive) (DW)	
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.[223]
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[224]	295[224]	215[224]	208[224]	208[225]	6.5[224]	4.25[224]	56%[224]	
Measure	$\%HW_{ELEC}$	$\%HW_{GAS}$	$\%HW_{OIL}$	$\%HW_{PROP}$	Eff_{GAS}	Eff_{OIL}	Eff_{PROP}	Life (yrs)	Cost ($)
ENERGY STAR® Dishwasher	23%[226]	10%[226]	53%[226]	9%[226]	75%[224]	75%[227]	75%[227]	10[224]	10[224]

IMPACT FACTORS

Measure	ISR	RR_E	RR_D	CF_S	CF_W	FR	SO
ENERGY STAR® Dishwasher	100%[228]	100%[229]	100%[229]	2.2%[230]	4.0%[230]	54.9%[231]	3.3%[231]

[223] Federal Standard, Code of Federal Regulations, Title 10, Part 430, Subpart C.
[224] Minimum federal efficiency standard (effective May 30, 2013).
[225] Assume that each cycle is 1 hour so the total operating hours is equal to the total number of cycles.
[226] NMR Group, Inc., Efficiency Maine Appliance Rebate Program Evaluation Overall Report – FINAL, July 18, 2014, Table 2-15
[227] Values are assumed to be the same as a gas-fired water heater.
[228] EMT assumes that all purchased units are installed (i.e. ISR = 100%). This is consistent with evaluation findings for other appliance measures.
[229] This measure has not yet been evaluated. Until the next program impact evaluation, EMT assumes 100 percent realization rate.
[230] See Appendix B: Coincidence and Energy Period Factors.
[231] 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	10/1/2017 (retroactive to 7/1/2016)
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.[232] 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	$\Delta kW = 0.505$ $\Delta kW_{SP} = 0.024$ $\Delta kW_{WP} = 0.032$
Annual energy savings	$\Delta kWh/yr = 163$ $\Delta MMBtu_{GAS}/yr = 0.100$ $\Delta MMBtu_{OIL}/yr = 0.292$ $\Delta MMBtu_{PROP}/yr = 0.065$
Annual water savings	$\Delta Gallons/yr = 2{,}444$
GROSS ENERGY SAVINGS ALGORITHMS (UNIT SAVINGS)	
Demand savings	$\Delta kW = \Delta kWh/yr / Loads$[233]
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	$\Delta Gallons/yr = CAP_{EE} \times (IWF_{BASE} - IWF_{EE}) \times Loads$

[232] ENERGY STAR® Clothes Washers Key Product Criteria: http://www.energystar.gov/index.cfm?c=clotheswash.pr_crit_clothes_washers
[233] 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	3.81[234]	1.66[235]	2.61[234]	75%[236]	75%[236]	75%[236]	11[237]	92[238]

Measure	$\%E_{MACHINE\_B}$	$\%E_{MACHINE\_EE}$	$\%E_{DRYER\_B}$	$\%E_{DRYER\_EE}$	$\%E_{DHW\_B}$	$\%E_{DHW\_EE}$
ENERGY STAR® CW	8%[239]	8%[239]	61%[239]	69%[239]	31%[239]	23%[239]

Measure	IWF_{BASE}	IWF_{EE}	$\%DHW_{ELEC}$	$\%DHW_{GAS}$	$\%DHW_{PROP}$	$\%DHW_{OIL}$
ENERGY STAR® CW	5.92[235]	3.93[234]	23%[240]	10%[240]	9%[240]	53%[240]

Measure	Loads	%Dried	$\%Dryer_{ELEC}$	$\%Dryer_{GAS}$	$\%Dryer_{PROP}$	%RES	%COMM
ENERGY STAR® CW	322.4[241]	100%[242]	89.6%[243]	7.8%[243]	2.6%	99%[244]	1%[244]

IMPACT FACTORS

Measure	ISR	RR_E	RR_D	CF_S	CF_W	FR	SO
ENERGY STAR® CW	100%[245]	100%[246]	100%[246]	4.8%%[247]	6.3%[248]	56.7%[249]	3.3%[249]

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[234] NMR Group, Inc., Efficiency Maine Appliance Rebate Program Evaluation Overall Report – FINAL, July 18, 2014, Table 2-13.
[235] 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.
[236] EMT assumes 75 percent efficiency for existing fossil fuel-fired water heaters.
[237] NMR Group, Inc., Efficiency Maine Appliance Rebate Program Evaluation Overall Report – FINAL, July 18, 2014, Table 2-18.
[238] 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.
[239] Illinois Statewide TRM Effective 06/01/15.
[240] Ibid., Table 2-15.
[241] Ibid., Table 2-14.
[242] 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.
[243] Ibid., Table 2-16.
[244] 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.
[245] NMR Group, Inc., Efficiency Maine Appliance Rebate Program Evaluation Overall Report – FINAL, July 18, 2014, p. 38.
[246] Realization rates are 100 percent since savings estimates are based on evaluation results.
[247] Derived from summer peak demand NMR Group, Inc., Efficiency Maine Appliance Rebate Program Evaluation Overall Report – FINAL, July 18, 2014, p. 45.
[248] Derived from winter peak demand Memo provided to supplement NMR Group, Inc., Efficiency Maine Appliance Rebate Program Evaluation Overall Report – FINAL, July 18, 2014.
[249] NMR Group, Inc., Efficiency Maine Appliance Rebate Program Evaluation Overall Report – FINAL, July 18, 2014, Table 2-41

Low-flow Kitchen Aerator (LFKA, LILFKA)	
Last Revised Date	7/1/2017
MEASURE OVERVIEW	
Description	This measure involves the replacement of existing kitchen aerators with low-flow aerators. The savings assume all fixtures are served by electric resistance water heaters.
Primary Energy Impact	Electric (additional impacts include: water)
Sector	Residential
Program(s)	Appliance Rebate Program
End-Use	Domestic Hot Water
Decision Type	Retrofit
DEEMED GROSS ENERGY SAVINGS (UNIT SAVINGS)	
Demand Savings[250]	HPWH: $\Delta kW = 0.007$ $\Delta kW_{WP} = 0.00008$ $\Delta kW_{SP} = 0.00005$ ERWH: $\Delta kW = 0.023$ $\Delta kW_{WP} = 0.0003$ $\Delta kW_{SP} = 0.0002$
Annual Energy Savings[251]	HPWH: $\Delta kWh/yr = 79$ ERWH: $\Delta kWh/yr = 283$
Annual Water Savings	$\Delta Gallons/yr = 2{,}696$
GROSS ENERGY SAVINGS ALGORITHMS (UNIT SAVINGS)	
Demand Savings	$\Delta kW = \Delta kWh/yr \times F_{ED}$
Annual Energy Savings	$\Delta kWh/yr = N_{ppl} \times t \times 365 \times (GPM_{BASE} - GPM_{EE}) / N_{fixtures} \times \rho_{H20} \times Cp_{H20} / 3{,}412 \times (T_{pou} - T_{in}) / RE_{EWH}$
Annual Water Savings	$\Delta Gallons/yr = N_{ppl} \times t \times 365 \times (GPM_{BASE} - GPM_{EE}) / N_{fixtures}$
Definitions	Unit = 1 kitchen aerator F_{ED} = Energy to 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_{EWH} = Recovery efficiency of electric hot 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 365 = Conversion: 365 days per year 60 = Conversion: 60 minutes per hour
EFFICIENCY ASSUMPTIONS	
Baseline Efficiency	Federal standards set a maximum 2.2 GPM for faucet aerators manufactured after January 1, 1994.[252]
Efficient Measure	High-efficiency Kitchen Faucet Aerator (1.5 GPM)

[250] For consumer products where water heater type is unknown savings listed in TRM for ERWH are multiplied by 21% in effRT to account for the percent of water heaters that are electric resistance. NMR, 2015 Maine Residential Baseline Study.
[251] For consumer products where water heater type is unknown savings listed in TRM for ERWH are multiplied by 21% in effRT to account for the percent of water heaters that are electric resistance. NMR, 2015 Maine Residential Baseline Study.
[252] Federal Standard, Code of Federal Regulations, Title 10, Part 430, Subpart C.

Low-flow Kitchen Aerator (LFKA, LILFKA)							
PARAMETER VALUES (DEEMED)							
Measure	t	N_{ppl}	GPM_{BASE}	GPM_{EE}	$N_{fixtures}$	Life (yrs)	Cost ($)
Low-flow Kitchen Aerator	4.51[253]	2.34[254]	2.2[252]	1.5	1[255]	10[256]	Actual[257]

	F_{ED}	T_{pou}	T_{in}	RE_{EWH}	
ERWH	0.00008013[258]	93[253]	50.8[259]	0.98[260]	
HPWH				3.5[261]	

IMPACT FACTORS							
Measure	ISR	RR_E	RR_D	CF_S	CF_W	FR	SO
Retail	100%[262]	100%[263]	100%[263]	0.8%[264]	1.2%[264]	25%[265]	0%[266]
Low Income	100%[267]	100%[268]	100%[268]	0.8%[269]	1.2%[269]	0%[270]	0%[271]

253 The Cadmus Group and Opinion Dynamics, MEMD: Showerhead and Faucet Aerator Meter Study, June 2013. Prepare for Michigan Evaluation Working Group.
254 American Community Survey, 2011 1-year estimate for population of Maine: http://www.census.gov/acs/www/
255 Assumed value: 1 kitchen faucet per home.
256 NREL, National Residential Efficiency Measure Database.
257 Total cost. For direct install it includes installation cost.
258 State of Pennsylvania, Technical Reference Manual, Rev date: March 2015, p. 126.
259 Standard Building America DHW Schedules, weighted average by population of all Maine water main sources.
260 NREL, Building America Research Benchmark Definition, 2009, p.12, http://www.nrel.gov/docs/fy10osti/47246.pdf
261 Program heat pump water heater required energy factor.
262 EMT assumes that all purchased units are installed (i.e. ISR = 100%). This is consistent with the MA 2013-2015 TRM.
263 This measure has not yet been evaluated. Until the next program impact evaluation, EMT assumes 100 percent realization rate.
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 EMT assumes that all received units are installed (i.e. ISR = 100%). This is consistent with the MA 2013-2015 TRM.
268 This measure has not yet been evaluated. Until the next program impact evaluation, EMT assumes 100 percent realization rate.
269 See Appendix B: Coincidence and Energy Period Factors.
270 Program assumes no free ridership for Low Income programs.
271 Program not yet evaluated, assume default SO of 0%.

Low-flow Bathroom Aerator (LFBA, LILFBA)	
Last Revised Date	7/1/2017
MEASURE OVERVIEW	
Description	EPA WaterSense Low-flow Aerator. This measure involves the replacement of existing bathroom aerators with low-flow aerators. The savings assume all fixtures are served by electric resistance water heaters.
Primary Energy Impact	Electric (additional impacts include: water)
Sector	Residential
Program(s)	Appliance Rebate Program
End-Use	Domestic Hot Water
Decision Type	Retrofit
DEEMED GROSS ENERGY SAVINGS (UNIT SAVINGS)	
Demand Savings[272]	HPWH: $\Delta kW = 0.001$ $\Delta kW_{WP} = 0.000003$ $\Delta kW_{SP} = 0.000002$ ERWH: $\Delta kW = 0.002$ $\Delta kW_{WP} = 0.000009$ $\Delta kW_{SP} = 0.000007$
Annual Energy Savings[273]	HPWH: $\Delta kWh/yr = 8$ ERWH: $\Delta kWh/yr = 29$
Annual Water Savings	$\Delta Gallons/yr = 333$
GROSS ENERGY SAVINGS ALGORITHMS (UNIT SAVINGS)	
Demand Savings	$\Delta kW = \Delta kWh/yr \times F_{ED}$
Annual Energy Savings	$\Delta kWh/yr = N_{ppl} \times t \times 365 \times (GPM_{BASE} – GPM_{EE}) / N_{fixture} \times \rho_{H20} \times Cp_{H20} / 3,412 \times (T_{pou} - T_{in}) / RE_{EWH}$
Annual Water Savings	$\Delta Gallons/yr = N_{ppl} \times t \times 365 \times (GPM_{BASE} – GPM_{EE}) / N_{fixture}$
Definitions	Unit = 1 bathroom aerator F_{ED} = Energy to 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_{EWH} = Recovery efficiency of electric hot 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 365 = Conversion: 365 days per year 60 = Conversion: 60 minutes per hour
EFFICIENCY ASSUMPTIONS	
Baseline Efficiency	Federal standards set a maximum 2.2 GPM for faucet aerators manufactured after January 1, 1994.[274]
Efficient Measure	USEPA WaterSense High-efficiency Bathroom Sink Faucet (1.5 GPM)[275]

[272] For consumer products where water heater type is unknown savings listed in TRM for ERWH are multiplied by 21% in effRT to account for the percent of water heaters that are electric resistance. NMR, 2015 Maine Residential Baseline Study.
[273] For consumer products where water heater type is unknown savings listed in TRM for ERWH are multiplied by 21% in effRT to account for the percent of water heaters that are electric resistance. NMR, 2015 Maine Residential Baseline Study.
[274] Federal Standard, Code of Federal Regulations, Title 10, Part 430, Subpart C.
[275] http://www.epa.gov/WaterSense/docs/faucet_spec508.pdf

Low-flow Bathroom Aerator (LFBA, LILFBA)							
PARAMETER VALUES (DEEMED)							
Measure	t	N_{ppl}	$N_{fixture}$	GPM_{BASE}	GPM_{EE}	Life (yrs)	Cost ($)
Low-flow Bathroom Aerator	1.65[276]	2.34[277]	2.96[278]	2.2[274]	1.5[275]	10[279]	actual
	F_{ED}	T_{pou}	T_{in}	RE_{EWH}			
ERWH	0.00008013[280]	86[276]	50.8[281]	0.98[282]			
HPWH				3.5[283]			

IMPACT FACTORS							
Measure	ISR	RR_E	RR_D	CF_S	CF_W	FR	SO
Retail	100%[284]	100%[285]	100%[286]	0.3%[287]	0.4%[288]	25%[289]	0%[290]
Low Income	100%[291]	100%[292]	100%[293]	0.3%[294]	0.4%[295]	0%[296]	0%[297]

[276] The Cadmus Group and Opinion Dynamics, MEMD: Showerhead and Faucet Aerator Meter Study, June 2013. Prepare for Michigan Evaluation Working Group.
[277] American Community Survey, 2011 1 year estimate for population of Maine: http://www.census.gov/acs/www/
[278] 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.
[279] NREL, National Residential Efficiency Measure Database.
[280] State of Pennsylvania, Technical Reference Manual, Rev date: March 2015, p. 126.
[281] Standard Building America DHW Schedules, weighted average by population of all Maine water main sources.
[282] NREL, Building America Research Benchmark Definition, 2009, p.12, http://www.nrel.gov/docs/fy10osti/47246.pdf
[283] Program heat pump water heater required energy factor.
[284] EMT assumes that all purchased units are installed (i.e. ISR = 100%). This is consistent with the MA 2013-2015 TRM.
[285] This measure has not yet been evaluated. Until the next program impact evaluation, EMT assumes 100 percent realization rate.
[286] Ibid.
[287] See Appendix B: Coincidence and Energy Period Factors.
[288] Ibid.
[289] Program not yet evaluated, assume default FR of 25%.
[290] Program not yet evaluated, assume default SO of 0%.
[291] EMT assumes that all purchased units are installed (i.e. ISR = 100%). This is consistent with the MA 2013-2015 TRM.
[292] This measure has not yet been evaluated. Until the next program impact evaluation, EMT assumes 100 percent realization rate.
[293] Ibid.
[294] See Appendix B: Coincidence and Energy Period Factors.
[295] Ibid.
[296] Program assumes no free ridership for Low Income programs.
[297] Program not yet evaluated, assume default SO of 0%.

Low-flow Showerhead (LFSH)	
Last Revised Date	3/1/2015
MEASURE OVERVIEW	
Description	EPA WaterSense Low-flow Showerhead. This measure involves the replacement of existing showerheads with low-flow showerheads. The savings assume all fixtures are served by electric resistance water heaters.
Primary Energy Impact	Electric (additional impacts include: water)
Sector	Residential
Program(s)	Appliance Rebate Program
End-Use	Domestic Hot Water
Decision Type	Retrofit
DEEMED ENERGY SAVINGS (UNIT SAVINGS)	
Demand Savings[298]	HPWH: $\Delta kW = 0.007$ $\Delta kW_{WP} = 0.00005$ $\Delta kW_{SP} = 0.00003$ ERWH: $\Delta kW = 0.012$ $\Delta kW_{WP} = 0.0001$ $\Delta kW_{SP} = 0.00006$
Annual Energy Savings[299]	HPWH: $\Delta kWh/yr = 84$ ERWH: $\Delta kWh/yr = 150$
Annual Water Savings	$\Delta Gallons/yr = 1,200$
GROSS ENERGY SAVINGS ALGORITHMS (UNIT SAVINGS)	
Demand Savings	$\Delta kW = \Delta kWh/yr \times F_{ED}$
Annual Energy Savings	$\Delta kWh/yr = N_{ppl} \times t \times 365 \times N_{showers} / N_{fixture} \times (GPM_{BASE} - GPM_{EE}) \times \rho_{H20} \times C_{H20} / 3{,}412 \times (T_{pou} - T_{in}) / RE_{EWH}$
Annual Water Savings	$\Delta Gallons/yr = N_{ppl} \times t \times 365 \times N_{showers} / N_{fixture} \times (GPM_{BASE} - GPM_{EE})$
Definitions	Unit = 1 efficient showerhead F_{ED} = Energy to 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 365 = Conversion: 365 day per year 60 = Conversion: 60 minutes per hour
EFFICIENCY ASSUMPTIONS	
Baseline Efficiency	Federal standards set a maximum 2.5 GPM for all showerheads manufactured after January 1, 1994.[300]
Efficient Measure	USEPA WaterSense High-efficiency Showerhead (2.0 GPM)[301]

[298] For consumer products where water heater type is unknown savings listed in TRM for ERWH are multiplied by 21% in effRT to account for the percent of water heaters that are electric resistance. NMR, 2015 Maine Residential Baseline Study.

[299] For consumer products where water heater type is unknown savings listed in TRM for ERWH are multiplied by 21% in effRT to account for the percent of water heaters that are electric resistance. NMR, 2015 Maine Residential Baseline Study.

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

[301] 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}	T_{pou}	Life (yrs)	Cost ($)
Low-flow Showerhead	7.83[302]	2.34[303]	0.61[304]	1.7[305]	2.5[300]	2.0[306]	101[307]	10[308]	actual

Measure	T_{in}	RE_{EWH}	F_{ED}
ERWH	50.8[309]	0.98[310]	0.00008013[311]
HPWH		3.5[312]	

IMPACT FACTORS

Measure	ISR	RR_E	RR_D	CF_S	CF_W	FR	SO
Retail	100%[313]	100%[314]	100%[314]	0.5%[315]	0.8%[315]	25%[316]	0%[317]
Low Income	100%[318]	100%[319]	100%[319]	0.5%[320]	0.8%[320]	0%[321]	0%[322]

302 The Cadmus Group and Opinion Dynamics, MEMD: Showerhead and Faucet Aerator Meter Study, June 2013. Prepare for Michigan Evaluation Working Group.
303 American Community Survey, 2011 1 year estimate for population of Maine: http://www.census.gov/acs/www/
304 The Cadmus Group and Opinion Dynamics, MEMD: Showerhead and Faucet Aerator Meter Study, June 2013. Prepare for Michigan Evaluation Working Group.
305 2009 Residential Energy Consumption Survey (RECS). Number of full bathrooms for single family detached home, microdata for CT, ME, NH, RI, and Vermont.
306 Measure flowrate: http://www.epa.gov/WaterSense/products/showerheads.html
307 The Cadmus Group and Opinion Dynamics, MEMD: Showerhead and Faucet Aerator Meter Study, June 2013. Prepare for Michigan Evaluation Working Group.
308 NREL, National Residential Efficiency Measure Database.
309 Standard Building America DHW Schedules, weighted average by population of all Maine water main sources.
310 NREL, Building America Research Benchmark Definition, 2009, p.12, http://www.nrel.gov/docs/fy10osti/47246.pdf
311 State of Pennsylvania, Technical Reference Manual, Rev date: March 2015, p.126.
312 Program heat pump water heater required energy factor.
313 EMT assumes that all purchased units are installed (i.e. .ISR = 100%). This is consistent with the MA 2013-2015 TRM.
314 This measure has not yet been evaluated. Until the next program impact evaluation, EMT assumes 100 percent realization rate.
315 See Appendix B: Coincidence and Energy Period Factors.
316 Program not yet evaluated, assume default FR of 25%.
317 Program not yet evaluated, assume default SO of 0%.
318 EMT assumes that all received units are installed (i.e. ISR = 100%). This is consistent with the MA 2013-2015 TRM.
319 This measure has not yet been evaluated. Until the next program impact evaluation, EMT assumes 100% realization rate.
320 See Appendix B: Coincidence and Energy Period Factors.
321 Program assumes no free ridership for Low Income programs.
322 Program not yet evaluated, assume default SO of 0%.

Thermostatic Shower Valve (TSV, LILFSH)	
Last Revised Date	7/1/2017
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. The savings assume all fixtures are served by electric resistance water heaters.
Primary Energy Impact	Electric (additional impacts include: water)
Sector	Residential
Program(s)	Appliance Rebate Program
End-Use	Domestic Hot Water
Decision Type	Retrofit
DEEMED ENERGY SAVINGS (UNIT SAVINGS)	
Demand Savings[323]	HPWH: $\Delta kW = 0.010$ $\Delta kW_{WP} = 0.00008$ $\Delta kW_{SP} = 0.00005$ ERWH: $\Delta kW = 0.035$ $\Delta kW_{WP} = 0.0003$ $\Delta kW_{SP} = 0.0002$
Annual Energy Savings[324]	HPWH: $\Delta kWh/yr = 123$ ERWH: $\Delta kWh/yr = 442$
Annual Water Savings	$\Delta Gallons/yr = 3,153$
GROSS ENERGY SAVINGS ALGORITHMS (UNIT SAVINGS)	
Demand Savings	$\Delta kW = \Delta kWh/yr \times F_{ED}$
Annual Energy Savings	$\Delta kWh/yr = N_{ppl} \times 365 \times N_{showers} / N_{fixture} \times \rho_{H20} \times C_{H20} / 3,412 \times (t \times (GPM_{BASE} - GPM_{EE}) \times (T_{pou} - T_{in}) + GPM_{BASE} \times t_W/60 \times (T_{WH} - T_{in})\ ) / RE_{EWH}$
Annual Water Savings	$\Delta Gallons/yr = N_{ppl} \times 365 \times N_{showers} / N_{fixture} \times (t \times (GPM_{BASE} - GPM_{EE}) + GPM_{BASE} \times t_W/60)$
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 365 = Conversion: 365 day per year 60 = Conversion: 60 minutes per hour F_{ED} = Energy to Demand factor

[323] For consumer products where water heater type is unknown savings listed in TRM for ERWH are multiplied by 21% in effRT to account for the percent of water heaters that are electric resistance. NMR, 2015 Maine Residential Baseline Study.

[324] For consumer products where water heater type is unknown savings listed in TRM for ERWH are multiplied by 21% in effRT to account for the percent of water heaters that are electric resistance. NMR, 2015 Maine Residential Baseline Study.

Thermostatic Shower Valve (TSV, LILFSH)	
EFFICIENCY ASSUMPTIONS	
Baseline Efficiency	Federal standards set a maximum 2.5 GPM for all showerheads manufactured after January 1, 1994.[325]
Efficient Measure	USEPA WaterSense High-efficiency Showerhead with Thermostatic Control Valve (1.5 GPM)[326]

PARAMETER VALUES (DEEMED)

Measure	N_{ppl}	$N_{showers}$	$N_{fixture}$	t	GPM_{BASE}	GPM_{EE}	T_{pou}	T_{in}	t_W
Low-flow Showerhead	2.34[327]	0.61[328]	1.7[329]	7.83[330]	2.5[331]	1.5[332]	101[333]	50.8[334]	59[335]
Measure	T_{WH}	RE_{HPWH}	F_{ED}					Life (yrs)	Cost ($)
ERWH	126.2[336]	0.98[337]	0.00008013[338]					10[339]	$30[340]
HPWH		3.5[341]							

IMPACT FACTORS

Measure	ISR	RR_E	RR_D	CF_S	CF_W	FR	SO
Retail	70%[342]	100%[343]	100%[344]	0.5%[345]	0.8%[346]	25%[347]	0%[348]
Low Income	70%[349]	100%[350]	100%[351]	0.5%[352]	0.8%[353]	0%[354]	0%[355]

[325] Federal Standard, Code of Federal Regulations, Title 10, Part 430, Subpart C.
[326] http://thinkevolve.com/wp-content/uploads/2014/11/evolve-1.5-gpm-Single-Function-Showerhead-with-ShowerStart-TSV.pdf
[327] American Community Survey, 2011 1 year estimate for population of Maine: http://www.census.gov/acs/www/
[328] Ibid.
[329] 2009 Residential Energy Consumption Survey (RECS). Number of full bathrooms for single family detached home, microdata for CT, ME, NH, RI, and Vermont.
[330] The Cadmus Group and Opinion Dynamics, MEMD: Showerhead and Faucet Aerator Meter Study, June 2013. Prepare for Michigan Evaluation Working Group.
[331] Federal Standard, Code of Federal Regulations, Title 10, Part 430, Subpart C.
[332] Measure flowrate: http://www.epa.gov/WaterSense/products/showerheads.html
[333] The Cadmus Group and Opinion Dynamics, MEMD: Showerhead and Faucet Aerator Meter Study, June 2013. Prepare for Michigan Evaluation Working Group.
[334] Standard Building America DHW Schedules, weighted average by population of all Maine water main sources.
[335] State of Pennsylvania, Technical Reference Manual, Rev date: March 2015, p. 126.
[336] NMR Group, Inc., Efficiency Maine Appliance Rebate Program Evaluation Overall Report – FINAL, July 18, 2014
[337] NREL, Building America Research Benchmark Definition, 2009, p.12, http://www.nrel.gov/docs/fy10osti/47246.pdf
[338] State of Pennsylvania, Technical Reference Manual, Rev date: March 2015, p. 126.
[339] 2010 Ohio TRM: conservative estimate based on review of TRM assumptions from other states.
[340] Based on program data. $40 TSV showerhead and $10 non-WaterSense showerhead.
[341] Program heat pump water heater required energy factor.
[342] Assumes same ISR as mailed kits.
[343] This measure has not yet been evaluated. Until the next program impact evaluation, EMT assumes 100 percent realization rate.
[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] See Appendix B: Coincidence and Energy Period Factors.
[347] Program not yet evaluated, assume default FR of 25%.
[348] Program not yet evaluated, assume default SO of 0%.
[349] ISR based on results of customer survey conducted in October 2016 by CLEAResult for kits mailed April-Sept 2016.
[350] This measure has not yet been evaluated. Until the next program impact evaluation, EMT assumes 100 percent realization rate.
[351] This measure has not yet been evaluated. Until the next program impact evaluation, EMT assumes 100 percent realization rate.
[352] See Appendix B: Coincidence and Energy Period Factors.
[353] See Appendix B: Coincidence and Energy Period Factors.
[354] Program assumes no free ridership for Low Income programs
[355] Program not yet evaluated, assume default SO of 0%.

Heat Pump Water Heater (HPWH)	
Last Revised Date	7/1/2017
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. Savings are counted only for the improved water heater efficiency.[356] 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
End-Use	Domestic Hot Water
Decision Type	New Construction, Replace on Burnout
DEEMED GROSS ENERGY SAVINGS (UNIT SAVINGS)	
Demand Savings	$\Delta kW_{SP} = 0.195$ $\Delta kW_{WP} = 0.417$
Annual Energy Savings	$\Delta kWh/yr = 2{,}115$
GROSS ENERGY SAVINGS ALGORITHMS (UNIT SAVINGS)	
Demand Savings	$\Delta kW_{SP} = \Delta kW_{SP}/y_{Evaluated}$ *Scaling factor Demand - Summer Peak kW savings from a HPWH field-evaluation study scaled for a COP of 3.35 $\Delta kW_{WP} = \Delta kW_{WP}/y_{Evaluated}$ *Scaling factor Demand - Winter Peak kW savings from a HPWH field-evaluation study scaled for a COP of 3.35
Annual Energy Savings	$\Delta kWh/yr = \Delta kWh/yr_{Evaluated}$ *Scaling factor Energy - Annual kWh savings from a HPWH field-evaluation study scaled for a COP of 3.35 Key assumptions include: • Average tank size for the Efficiency Maine Trust (EMT) in-program HPWHs is approximately 50 gallons.[357] • Typical HPWH set-point temperature in Maine households is expected to be comparable to the set-point temperature in Massachusetts and Rhode Island households metered.[358] • Most, if not all, of EMT's in-program HPWHs will be installed in conditioned or partially conditioned spaces (i.e. regulated temperature and/or humidity), as was the case for most HPWH units studied in the evaluation[359] • Realized energy savings scale by COP and water use as follows: Scaling factor energy = $(1/COP_{BASE} - 1/COP_{EE})/(1/COP_{BASE\_STUDY} - 1/COP_{STUDY}) * WU_{ME}/WU_{STUDY} =$ 1.254 • Realized demand savings scale by COP as follows: Scaling factor demand = $(1/COP_{BASE} - 1/COP_{EE})/(1/COP_{BASE\_STUDY} - 1/COP_{STUDY}) = 1.116$ Where ○ $COP_{BASE\_STUDY} = 0.904$ – coefficient of performance for standard 50 gallon water heater included in the study[360]

[356] 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.

[357] NMR Group, Inc., Efficiency Maine Appliance Rebate Program Evaluation Overall Report – FINAL, July 18, 2014, Table 2-31; at least 89 percent of HPWH units in EMT program are 50 gallons units (with the remaining 11 percent with unknown tank size). Steven Winter Associates Inc., Heat Pump Water Heaters, Evaluation of Field Installed Performance, June 26, 2012 included 10 units with 50 gallon tanks; 1 unit with a 60 gallon tank; and 3 units with 80 gallon tanks.

[358] NMR Group, Inc., Efficiency Maine Appliance Rebate Program Evaluation Overall Report – FINAL, July 18, 2014, Table 2-35; the average set-point temperature in Maine is 126.2°F, compared to the average set-point temperature of 127.6°F found in Steven Winter Associates Inc., Heat Pump Water Heaters, Evaluation of Field Installed Performance, June 26, 2012.

[359] Considering Maine's climate (winter), it can be anticipated that most, if not all, properly installed HPWHs will be installed in fully or partially conditioned spaces.

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

Heat Pump Water Heater (HPWH)							
	○ COP_{STUDY} = 2.35 – average rated coefficient of performance of water heaters included in the study[361] ○ COP_{BASE} = 0.945 – coefficient of performance for standard 50 gallon water heater • COP_{EE} = 3.35 – Average EF of a participating Heat Pump Water Heater based on PY 2017 sales data for the time period of 3/23/17 - 4/7/17 (reflects new models entering the marketplace) • WU_{ME} = 51.1[362] • WU_{STUDY} = 45.5[363]						
EFFICIENCY ASSUMPTIONS							
Baseline Efficiency	Standard 50-gallon residential water heater with an AHRI Energy Factor = 0.945.[364]						
Efficient Measure	ENERGY STAR®-certified model (EF = 3.11[365])						
PARAMETER VALUES (DEEMED)							
Measure	%RES	%COMM	Life (yrs)	Cost ($)			
ENERGY STAR® HPWH	98%[366]	2%[366]	13[367]	1,028[368]			
	$\Delta kWh/y_{Evaluated}$	$\Delta kW_{SP,\ Evaluated}$	$\Delta kW_{WP,\ Evaluated}$	Scaling factors			
				Energy	Demand		
ENERGY STAR® HPWH	1,687	0.175	0.374	1.254	1.116		
IMPACT FACTORS							
Measure	ISR	RR_E	RR_D	CF_S	CF_W	FR	SO
ENERGY STAR® HPWH	100%[369]	100%[370]	100%[370]	100%[371]	100%[371]	21.0%[372]	3.3%[372]

[361] Steven Winter Associates Inc., Heat Pump Water Heaters, Evaluation of Field Installed Performance, June 26, 2012, Table 1.
[362] For Maine, 51.1 GPD is used 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.
[363] Average GPD found in the Steven Winter Associates Inc., Heat Pump Water Heaters, Evaluation of Field Installed Performance, June 26, 2012, was 45.5 GPD.
[364] Federal Standard, Code of Federal Regulations, Title 10, Part 430, Subpart C. EF = 0.945 value is calculated for 50-gallon water heater.
[365] Average EF of a 50 gallon Heat Pump Water Heater based on PY 2016 sales data for the time period of 3/3/16-4/7/16.
[366] 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.
[367] NREL, National Residential Efficiency Measure Database.
[368] Incremental cost for 40-50-gallon unit, based on water heater cost market research conducted by CleaResult, August 2017. Weighted average MSRP for heat pump water heaters rebated between Feb-Oct 2017 is $1,379 and average retail price for top selling electric resistance water heater is $352 based on November 2017 shelf prices from Home Depot, and Lowe's.
[369] NMR Group, Inc., Efficiency Maine Appliance Rebate Program Evaluation Overall Report – FINAL, July 18, 2014, p. 60.
[370] Realization rates are 100 percent since savings estimates are based on evaluation results.
[371] Peak coincidence factors for this measure are embedded in the evaluated peak demand impacts.
[372] NMR Group, Inc., Efficiency Maine Appliance Rebate Program Evaluation Overall Report – FINAL, July 18, 2014, Table 2-41.

Wi-Fi Enabled Thermostat (WIFITSTAT)	
Last Revised Date	2/1/2016 (new measure)
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
End-Use	Heating and Cooling
Decision Type	Retrofit
DEEMED GROSS ENERGY SAVINGS (UNIT SAVINGS)	
Demand Savings	$\Delta kW = 0$
Annual Energy Savings	Electric Savings: $\Delta kWh/yr = 2$ Fuel Savings: $\Delta MMBtu/yr = 11.4$ Fuel Savings by Type: $\Delta MMBtu_{GAS} = 1.2$ $\Delta MMBtu_{PROP} = 0.8$ $\Delta MMBtu_{OIL} = 8.5$ $\Delta MMBtu_{KERO} = 0.8$
GROSS ENERGY SAVINGS ALGORITHMS (UNIT SAVINGS)	
Demand Savings	$\Delta kW = 0$
Annual Energy Savings	Electric: $\Delta kWh/yr = CSF \times \%COOL \times SEER \times CL + HSF \times HC / 0.003412 \times \%FUEL$ Fuel: $\Delta MMBtu/yr = HSF \times HC$ $\Delta MMBtu_{FUEL} = \Delta MMBtu/yr \times \%FUEL$
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 excluding wood, coal and other
EFFICIENCY ASSUMPTIONS	
Baseline Efficiency	Standard non-programmable thermostat
Efficient Measure	Wi-Fi enabled thermostat

PARAMETER VALUES (DEEMED)

Measure	CSF	%COOL	CL	HSF	HC	%FUEL	Life (yrs)	Cost ($)
Wi-Fi Thermostat	16%[373]	2.4%[374]	6.4[374]	10%[375]	114[374]	Table E-1	10[376]	$249[377]

IMPACT FACTORS

Measure	ISR	RR_E	RR_D	CF_S	CF_W	FR	SO
ENERGY STAR® HPWH	100%[378]	100%[379]	100%[379]	100%[380]	100%[380]	25%[381]	0%[382]

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[373] Based on electricity savings per thermostat from Cadmus Group, Wi-Fi Programmable Controllable Thermostat Pilot Program Evaluation, September 2012.
[374] NMR Group, Maine Single-Family Residential Baseline Study, September 14, 2015.
[375] Based on gas savings per thermostat from Cadmus Group, Wi-Fi Programmable Controllable Thermostat Pilot Program Evaluation, September 2012.
[376] 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.
[377] Based on online pricing from multiple retailers as of February 2016.
[378] This measure has not yet been evaluated. Until the next program impact evaluation, EMT assumes 100 percent ISR.
[379] This measure has not yet been evaluated. Until the next program impact evaluation, EMT assumes 100 percent Realization Rate.
[380] Peak coincidence factors for this measure are embedded in the evaluated peak demand impacts.
[381] Program not yet evaluated, assume default FR of 25%.

Home Energy Savings Program

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

Custom Path (T1,T2)								
Last Revised Date	7/1/2016							
MEASURE OVERVIEW								
Description	The HESP custom path involves multiple energy-efficiency measures that achieve at least 20 percent energy savings compared to baseline annual energy consumption.[383]							
Energy Impacts	Electric, Natural Gas, Heating Oil, Propane, Kerosene, Wood, Pellet							
Sector	Residential							
Program(s)	Home Energy Savings Program							
End-Use	Lighting, Heating, Cooling, Domestic Hot Water, Refrigeration, Appliances							
Decision Type	Retrofit							
DEEMED GROSS ENERGY SAVINGS (UNIT SAVINGS)								
Demand savings	ΔkW = NA							
Annual energy savings	*Annual energy savings depend on project-specific data.*							
GROSS ENERGY SAVINGS ALGORITHMS (UNIT SAVINGS)								
Demand savings	ΔkW = NA[384]							
Annual Energy savings	If fuel known: $\Delta MMBtu_{FUEL} = \Delta MMBTU$ If fuel is unknown: $\Delta kWh = \Delta MMBTU \times \%FUEL \times (1{,}000 / 3.412)$ $\Delta MMBtu_{FUEL} = \Delta MMBTU \times \%FUEL$							
Definitions	Unit = HESP custom project ΔMMBTU = Annual energy savings predicted using the Real Home Analyzer (RHA) building simulation software (MMBtu) or other approved modeling software %FUEL = Home heating fuel distribution excluding coal and other to be used when fuel type is unknown[385]							
EFFICIENCY ASSUMPTIONS								
Baseline Efficiency	The baseline case is the baseline annual energy consumption of the existing home, before any energy-efficiency measures are installed.							
Efficient Measure	The high-efficiency case involves multiple measures that reduce baseline annual energy consumption by a minimum of 20 percent. The energy savings estimate is based on building energy simulation using the RHA or other approved modeling software.							
PARAMETER VALUES								
Measure	ΔMMBTU	%FUEL				Life (yrs)	Cost ($)	
Custom Path	Model[386]	Table E-1				20[387]	Actual	
IMPACT FACTORS								
Measure	ISR	RR_E	RR_D	CF_S	CF_W	FR	SO	
Custom Path	100%	100%[388]	NA	10.7[389]	79.7[389]	25%[390]	0%[391]	

[383] While not limited to any specific energy-efficiency measure, it is expected that a vast majority of projects in the HESP Custom Path will be weatherization measures that do not perfectly align with the prescriptive weatherization measures offered as part of the Home Energy Savings Program.
[384] While there may be some net kW impact associated with Custom Path measures, they are expected to be insignificant in magnitude, and therefore assumed to be negligible.
[385] Heating fuel distribution is used to allocate savings to different fuels because the vast majority of the HESP Custom Path projects are expected to be weatherization measures, which predominantly impact the home's heating energy consumption.
[386] Annual energy savings are determined on a case-by-case basis by performing building energy simulations using the Real Home Analyzer (RHA) or other approved modeling software.
[387] 20 years is assumed by EMT. Prescriptive building envelope insulation measures in the Home Energy Savings Program have measure lives of 25 years. To account for any projects that are not weatherization measures and potentially have shorter measure lives, the measure life was adjusted down 20 percent to 20 years.
[388] The measure has not yet been evaluated. Until the next program impact evaluation, EMT assumes 100 percent realization rate.
[389] Since most custom path projects will be related to weatherization and savings will be for heating and cooling, the same factors as Ductless Heat Pump are assumed.
[390] Program not yet evaluated, assume default FR of 25%.
[391] Program not yet evaluated, assume default SO of 0%.

Air Sealing (AA, LAA)		
Last Revised Date	7/1/2016	
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	Electric, Natural Gas, Oil, Propane, Wood, Kerosene	
Sector	Residential	
Program(s)	Home Energy Savings Program	
End-Use	Heating, Cooling	
Decision Type	Retrofit	
DEEMED GROSS ENERGY SAVINGS (UNIT SAVINGS)		
Demand savings	$\Delta kW_{SP} = 0.023$ $\Delta kW_{WP} = 0.000$	
Annual energy savings	For electric heat: $\Delta kWh = 2953$ For non-electric heat: $\Delta kWh = 12.816$ $\Delta MMBtu = 10.033$	If fuel is unknown distribute savings based on % Fuel $\Delta kWh = 36$ $\Delta MMBtu_{GAS} = 0.914$ $\Delta MMBtu_{OIL} = 6.601$ $\Delta MMBtu_{WOOD} = 1.219$ $\Delta MMBtu_{PROP} = 0.609$ $\Delta MMBtu_{KERO} = 0.609$
GROSS ENERGY SAVINGS ALGORITHMS (UNIT SAVINGS)		
Demand savings	$\Delta kW = \Delta kWh_{COOL} \times LSF_{SP} \times \%COOL$	
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 known electric heat: $\Delta kWh = \Delta MMBtu_{HEAT} / 0.003412 / EFF + \Delta MMBtu_{COOL} / EER \times 1000 \times \%COOL$ For unknown fuel: $\Delta MMBtu_{FUEL} = \Delta MMBtu_{HEAT} / EFF \times \%FUEL$ $\Delta kWh = \Delta MMBtu_{HEAT} / 0.003412 / EFF \times \%FUEL + \Delta MMBtu_{COOL} / EER \times 1000 \times \%COOL$	
Definitions	Unit = Air sealing project $\Delta MMBtu_{HEAT}$ = Reduction in annual heat loss due to improved insulation and associated air sealing derived from temperature bin analysis using Typical Meteorological Year 3 (TMY3) $\Delta MMBtu_{COOL}$ = Reduction in annual heat gain due to improved insulation and associated air sealing derived from temperature bin analysis using TMY3 EFF = Efficiency factor of representative heating system (Btu/Btu) EER = Energy-efficiency ratio of representative cooling system (Btu/Wh) %FUEL = Home heating fuel distribution excluding coal and other[392] LSF_{SP} = Summer 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)	
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.	

392 Heating fuel distribution is used when heating system fuel is unknown.

Air Sealing (AA, LAA)

PARAMETER VALUES (DEEMED)

Measure	$\Delta CFM50$	$\Delta MMBtu_{HEAT}$	$\Delta MMBtu_{COOL}$	%COOL	LSF_{SP}	%FUEL	Life (yrs)	Cost ($)
Air Sealing	593[393]	8.077[394]	0.238[394]	53%[395]	0.00176[396]	Table E-1	15[397]	$700[398]
Measure	EFF	EER						
Air Sealing	80.5[399]	9.8[400]						

IMPACT FACTORS

Measure	ISR	RR_E	RR_D	CF_S	CF_W	FR	SO
Air Sealing	100%[401]	100%[402]	100%[402]	100%[403]	100%[403]	25%[404]	0%[405]
Low Income Air Sealing						0%[406]	

393 Average participant improvement in cubic feet per minute at 50 pounds per square inch pressure, Opinion Dynamics, Evaluation of the Efficiency Maine Trust PACE, PowerSaver, and RDI Programs – Final Evaluation Report, Volume II: Residential Direct Install Program, October 2013.

394 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. CFM50 converted to cubic feet per hour (CFH) at natural pressure using 14.8 LBNL factor. Btu savings estimated using 0.018 Btu/CFH natural/delta temperature* hours per year for each delta temperature. Delta temperature defined as ambient minus 65 degrees F for heating season and 70 degrees F minus ambient temperature for cooling season.

395 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%).

396 Based on temperature bin analysis of ductless heat pump seasonal cooling using TMY3 temperature bins.

397 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.

398 Average cost of sampled 2016 projects where attic insulation was itemized separately on contractor invoice (N=51).

399 Representative heating system efficiency NMR Group, Maine Single-Family Residential Baseline Study, September 14, 2015.

400 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.

401 ISR is 100 percent because deemed savings results are based on evaluated results that include installation verification.

402 The measure has not yet been evaluated. Until the next program impact evaluation, EMT assumes 100 percent realization rate.

403 Peak coincidence factors for this measure are embedded in the evaluated peak demand impacts.

404 Program not yet evaluated, assume default FR of 25%.

405 Program not yet evaluated, assume default SO of 0%.

406 Program assumes no free ridership for the LIHESP program

<table>
<tr><th colspan="3">Attic/Roof Insulation All Fuels (excluding natural gas) (BA, LBA)</th></tr>
<tr><td>Last Revised Date</td><td colspan="2">7/1/2016</td></tr>
<tr><td colspan="3">MEASURE OVERVIEW</td></tr>
<tr><td>Description</td><td colspan="2">This measure involves the insulation of the attic floor 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 attic/roof insulation and improved air sealing.</td></tr>
<tr><td>Energy Impacts</td><td colspan="2">Electric, Oil, Propane, Wood, Kerosene</td></tr>
<tr><td>Sector</td><td colspan="2">Residential</td></tr>
<tr><td>Program(s)</td><td colspan="2">Home Energy Savings Program</td></tr>
<tr><td>End-Use</td><td colspan="2">Heating, Cooling</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">$\Delta kW_{SP} = 0.043$
$\Delta kW_{WP} = 0.0$</td></tr>
<tr><td>Annual energy savings</td><td>For electric heat:
$\Delta kWh = 5661$

For non-electric heat:
$\Delta kWh = 25$
$\Delta MMBtu = 19.315$</td><td>If fuel is unknown distribute savings based on % Fuel
$\Delta kWh = 75$
$\Delta MMBtu_{GAS} = 0$
$\Delta MMBtu_{OIL} = 13.847$
$\Delta MMBtu_{WOOD} = 2.500$
$\Delta MMBtu_{PROP} = 1.346$
$\Delta MMBtu_{KERO} = 1.346$</td></tr>
<tr><td></td><td colspan="2"></td></tr>
<tr><td colspan="3">GROSS ENERGY SAVINGS ALGORITHMS (UNIT SAVINGS)</td></tr>
<tr><td>Demand savings</td><td colspan="2">$\Delta kW = \Delta kWh_{COOL} \times LSF_{SP} \times \%COOL$</td></tr>
<tr><td>Annual Energy savings</td><td colspan="2">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 known electric heat: $\Delta kWh = \Delta MMBtu_{HEAT} / 0.003412 / EFF + \Delta MMBtu_{COOL} / EER \times 1000 \times \%COOL$
For unknown fuel: $\Delta MMBtu_{FUEL} = \Delta MMBtu_{HEAT} / EFF \times \%FUEL$
$\Delta kWh = \Delta MMBtu_{HEAT} / 0.003412 / EFF \times \%FUEL + \Delta MMBtu_{COOL} / EER \times 1000 \times \%COOL$</td></tr>
<tr><td>Definitions</td><td colspan="2">Unit = Attic/roof insulation project
$\Delta MMBtu_{HEAT}$ = Reduction in annual heat loss due to improved insulation and associated air sealing derived from temperature bin analysis using TMY3
$\Delta MMBtu_{COOL}$ = Reduction in annual heat gain due to improved insulation and associated air sealing derived from temperature bin analysis using TMY3
EFF = Efficiency factor of representative heating system (Btu/Btu)
EER = Energy-efficiency ratio of representative cooling system (Btu/Wh)
%FUEL = Home heating fuel distribution excluding natural gas, coal and other[407]
LSF_{SP} = Summer 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)
SQFT = Area of attic insulation (ft^2) assumed in temperature bin analysis
$RVAL_{PRE}$ = Pre-upgrade attic R-value (ft^2-°F-hr/Btu) assumed in temperature bin analysis
$RVAL_{POST}$ = Post-upgrade attic R-value (ft^2-°F-hr/Btu) assumed in temperature bin analysis</td></tr>
</table>

[407] Heating fuel distribution is used to allocate savings to different fuels because the savings achieved through insulation impact the home's heating energy consumption.

Attic/Roof Insulation All Fuels (excluding natural gas) (BA, LBA)

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	$\Delta MMBtu_{HEAT}$	$\Delta MMBtu_{COOL}$	EFF	EER	%FUEL	Life (yrs)	Cost ($)
Attic/Roof Insulation	15.481[408]	0.455[408]	80.5[409]	9.8[410]	Table E-1	25[411]	2,617[412]

Measure	SQFT	$RVAL_{PRE}$	$RVAL_{POST}$	LSF_{SP}		%COOL	$\Delta CFM50$
Attic/Roof Insulation	986[413]	13.3[414]	50.8[415]	0.00176[416]		53%[417]	387[418]

IMPACT FACTORS

Program	ISR	RR_E	RR_D	CF_S	CF_W	FR[419, 420]	SO[421]
HESP	100%[422]	100%[423]	100%[423]	100%[424]	100%[424]	25%	0%
LIHESP						0%	

[408] 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 ambient minus 65 degrees F for heating season and 70 degrees F minus ambient temperature for cooling season.

[409] Representative heating system efficiency based on NMR Group, Maine Single-Family Residential Baseline Study, September 14, 2015.

[410] 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.

[411] 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.

[412] Average cost of sampled 2016 projects where attic insulation was itemized separately on contractor invoice (N=58).

[413] Representative square footage for a footprint of 32 ft x 40 ft and 23 percent framing. Representative footprint based on average square footage from NMR Residential Baseline Study, 2015 and General Housing Data - All Occupied Units (National) 2013 American Housing Survey.

[414] Average pre and post cavity R-values from FY16 projects consisting of only air sealing and attic insulation.

[415] Ibid.

[416] Based on temperature bin analysis of ductless heat pump seasonal cooling using TMY3 temperature bins.

[417] 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 79percent, 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%).

[418] Based on FY16 project blower-door tests for projects consisting of only air sealing and attic insulation minus the average CFM50 reduction of air sealing only projects. CFM50 converted to CFH natural using 14.8 LBNL factor. Btu savings estimated using 0.018 Btu/CFH natural/delta temperature* hours per year for each delta temperature.

[419] HESP Program not yet evaluated, assume default FR of 25%.

[420] Program assumes no free ridership for the LIHESP program

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

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

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

[424] Peak coincidence factors for this measure are embedded in the evaluated peak demand impacts.

Attic/Roof Insulation Natural Gas (BA, LBA)	
Last Revised Date	7/1/2016
MEASURE OVERVIEW	
Description	This measure involves the insulation of the attic floor to decrease heating and cooling losses in homes heated with natural gas where the existing attic insulation is rated at R-8 or lower. The participant must also complete a comprehensive air-sealing project. The total savings below reflect savings due to the added attic/roof insulation and improved air sealing.
Energy Impacts	Natural Gas
Sector	Residential
Program(s)	Home Energy Savings Program
End-Use	Heating, Cooling
Decision Type	Retrofit
DEEMED GROSS ENERGY SAVINGS (UNIT SAVINGS)	
Demand savings	$\Delta kW_{SP} = 0.069$ $\Delta kW_{WP} = 0.0$
Annual energy savings	$\Delta kWh = 39$ $\Delta MMBtu_{NG} = 30.615$
GROSS ENERGY SAVINGS ALGORITHMS (UNIT SAVINGS)	
Demand savings	$\Delta kW = \Delta kWh_{COOL} \times LSF_{SP} \times \%COOL$
Annual Energy savings	$\Delta MMBtu_{FUEL} = \Delta MMBtu_{HEAT} / EFF$ $\Delta kWh = \Delta MMBtu_{COOL} / EER \times 1000 \times \%COOL$
Definitions	Unit = Attic/roof insulation project $\Delta MMBtu_{HEAT}$ = Reduction in annual heat loss due to improved insulation and associated air sealing derived from temperature bin analysis using TMY3 $\Delta MMBtu_{COOL}$ = Reduction in annual heat gain due to improved insulation and associated air sealing derived from temperature bin analysis using TMY3 EFF = Efficiency factor of representative heating system (Btu/Btu) EER = Energy-efficiency ratio of representative cooling system (Btu/Wh) %FUEL = Home heating fuel distribution excluding coal and other[425] LSF_{SP} = Summer 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) SQFT = Area of attic insulation (ft^2) assumed in temperature bin analysis $RVAL_{PRE}$ = Pre-upgrade attic R-value (ft^2-°F-hr/Btu) assumed in temperature bin analysis $RVAL_{POST}$ = Post-upgrade attic R-value (ft^2-°F-hr/Btu) assumed in temperature bin analysis
EFFICIENCY ASSUMPTIONS	
Baseline Efficiency	The baseline is the existing (pre-upgrade) insulation
Efficient Measure	The high-efficiency case is the upgraded insulation

425 Heating fuel distribution is used to allocate savings to different fuels because the savings achieved through insulation impact the home's heating energy consumption.

Attic/Roof Insulation Natural Gas (BA, LBA)							
PARAMETER VALUES (DEEMED)							
Measure	$\Delta MMBtu_{HEAT}$	$\Delta MMBtu_{COOL}$	EFF	EER	%FUEL	%COOL	ΔCFM50
Attic/Roof Insulation	24.645[426]	0.725[426]	80.5[427]	9.8[428]	Table E-1	53%[429]	387[430]
Measure	SQFT	$RVAL_{PRE}$	$RVAL_{POST}$	LSF_{SP}		Life (yrs)	Cost ($)
Attic/Roof Insulation	986[431]	8[432]	50.8[433]	0.00176[434]		25[435]	2,617[436]
IMPACT FACTORS							
Program	ISR	RR_E	RR_D	CF_S	CF_W	FR[437, 438]	SO[439]
HESP	100%[440]	100%[441]	100%[423]	100%[442]	100%[424]	25%	0%
LIHESP						0%	

[426] 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 ambient minus 65 degrees F for heating season and 70 degrees F minus ambient temperature for cooling season.

[427] Representative heating system efficiency based on NMR Group, Maine Single-Family Residential Baseline Study, September 14, 2015.

[428] 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.

[429] 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% 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 21percent have no cooling equipment installed. Assuming that the 39 percent of homes with 1 or 2 window units are equivalent to 33 percent of whole home cooling, the resulting equivalent cooling for all homes is 53percent (40%*100% + 39%*33%).

[430] Based on FY16 project blower door tests for projects consisting of only air sealing and attic insulation minus the average CFM50 reduction of air sealing only projects. CFM50 converted to CFH natural using 14.8 LBNL factor. Btu savings estimated using 0.018 Btu/CFH natural/delta temperature* hours per year for each delta temperature.

[431] Representative square footage for a footprint of 32 ft x 40 ft and 23 percent framing. Representative footprint based on average square footage from NMR Residential Baseline Study, 2015 and General Housing Data - All Occupied Units (National) 2013 American Housing Survey.

[432] Program pre-condition criteria.

[433] Average pre and post cavity R-values from FY16 projects consisting of only air sealing and attic insulation.

[434] Based on temperature bin analysis of ductless heat pump seasonal cooling using TMY3 temperature bins.

[435] 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.

[436] Average cost of sampled 2016 projects where attic insulation was itemized separately on contractor invoice (N=58).

[437] HESP Program not yet evaluated, assume default FR of 25%.

[438] Program assumes no free ridership for the LIHESP program

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

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

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

[442] Peak coincidence factors for this measure are embedded in the evaluated peak demand impacts.

Wall Insulation (BW, LBW)		
Last Revised Date	7/1/2016	
MEASURE OVERVIEW		
Description	This measure involves the insulation of exterior walls 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.	
Energy Impacts	Electric, Natural Gas, Oil, Propane, Wood, Kerosene	
Sector	Residential	
Program(s)	Home Energy Savings Program	
End-Use	Heating, Cooling	
Decision Type	Retrofit	
DEEMED GROSS ENERGY SAVINGS (UNIT SAVINGS)		
Demand savings	ΔkW_{SP} = 0.16 ΔkW_{WP} = 0.0	
Annual energy savings	For electric heat: ΔkWh = 21,044 For non-electric heat: ΔkWh = 91 $\Delta MMBtu$ = 71.492	If fuel is unknown distribute savings based on % Fuel ΔkWh = 259 $\Delta MMBtu_{GAS}$ = 6.512 $\Delta MMBtu_{OIL}$ = 47.034 $\Delta MMBtu_{WOOD}$ = 8.683 $\Delta MMBtu_{PROP}$ = 4.342 $\Delta MMBtu_{KERO}$ = 4.342
GROSS ENERGY SAVINGS ALGORITHMS (UNIT SAVINGS)		
Demand savings	$\Delta kW = \Delta kWh_{COOL} \times LSF_{SP} \times \%COOL$	
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 known electric heat: $\Delta kWh = \Delta MMBtu_{HEAT} / 0.003412 / EFF + \Delta MMBtu_{COOL} / EER \times 1000 \times \%COOL$ For unknown fuel: $\Delta MMBtu_{FUEL} = \Delta MMBtu_{HEAT} / EFF \times \%FUEL$ $\Delta kWh = \Delta MMBtu_{HEAT} / 0.003412 / EFF \times \%FUEL + \Delta MMBtu_{COOL} / EER \times 1000 \times \%COOL$	
Definitions	Unit = Exterior walls insulation project $\Delta MMBtu_{HEAT}$ = Reduction in annual heat loss due to improved insulation and associated air sealing derived from temperature bin analysis using TMY3 $\Delta MMBtu_{COOL}$ = Reduction in annual heat gain due to improved insulation and associated air sealing derived from temperature bin analysis using TMY3 EFF = Efficiency factor of representative heating system (Btu/Btu) EER = Energy-efficiency ratio of representative cooling system (Btu/Wh) %FUEL = Home heating fuel distribution excluding coal and other[443] LSF_{SP} = Summer 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) SQFT = Area of wall insulation (ft^2) assumed in temperature bin analysis $RVAL_{PRE}$ = Pre-upgrade R-value (ft^2-°F-hr/Btu) assumed in temperature bin analysis $RVAL_{POST}$ = Post-upgrade R-value (ft^2-°F-hr/Btu) assumed in temperature bin analysis $\Delta CFM50$ = Change in air leakage resulting from improved air sealing assumed in temperature bin analysis	

[443] Heating fuel distribution is used to allocate savings to different fuels because the savings achieved through insulation impact the home's heating energy consumption.

Wall Insulation (BW, LBW)

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	$\Delta MMBtu_{HEAT}$	$\Delta MMBtu_{COOL}$	EFF	EER	%FUEL	%COOL	ΔCFM50
Wall Insulation	57.551[444]	1.693[444]	80.5[445]	9.8[446]	Table E-1	53%[447]	816[448]

Measure	SQFT	$RVAL_{PRE}$	$RVAL_{POST}$	LSF_{SP}	Life (yrs)	Cost ($)
Wall Insulation	1,148[449]	3.6[450]	16.4[451]	0.00176[452]	25[453]	2,735[454]

IMPACT FACTORS

Program	ISR	RR_E	RR_D	CF_S	CF_W	FR[455, 456]	SO
HESP	100%[457]	100%[458]	100%[423]	100%[459]	100%[424]	25%	0%[460]
LIHESP						0%	

[444] 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 ambient minus 65 degrees F for heating season and 70 degrees F minus ambient temperature for cooling season.

[445] Representative heating system efficiency based on NMR Group, Maine Single-Family Residential Baseline Study, September 14, 2015.

[446] 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.

[447] 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 percent of whole home cooling, the resulting equivalent cooling for all homes is 53 percent (40%*100% + 39%*33%).

[448] Based on RHA data for HESP1 project in 2010 and 2011. Average CFM50 reduction across all insulation types was 1712 CFM50. From this 514 CFM50 was subtracted to account for the air-sealing reduction based on RDI evaluation and the result divided in half to account for multiple zones per project. 600 CFM50 per insulation zone assumed in the temperature bin analysis. CFM50 converted to CFH natural using 14.8 LBNL factor. Btu savings estimated using 0.018 Btu/CFH natural/delta temperature* hours per year for each delta temperature.

[449] Representative square footage for a footprint of 32 ft x 40 ft, 1.5 stories, 23 percent framing and 183 square feet of windows and doors. Representative footprint and stories based on average square footage from NMR Residential Baseline Study, 2015 and General Housing Data - All Occupied Units (National) 2013 American Housing Survey.

[450] Average pre and post cavity R-values from FY16 projects consisting of only air sealing and wall insulation.

[451] Ibid.

[452] Based on temperature bin analysis of ductless heat pump seasonal cooling using TMY3 temperature bins.

[453] 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.

[454] Average cost of sampled 2016 projects where wall insulation was itemized separately on contractor invoice (N=42)

[455] Program not yet evaluated, assume default FR of 25%.

[456] Program assumes no free ridership for the LIHESP program

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

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

[459] Peak coincidence factors for this measure are embedded in the evaluated peak demand impacts.

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

Basement Insulation (BB, LBB)		
Last Revised Date	7/1/2016	
MEASURE OVERVIEW		
Description	This measure involves the insulation of 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.	
Energy Impacts	Electric, Natural Gas, Oil, Propane, Wood, Kerosene	
Sector	Residential	
Program(s)	Home Energy Savings Program	
End-Use	Heating, Cooling	
Decision Type	Retrofit	
DEEMED GROSS ENERGY SAVINGS (UNIT SAVINGS)		
Demand savings	ΔkW_{SP} = 0.011 ΔkW_{WP} = 0.0	
Annual energy savings	For electric heat: ΔkWh = 11,175 For non-electric heat: ΔkWh = 6 $\Delta MMBtu$ = 38.130	If fuel is unknown distribute savings based on % Fuel ΔkWh = 96 $\Delta MMBtu_{GAS}$ = 3.471 $\Delta MMBtu_{OIL}$ = 25.071 $\Delta MMBtu_{WOOD}$ = 4.629 $\Delta MMBtu_{PROP}$ = 2.314 $\Delta MMBtu_{KERO}$ = 2.314
GROSS ENERGY SAVINGS ALGORITHMS (UNIT SAVINGS)		
Demand savings	$\Delta kW = \Delta kWh_{COOL} \times LSF_{SP} \times \%COOL$	
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 known electric heat: $\Delta kWh = \Delta MMBtu_{HEAT} / 0.003412 / EFF + \Delta MMBtu_{COOL} / EER \times 1000 \times \%COOL$ For unknown fuel: $\Delta MMBtu_{FUEL} = \Delta MMBtu_{HEAT} / EFF \times \%FUEL$ $\Delta kWh = \Delta MMBtu_{HEAT} / 0.003412 / EFF \times \%FUEL + \Delta MMBtu_{COOL} / EER \times 1000 \times \%COOL$	
Definitions	Unit = Exterior walls insulation project $\Delta MMBtu_{HEAT}$ = Reduction in annual heat loss due to improved insulation and associated air sealing derived from temperature bin analysis using TMY3 $\Delta MMBtu_{COOL}$ = Reduction in annual heat gain due to improved insulation and associated air sealing derived from temperature bin analysis using TMY3 EFF = Efficiency factor of representative heating system (Btu/Btu) EER = Energy-efficiency ratio of representative cooling system (Btu/Wh) %FUEL = Home heating fuel distribution excluding coal and other[461] LSF_{SP} = Summer 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) SQFT = Area of basement insulation (ft^2) assumed in temperature bin analysis $RVAL_{PRE}$ = Pre-upgrade R-value (ft^2-°F-hr/Btu) assumed in temperature bin analysis $RVAL_{POST}$ = Post-upgrade R-value (ft^2-°F-hr/Btu) assumed in temperature bin analysis	

[461] Heating fuel distribution is used to allocate savings to different fuels because the savings achieved through insulation impact the home's heating energy consumption.

Basement Insulation (BB, LBB)							
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	$\Delta MMBtu_{HEAT}$	$\Delta MMBtu_{COOL}$	EFF	EER	%FUEL	%COOL	ΔCFM50
Basement Insulation	30.677[462]	0.119[463]	80.5[464]	9.8[465]	Table E-1	53%[466]	298[467]
Measure	SQFT	$RVAL_{PRE}$	$RVAL_{POST}$	LSF_{SP}	Life (yrs)	Cost ($)	
Basement Insulation	432[468]	1.4[469]	15.4[470]	0.00176[471]	25[472]	2,688[473]	
IMPACT FACTORS							
Program	ISR	RR_E	RR_D	CF_S	CF_W	FR[474, 475]	SO[476]
HESP	100%[477]	100%[478]	100%[479]	100%[480]	100%[481]	25%	0%
LIHESP						0%	

[462] Heat loss 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 ambient minus 50 degrees F for heating season.
[463] Cooling load for basement assumed to be zero since it is rare for a home in Maine to provide cooling in a basement.
[464] Representative heating system efficiency based on NMR Group, Maine Single-Family Residential Baseline Study, September 14, 2015.
[465] 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.
[466] 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 percent of whole home cooling, the resulting equivalent cooling for all homes is 53% (40%*100% + 39%*33%).
[467] Based on RHA data for HESP1 project in 2010 and 2011. Average CFM50 reduction across all insulation types was 1712 CFM50. From this 514 CFM50 was subtracted to account for the air sealing reduction based on RDI evaluation and the result divided in half to account for multiple zones per project. 600 CFM50 per insulation zone assumed in the temperature bin analysis. CFM50 converted to CFH natural using 14.8 LBNL factor. Btu savings estimated using 0.018 Btu/CFH natural/delta temperature* hours per year for each delta temperature.
[468] Representative square footage for a footprint of 32 ft x 40 ft with equivalent of 3 ft exposed to ambient temperature (1 ft above grade, 4 ft below grade). Representative footprint based on average square footage from NMR Residential Baseline Study, 2015 and General Housing Data - All Occupied Units (National) 2013 American Housing Survey.
[469] Average pre- and post-cavity R-values from FY16 projects consisting of only air sealing and basement insulation.
[470] Ibid.
[471] Based on temperature bin analysis of ductless heat pump seasonal cooling using TMY3 temperature bins.
[472] 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.
[473] Average cost of sampled 2016 projects where attic insulation was itemized separately on contractor invoice (N=42)
[474] Program not yet evaluated, assume default FR of 25%.
[475] Program assumes no free ridership for the LIHESP program
[476] Program not yet evaluated, assume default SO of 0%.
[477] EMT assumes that all purchased units are installed (i.e. ISR = 100%).
[478] The measure has not yet been evaluated. Until the next program impact evaluation, EMT assumes 100% realization rate.
[479] Ibid.
[480] Peak coincidence factors for this measure are embedded in the evaluated peak demand impacts.
[481] Ibid.

<table>
<tr><th colspan="3">Mobile Home Underbelly Insulation (Component of LUB)</th></tr>
<tr><td>Last Revised Date</td><td colspan="2">7/1/2016</td></tr>
<tr><td colspan="3">MEASURE OVERVIEW</td></tr>
<tr><td>Description</td><td colspan="2">This measure involves the installation of insulation on the underbelly of mobile homes that separates conditioned space and unconditioned space (including unconditioned basements, unconditioned garages and crawl spaces). This measure only has heating savings associated with it.</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">Home Energy Savings Program</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 electric heat: $\Delta kW_{WP} = 3.40$</td></tr>
<tr><td>Annual energy savings</td><td>For electric heat:
$\Delta kWh = 5{,}962$

For non-electric heat:
$\Delta MMBtu = 25.270$</td><td>If fuel is unknown distribute savings based on % Fuel
$\Delta kWh = 48$
$\Delta MMBtu_{GAS} = 2.274$
$\Delta MMBtu_{PROP} = 1.516$
$\Delta MMBtu_{OIL} = 16.729$
$\Delta MMBtu_{KERO} = 1.516$
$\Delta MMBtu_{WOOD} = 3.032$</td></tr>
<tr><td colspan="3">GROSS ENERGY SAVINGS ALGORITHMS (UNIT SAVINGS)</td></tr>
<tr><td>Demand savings</td><td colspan="2">$\Delta kW_{WP} = \Delta kWh \times LSF_{WP}$</td></tr>
<tr><td>Annual Energy savings</td><td colspan="2">$\Delta MMBtu_{HEAT} = ((1/(0.55 \times RVAL_{PRE} + 3.9) - 1/(1.0 \times RVAL_{POST} + 3.9)) \times HDD \times 24 \times F_{ADJ} \times SQFT \times GF) / 1{,}000{,}000$

For non-electric heat
$\Delta MMBtu = \Delta MMBtu_{HEAT} / EFF$

For electric heat
$\Delta kWh = \Delta MMBtu_{HEAT} / 0.003412$

For unknown fuel
$\Delta MMBtu_{FUEL} = \Delta MMBtu_{HEAT} / EFF \times \%FUEL$
$\Delta kWh = \Delta MMBtu_{HEAT} / 0.003412 \times \%FUEL$</td></tr>
</table>

Mobile Home Underbelly Insulation (Component of LUB)		
Definitions	Unit	= Floor insulation project
	$\Delta MMBtu_{HEAT}$	= Annual heat loss reduction (MMBtu)
	$RVAL_{PRE}$	= Pre-upgrade floor insulation R-value (ft^2-°F-hr/Btu)
	$RVAL_{POST}$	= Post-upgrade floor insulation R-value (ft^2-°F-hr/Btu)
	HDD	= Heating Degree Days, Maine state average[486]
	F_{ADJ}	= ASHRAE adjustment factor
	SQFT	= Area of floor insulation (ft^2)
	GF	= Ground Factor, based on percent of unconditioned space walls above grade (%)
	EFF	= Efficiency factor of representative heating system (Btu/Btu)
	%FUEL	= Home heating fuel distribution excluding coal and other[482]
	LSF_{WP}	= Winter peak load shape factor (kW/kWh/yr)
	0.55	= Assumed factor to account for typical floor structure/framing and poor insulation installation
	1.0	= Assumed factor to account for continuous, well installed insulation
	3.9	= Assumed R-value of existing floor materials
	0.003412	= Conversion factor (kWh/MMBtu)
	1,000,000	= Conversion factor (Btu/MMBtu)
	24	= Conversion factor (hrs/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	$RVAL_{PRE}$[483]	$RVAL_{POST}$[484]	SQFT[485]	HDD[486]	F_{ADJ}[487]	Life (yrs)[488]	Cost ($)
Underbelly Insulation	0	12	880	7,777	0.64	25	Actual
Measure	GF[489]	EFF[490]	%FUEL	LSF_{SP}[491]			
Underbelly Insulation	1	80.5	Table E-1	0.00176			

IMPACT FACTORS

Measure	ISR[492]	RR_E[493]	RR_D[493]	CF_S[494]	CF_W[494]	FR[495]	SO[496]
Underbelly Insulation	100%	100%	100%	100%	100%	25%	0%

482 Heating fuel distribution is used to allocate savings to different fuels because the savings achieved through insulation impact the home's heating energy consumption.
483 Engineering estimate of no insulation or poorly installed, ineffective insulation.
484 Based on standard practice of 2 inch spray foam or 2 inch rigid insulation.
485 Estimated average size of mobile homes in Maine.
486 Based on a population-weighted average HDD of Caribou, Bangor, and Portland from TMY3 dataset.
487 ASHRAE degree-day correction. 1989 ASHRAE Handbook – Fundamentals, 28.2, Fig 1.
488 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.
489 It is assumed that the floor is 100% above grade.
490 Representative heating system efficiency based on NMR Group, Maine Single-Family Residential Baseline Study, September 14, 2015.
491 Based on temperature bin analysis of ductless heat pump seasonal cooling using TMY3 temperature bins.
492 EMT assumes 100% installation.
493 The measure has not yet been evaluated. Until the next program impact evaluation, EMT assumes 100% realization rate.
494 Peak coincidence factors for this measure are embedded in the calculated peak demand impacts.
495 Program not yet evaluated, assume default FR of 25%.
496 Program not yet evaluated, assume default SO of 0%.

Insulate Attic Openings (Component of LUB)				
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)	Home Energy Savings Program			
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	$\Delta kW_{WP} = 0.087$	$\Delta kW_{WP} = 0.203$	$\Delta kW_{WP} = 0.094$
	Without infiltration	$\Delta kW_{WP} = 0.061$	$\Delta kW_{WP} = 0.114$	$\Delta kW_{WP} = 0.053$
Annual energy savings[497]		Attic hatch insulation	Attic pull down stairs insulation	Whole house fan insulation
	For homes with non-electric heating			
	With infiltration	$\Delta MMBtu = 0.646$	$\Delta MMBtu = 1.508$	$\Delta MMBtu = 0.699$
	Without infiltration	$\Delta MMBtu = 0.453$	$\Delta MMBtu = 0.845$	$\Delta MMBtu = 0.397$
	For homes with electric resistance heating			
	With infiltration	$\Delta kWh = 152$	$\Delta kWh = 356$	$\Delta kWh = 165$
	Without infiltration	$\Delta kWh = 107$	$\Delta kWh = 199$	$\Delta kWh = 94$
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 $\Delta kWh = \Delta MMBtu / 0.003412$			

[497] 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 Table E-1.

Insulate Attic Openings (Component of LUB)		
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[500]
	F_{ADJ}	= ASHRAE adjustment factor[502]
	EFF	= Efficiency factor of representative heating system (Btu/Btu)
	LSF_{WP}	= Winter peak load shape factor (W/kWh/yr)504
	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	$\Delta MMBtu_{INFIL}$ [498]	SQFT[499]	$RVAL_{PRE}$[499]	$RVAL_{POST}$[499]	HDD[500]	Life (yrs) [501]	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}[502]	EFF[503]	LSF_{WP}[504]
Insulate Attic Openings	0.64	80.5	0.00057

IMPACT FACTORS

Measure	ISR[505]	RR_E[506]	RR_D[506]	CF_S[507]	CF_W[507]	FR[508]	SO[509]
Insulate Attic Openings	100%	100%	100%	100%	100%	25%	0%

498 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.
499 UI/CL&P C&LM Program Savings Documentation – 2015 p. 235, 4.4.11 Insulate Attic Openings measure, Table 1.
500 Based on a population-weighted average of Caribou, Bangor, and Portland from TMY3 dataset.
501 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.
502 ASHRAE degree-day correction. 1989 ASHRAE Handbook – Fundamentals, 28.2, Fig 1.
503 Representative heating system efficiency based on NMR Group, Maine Single-Family Residential Baseline Study, September 14, 2015.
504 Evaluation of WRAP and Helps Program, KEMA, 2010, Table ES-8, p. 1-10 divided by 1000 W/kW.
505 EMT assumes that all purchased units are installed (i.e. ISR = 100%).
506 The measure has not yet been evaluated. Until the next program impact evaluation, EMT assumes 100 percent realization rate.
507 Peak coincidence factors for this measure are embedded in the calculated peak demand impacts.
508 Program not yet evaluated, assume default FR of 25%.
509 Program not yet evaluated, assume default SO of 0%.

Duct Insulation (Component of LUB)				
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			
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			
	$\Delta kW_{WP} = 0.0$ $\Delta kW_{SP} = 0.136$	$\Delta kW_{WP} = 0.0$ $\Delta kW_{SP} = 0.041$	$\Delta kW_{WP} = 0.0$ $\Delta kW_{SP} = 0.251$	$\Delta kW_{WP} = 0.0$ $\Delta kW_{SP} = 0.144$
	For homes with electric resistance heating			
	$\Delta kW_{WP} = 1.310$ $\Delta kW_{SP} = 0.136$	$\Delta kW_{WP} = 0.316$ $\Delta kW_{SP} = 0.041$	$\Delta kW_{WP} = 1.453$ $\Delta kW_{SP} = 0.251$	$\Delta kW_{WP} = 0.421$ $\Delta kW_{SP} = 0.144$
Annual energy savings[510]	Basement Supply	Basement Return	Attic Supply	Attic Return
	For homes with non-electric heating			
	$\Delta MMBtu = 9.743$ $\Delta kWh = 8$	$\Delta MMBtu = 2.352$ $\Delta kWh = 2$	$\Delta MMBtu = 10.802$ $\Delta kWh = 15$	$\Delta MMBtu = 3.132$ $\Delta kWh = 8$
	For homes with electric resistance heating			
	$\Delta kWh = 2307$	$\Delta kWh = 557$	$\Delta kWh = 2563$	$\Delta kWh = 747$
GROSS ENERGY SAVINGS ALGORITHMS (UNIT SAVINGS)				
Demand savings	$\Delta kW_{WP} = \Delta kWh_H \times LSF_{WP}$			
Annual Energy savings	$\Delta kWh_H = SQFT \times F_H / 0.003412$ $\Delta kWh_C = AKW_C \times SQFT \times \%COOL$ $\Delta kWh = \Delta kWh_H + \Delta kWh_C$ $\Delta MMBtu = SQFT \times F_H / EFF$			

[510] 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 Table E-1.

Duct Insulation (Component of LUB)		
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)
	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[511]	F_H[512]	AKW_C[513]	%COOL[514]	EFF[515]	LSF_{SP}[516]	LSF_{WP}[517]	Life (yrs)[518]	Cost ($)
Basement Supply	50	0.1569	0.3016	53%	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						

IMPACT FACTORS

Measure	ISR[519]	RR_E[520]	RR_D[520]	CF_S[521]	CF_W[521]	FR[522]	SO[523]
Duct Insulation	100%	100%	100%	100%	100%	25%	0%

511 Program assumption.
512 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.
513 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
514 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 percent of whole home cooling, the resulting equivalent cooling for all homes is 53 percent (40%*100% + 39%*33%).
515 Representative heating system efficiency based on NMR Group, Maine Single-Family Residential Baseline Study, September 14, 2015.
516 Evaluation of the Weatherization Residential Assistance Partnership (WRAP) and Helps Programs, conducted by KEMA, September 2010, table ES-9 p. 1-11.
517 Evaluation of WRAP and Helps Program, KEMA, 2010, Table ES-8, p. 1-10 divided by 1000 W/kW.
518 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.
519 EMT assumes that all purchased units are installed (i.e. ISR = 100%).
520 The measure has not yet been evaluated. Until the next program impact evaluation, EMT assumes 100 percent realization rate.
521 Peak coincidence factors for this measure are embedded in the calculated peak demand impacts.
522 Program not yet evaluated, assume default FR of 25%.
523 Program not yet evaluated, assume default SO of 0%.

Duct Sealing (Component of LUB)	
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
End-Use	Heating, Cooling
Decision Type	Retrofit
DEEMED GROSS ENERGY SAVINGS (UNIT SAVINGS)	
Demand savings	$\Delta kW_{SP} = 0.140$ For homes with electric resistance heating: $\Delta kW_{WP} = 1.817$
Annual energy savings[524]	For homes with non-electric heating $\Delta MMBtu = 6.607$ $\Delta kWh = 192$ For homes with electric resistance heating $\Delta kWh = 1{,}194$
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 $\Delta kWh = REM_{COOL} \times (CFM_{PRE} - CFM_{POST}) \times \%COOL + REM_{ER} \times (CFM_{PRE} - CFM_{POST})$
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)[525] CFM_{POST} = Air leakage rate after duct sealing at 25 Pa (CFM)[526] EFF = Efficiency factor of representative heating system (Btu/Btu) 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

[524] 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 Table E-1.
[525] 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.
[526] 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.

Duct Sealing (Component of LUB)

PARAMETER VALUES (DEEMED)

Measure	REM_{HEAT}[527]	CFM_{PRE}[528]	CFM_{POST}[529]	EFF[530]	REM_{COOL}[531]	%COOL[532]	Life (yrs)[533]	Cost ($)[534]
Duct Sealing	0.046	195	80	80.5%	0.414	53%	25	Actual

Measure	REM_{FAN}[535]	REM_{ER}[536]	REM_{WP}[537]	REM_{SP}[537]			
Duct Sealing	1.454	10.166	0.0158	0.0023			

IMPACT FACTORS

Measure	ISR[538]	RR_E[539]	RR_D[539]	CF_S[540]	CF_W[540]	FR[541]	SO[542]
Duct Sealing	100%	100%	100%	100%	100%	25%	0%

527 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.
528 UI/CL&P C&LM Program Savings Documentation – 2015 p. 140, 4.2.9 Duct Sealing measure, Note 1.
529 UI/CL&P C&LM Program Savings Documentation – 2015 p. 140, 4.2.9 Duct Sealing measure, Note 2.
530 Representative heating system efficiency based on NMR Group, Maine Single-Family Residential Baseline Study, September 14, 2015.
531 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
532 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% 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 percent of whole home cooling, the resulting equivalent cooling for all homes is 53 percent (40%*100% + 39%*33%).
533 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.
534 Cost of service where duct sealing was the sole service performed.
535 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.
536 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.
537 UI/CL&P C&LM Program Savings Documentation – 2015 p. 139, 4.2.9 Duct Sealing measure, Table 3.
538 EMT assumes that all purchased units are installed (i.e. ISR = 100%).
539 The measure has not yet been evaluated. Until the next program impact evaluation, EMT assumes 100 percent realization rate.
540 Peak coincidence factors for this measure are embedded in the calculated peak demand impacts.
541 Program not yet evaluated, assume default FR of 25%.
542 Program not yet evaluated, assume default SO of 0%.

Hydronic Heating Pipe Insulation (Component of LUB)	
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
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	$\Delta MMBtu = AF_H \times L / EFF$
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)
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)[543]	EFF[544]	AF_H[545]	Life (yrs)[546]	Cost ($)
Pipe Insulation	100	80.5	0.0387	25	Actual

IMPACT FACTORS

Measure	ISR[547]	RR_E[548]	RR_D[548]	CF_S	CF_W	FR[549]	SO[550]
Duct Sealing	100%	100%	100%	N/A	N/A	25%	0%

543 Program estimate.
544 Representative heating system efficiency based on NMR Group, Maine Single-Family Residential Baseline Study, September 14, 2015.
545 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.
546 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.
547 EMT assumes that all purchased units are installed (i.e. ISR = 100%).
548 The measure has not yet been evaluated. Until the next program impact evaluation, EMT assumes 100 percent realization rate.
549 Program not yet evaluated, assume default FR of 25%.
550 Program not yet evaluated, assume default SO of 0%.

Seal/Insulate Pipes/Ducts (Component of LUB)	
Last Revised Date	10/1/2016 (effective 7/1/2016)
MEASURE OVERVIEW	
Description	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.
Energy Impacts	Electric, Natural Gas, Oil, Propane, Wood, Kerosene
Sector	Residential
Program(s)	Home Energy Savings Program
End-Use	Heating
Decision Type	Retrofit
DEEMED GROSS ENERGY SAVINGS (UNIT SAVINGS)	
Demand savings	For homes with non-electric heating $\Delta kW_{SP} = 0.035$ For homes with electric resistance heating $\Delta kW_{SP} = 1.614$ $\Delta kW_{SP} = 0.138$
Annual energy savings	For homes with non-electric heating $\Delta MMBtu = 5.57$ $\Delta kWh = 30$ For homes with electric resistance heating $\Delta kWh = 1{,}639$
GROSS ENERGY SAVINGS ALGORITHMS (UNIT SAVINGS)	
Demand savings	For homes with non-electric heating $\Delta kW_{SP} = W_{DI} \text{ X } CDS_{DI} + W_{DS} \text{ X } CDS_{DS}$ For homes with electric resistance heating $\Delta kW_{WP} = W_{DI} \text{ X } HDS_{DI} + W_{DS} \text{ X } HDS_{DS} /(W_{DI} + W_{DS})$ $\Delta kW_{SP} = W_{DI} \text{ X } CDS_{DI} + W_{DS} \text{ X } CDS_{DS} /(W_{DI} + W_{DS})$
Annual Energy savings	For homes with non-electric heating $\Delta MMBtu = W_{DI} \text{ X } FS_{DI} + W_{DS} \text{ X } FS_{DS} + W_{PI} \text{ X } FS_{PI}$ $\Delta kWh = W_{DI} \text{ X } ECS_{DI} + W_{DS} \text{ X } ECS_{DS}$ For homes with electric resistance heating $\Delta kWh = W_{DI} \text{ X } EHS_{DI} + W_{DS} \text{ X } EHS_{DS} /(W_{DI} + W_{DS})$
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

Seal/Insulate Pipes/Ducts (Component of LUB)	
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} [551]	W_{DS} [552]	W_{PI} [553]	Life (yrs) [554]	Cost ($)	
Seal/Insulate Pipes/Ducts	10%	15%	75%	25	Actual	
Measure	CDS_{DI} [555]	CDS_{DS} [556]	HDS_{DI} [557]	HDS_{DS} [558]	ECS_{DI} [559]	ECS_{DS} [560]
Seal/Insulate Pipes/Ducts	0.136	0.140	1.310	1.817	8	192
Measure	FS_{DI} [561]	FS_{DS} [562]	FS_{PI} [563]	EHS_{DI} [564]	EHS_{DI} [565]	
Seal/Insulate Pipes/Ducts	9.743	6.607	4.807	2,307	1,194	

IMPACT FACTORS

Measure	ISR[566]	RR_E [567]	RR_D [548]	CF_S	CF_W	FR[568]	SO[569]
Duct Sealing	100%	100%	100%	N/A	N/A	25%	0%

551 Program estimate.
552 Program estimate.
553 Program estimate.
554 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.
555 Summer peak demand reduction for duct insulation basement supply. See Duct Insulation.
556 Summer peak demand reduction for duct sealing. See Duct Sealing.
557 Winter peak demand reduction for duct insulation basement supply. See Duct Insulation.
558 Winter peak demand reduction for duct sealing. See Duct Sealing.
559 Electric savings for cooling for duct insulation basement supply. See Duct Insulation.
560 Electric savings for cooling for duct sealing. See Duct Sealing.
561 Fuel savings for heating for duct insulation basement supply. See Duct Insulation.
562 Fuel savings for heating for duct sealing. See Duct Sealing.
563 Fuel savings for heating for pipe insulation. See Hydronic Heating Pipe Insulation.
564 Electric savings for heating for duct insulation basement supply. See Duct Insulation.
565 Electric savings for heating for duct sealing. See Duct Sealing.
566 EMT assumes that all purchased units are installed (i.e. ISR = 100%).
567 The measure has not yet been evaluated. Until the next program impact evaluation, EMT assumes 100 percent realization rate.
568 Program not yet evaluated, assume default FR of 25%.
569 Program not yet evaluated, assume default SO of 0%.

Ductless Heat Pump (CH)		
Last Revised Date	9/16/2016	
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	Electric	
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	For single head unit ΔkW_{max} = 1.23 ΔkW_{WP} = 0.40 ΔkW_{SP} = 0.05	For multi-head or multiple units ΔkW_{max} = 1.33 ΔkW_{WP} = 0.785 ΔkW_{SP} = 0.05
Annual energy savings	For single head unit ΔkWh/yr = 1,902 ΔkWh_H/yr = 1,815 ΔkWh_C/yr = 88	For multi-head or multiple units ΔkWh/yr = 3,603 ΔkWh_H/yr = 3,516 ΔkWh_C/yr = 88
GROSS ENERGY SAVINGS ALGORITHMS (UNIT SAVINGS)		
Demand Savings	Modeled[570]	
Annual Energy Savings	Modeled[570] 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).[571] Savings were calculated based on a model employing the following key assumptions: • Average annual heat Loss is 92 MMBtu corresponding to an average UA of 493 MMBtu/h/deg F. • A single head DHP unit's contribution to heating does not exceed 35 percent of the home's heating load in any temperature bin. Even in temperature bins in which 100 percent of the home's heating load can be supplied by the DHP, the DHP supplies 35 percent of the heating load, and the remaining 65 percent is supplied by the existing heating system to account for distribution and behavior effects.[572] • For DHP units with multiple heads or multiple units, the DHP contribution to heating is capped at 70 percent of the home's heating load in any temperature bin to account for more effective distribution.[573] • DHP heating output capacity and DHP heating efficiency (both baseline and efficient units) vary with outside air temperature as defined by performance curves. • Baseline unit heating capacity is the same as the efficient unit. • Heating is called for when outside air temperature is less than or equal to 65°F.	

[570] Based on Excel Workbook for Ductless Heat Pump
[571] Calculated based on population of each region; U.S. Census Bureau Census 2010 Summary File 1 population by census tract
[572] Heat load offset of 35 percent is consistent with other findings. Ecotope, NEEA Final Summary Report for the Ductless Heat Pump Impact and Process Evaluation, February 19, 2014 reported savings were analyzed to be equivalent to 30%-40% heat load offset.
[573] Program assumption to be validated and refined during next evaluation.

Ductless Heat Pump (CH)		
Definitions	Unit	= 1 single-head DHP. Multiple-head systems or more than one single head unit installed count as 2 units. No more than 2 units can be claimed per dwelling.
	$HSPF_B$	= Heating seasonal performance factor of the baseline DHP (Btu/Watt-hr)
	$HSPF_{EE}$	= Heating seasonal performance factor of the high-efficiency DHP (Btu/Watt-hr)
	CAP_{Cool}	= Rated cooling capacity of the DHP (kBtu/h)
	CAP_{Heat}	= Rated heating capacity of the DHP (kBtu/h)
	$SEER_B$	= Seasonal energy-efficiency ratio for baseline DHP (Btu/Watt-hr)
	$SEER_E$	= Seasonal energy-efficiency ratio for high-efficiency DHP (Btu/Watt-hr)

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 the home retains its existing heating system and adds a new high-efficiency DHP that meets minimum efficiency requirements for program rebate: HSPF=12.0 and SEER=18.0.

PARAMETER VALUES (DEEMED)

Measure	CAP_{Heat}	CAP_{Cool}	$HSPF_B$	$HSPF_E$	Life (yrs)	Cost ($)
Ductless Heat Pump	17.5[574]	14.2[574]	8.2[575]	13.2[574]	18[576]	$682[577]
Measure	$SEER_B$	$SEER_E$				
Ductless Heat Pump	14[575]	25.6[574]				

IMPACT FACTORS

Measure	ISR	RR_E	RR_D	CF_S	CF_W	FR	SO
Ductless Heat Pump	100%[578]	100%[579]	100%[579]	100%[580]	100%[580]	25%[581]	0%[582]

[574] Weighted average values of the most popular units that have been incentivized under the Efficiency Maine program.
[575] Federal minimum efficiency requirement for units manufactured on or after January 1, 2015 (changes to 8.8 HSPF and 15 SEER January 1, 2023).
[576] GDS Associates, Inc., Measure Life Report – Residential and Commercial/Industrial Lighting and HVAC Measures, June 2007; Table 1.
[577] 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).
[578] EMT assumes that all purchased units are installed (i.e. ISR = 100%). This is consistent with the MA 2013-2015 TRM.
[579] The measure has not yet been evaluated. Until the next program impact evaluation, EMT assumes 100 percent realization rate.
[580] The on-peak summer and winter kW savings are calculated directly from the modeling.
[581] Program not yet evaluated, assume default FR of 25%.
[582] Program not yet evaluated, assume default SO of 0%.

High-Efficiency Furnaces and Boilers (DB, DF)	
Last Revised Date	7/1/2016
MEASURE OVERVIEW	
Description	This measure involves the installation of a high-efficiency furnace, boiler or combination boiler plus domestic hot water (Combi) instead of a code-compliant 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
Sector	Residential
Program(s)	Home Energy Savings Program
End-Use	Heating
Decision Type	New Construction, Replace on Burnout
DEEMED GROSS ENERGY SAVINGS (UNIT SAVINGS)	
Demand Savings	$\Delta kW = 0.000$
Annual Energy Savings	NG Furnace Savings $\Delta MMBtu_{GAS} = 18.361$ Propane Furnace Savings $\Delta MMBtu_{PROP} = 18.665$ Heating Oil/Kerosene Furnace Savings $\Delta MMBtu_{OIL/KERO} = 5.940$ NG Boiler Savings $\Delta MMBtu_{GAS} = 14.841$ Propane Boiler Savings $\Delta MMBtu_{PROP} = 15.149$ Heating Oil/Kerosene Boiler Savings $\Delta MMBtu_{OIL/KERO} = 4.140$ NG Combi Savings $\Delta MMBtu_{GAS} = 21.969$
GROSS ENERGY SAVINGS ALGORITHMS (UNIT SAVINGS)	
Demand Savings	$\Delta kW = 0.0000$
Annual Energy Savings	For Boiler and Furnaces $\Delta MMBtu/yr = AHL \times (AFUE_{EE} / AFUE_{BASE} - 1)$ For Combination Boiler and Domestic Hot Water $\Delta MMBtu/yr = AHL \times (AFUE_{EE} / AFUE_{BASE} - 1) + GPD \times 365 \times 8.33 \times 1 \times (T_{WH} - T_{in}) \times (EF_{EE}/EF_{BASE})$
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 (%)
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 federal minimum efficiency requirements.
Efficient Measure	The high-efficiency equipment exceeds the federal minimum efficiency.

High-Efficiency Furnaces and Boilers (DB, DF)

PARAMETER VALUES (DEEMED)

Measure	AHL[583]	$AFUE_{BASE}$[584]	$AFUE_{EE}$[585]	Life (yrs)[586]	Cost ($)[587]
Oil/Kerosene Furnace	92	83%	87.7%	25	668
Natural Gas Furnace		80%	95.2%		1,438
Propane Furnace		80%	95.5%		742
Oil/Kerosene Boiler		84%	87.3%		326
Natural Gas Boiler/Combi		82%	94.5%		1,785
Propane Boiler		82%	94.8%		2,030
Measure	**GPD[588]**	**T_{in}[589]**	**T_{WH}[590]**	**EF_{BASE}[591]**	**EF_{EE}[592]**
Natural Gas Combi Unit	51.1	50.8	126.2	60%	94.5%

IMPACT FACTORS

Measure	ISR	RR_E	RR_D	CF_S	CF_W	FR	SO
High Eff. Furnaces/Boilers	100%[593]	100%[594]	100%[594]	NA	NA	25%[595]	0%[596]

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[583] NMR Group, Maine Single-Family Residential Baseline Study, September 14, 2015.
[584] Table E-2. Minimum Efficiency Requirements for Furnaces and Boilers- based on 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
[585] Average AFUE for new high-efficiency equipment are based on average EMT program tracking data from November 2014 to April 2016.
[586] GDS, Measure Life Report, Residential and Commercial/Industrial Lighting and HVAC Measures, June 2007; Table 1, value for new construction.
[587] 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.
[588] 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.
[589] Standard Building America DHW Schedules, weighted average by population of all Maine water main sources.
[590] NMR Group, Inc., Efficiency Maine Appliance Rebate Program Evaluation Overall Report – FINAL, July 18, 2014.
[591] Federal water heater standard, DOE Standard 10 CFR 430.32(d), effective 4/16/2015. EF assumes a 50 gallon storage tank (EF = 0.675-(0.0015*50)) = 0.60. http://www.ecfr.gov/cgi-bin/retrieveECFR?gp=&SID=23d182b583bbfb7d624f02a8d30ccc30&mc=true&n=pt10.3.430&r=PART&ty=HTML#sp10.3.430.c
[592] Average AFUE for new high-efficiency equipment are based on average EMT program tracking data from November 2014 to April 2016.
[593] EMT assumes that all purchased units are installed (i.e. ISR = 100%).
[594] This measure has not yet been evaluated. Until the next program impact evaluation, EMT assumes 100 percent realization rate.
[595] Program not yet evaluated, assume default FR of 25%.
[596] Program not yet evaluated, assume default SO of 0%.

Pellet/Wood Stove (CPS, CWS)	
Last Revised Date	7/1/2014
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 and the addition of an outdoor make-up air kit.
Energy Impacts	Wood
Sector	Residential
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_{SP} = NA ΔkW_{WP} = NA
Annual energy savings	$\Delta MMBtu_{WOOD}$ = 21.078
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 a non EPA certified pellet/wood stove to provide supplemental heat.
Efficient Measure	The high-efficiency case assumes the home retains its existing heating system and adds a new pellet/wood stove to provide supplemental heat.

PARAMETER VALUES

Measure	AHL[597]	%STOVE	EFF_{BASE}	EFF_{EE}			Life (yrs)	Cost ($)
Pellet/Wood Stove	92	50%[598]	53%[599]	70%[600]			25[601]	3,000[602]

IMPACT FACTORS

Measure	ISR	RR_E	RR_D	CF_S	CF_W	FR	SO
Pellet/Wood Stove	100%[603]	100%[604]	100%[604]	NA	NA	25%[605]	0%[606]

[597] NMR Group, Maine Single-Family Residential Baseline Study, September 14, 2015.
[598] 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.
[599] Engineering judgment based on 60 percent combustion efficiency derated to account for distribution and heat losses associated with not having an outdoor make-up air kit.
[600] U.S. DOE, conservative estimate of pellet stove efficiency: http://energy.gov/energysaver/articles/wood-and-pellet-heating
[601] 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.
[602] Average full cost of participant pellet/wood stove installation minus $700 for standard efficiency stove. Represents installations where the stove was the sole upgrade installed.
[603] EMT assumes that all purchased units are installed (i.e. ISR = 100%).
[604] The measure has not yet been evaluated. Until the next program impact evaluation, EMT assumes 100 percent realization rate.
[605] Program not yet evaluated, assume default FR of 25%.
[606] Program not yet evaluated, assume default SO of 0%.

Pellet/Cord Wood Boiler (APB)							
Last Revised Date	7/1/2016						
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. EMT estimates minimal energy savings for this measure, but the participating customer achieves overall GHG and fuel-cost reductions due to the change in fuel type.						
Energy Impacts	Wood, Oil						
Sector	Residential						
Program(s)	Home Energy Savings Program						
End-Use	Heating						
Decision Type	New Construction, Replacement						
DEEMED GROSS ENERGY SAVINGS (UNIT SAVINGS)							
Demand savings	ΔkW_{SP} = NA ΔkW_{WP} = NA						
Annual energy savings	$\Delta MMBtu_{WOOD}$=-45.680 $\Delta MMBtu_{PELLET}$ = – 41.108 $\Delta MMBtu_{CORD}$= – 4.568 $\Delta MMBtu_{PROPANE}$ = 37.024 $\Delta MMBtu_{OIL}$ = 36.143						
GROSS ENERGY SAVINGS ALGORITHMS (UNIT SAVINGS)							
Demand savings	ΔkW = NA						
Annual Energy savings	$\Delta MMBtu_{BASEFUEL}/yr = MMBtu_{HEAT} \times 1 / EFF_{BASE} \times \%FUEL_{BASE}$ $\Delta MMBtu_{NEWFUEL}/yr = - (MMBtu_{HEAT} \times 1 / EFF_{PB}) \times \%FUEL_{EE}$						
Definitions	Unit = New pellet boiler AHL = Average annual heating load for Maine home (MMBtu) EF_{BASE} = Average baseline heating system efficiency (%) 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						
EFFICIENCY ASSUMPTIONS							
Baseline Efficiency	The baseline case is a 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.						
PARAMETER VALUES (DEEMED)							
Measure	AHL[607]	EFF_{BASE}	EFF_{PB}	$\%FUEL_{BASE}$[608]	$\%FUEL_{EE}$[609]	Life (yrs)	Cost ($)
Boiler	92	84%[610]	85%[611]	33% Oil 33% Propane 34% Wood	90% Pellets 10% Cord Wood	25[612]	12,942[613]

[607] NMR Group, Maine Single-Family Residential Baseline Study, September 14, 2015.
[608] Program Assumption
[609] Program Assumption
[610] 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
[611] Average efficiency of residential pellet boiler, based on the following models: Pellergy KPS-100-5, Woodpecker Wood-Pellet Boiler, Froling P4, Kedel cord wood boiler and MeSys cord wood boiler.
[612] 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.
[613] Average incremental cost of participant pellet boiler. Represents installations where pellet boiler was the sole upgrade installed. Baseline cost reflects cost of a new, code-compliant, 80 kBtuh boiler. Baseline cost based on DEER 2008 cost workbook.

Pellet/Cord Wood Boiler (APB)							
IMPACT FACTORS							
Measure	ISR	RR_E	RR_D	CF_S	CF_W	FR	SO
Boiler	100%[614]	100%[615]	NA	NA	NA	25%[616]	0%[617]

[614] EMT assumes that all purchased units are installed (i.e. ISR = 100%).
[615] The measure has not yet been evaluated. Until the next program impact evaluation, EMT assumes 100 percent realization rate.
[616] Program not yet evaluated, assume default FR of 25%.
[617] Program not yet evaluated, assume default SO of 0%.

Central Air-source Heat Pump (ducted) (DHA)	
Last Revised Date	7/1/2016
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	ΔkW_{SP} = 0.054 (0.013 after 1/1/17, based on updated EER baseline of 11.8) ΔkW_{WP} = 0.538 (0.395 after 1/1/17, based on updated HSPF baseline of 8.2)
Annual energy savings	$\Delta kWh/yr$ = 2,806 (2,062 after 1/1/17, based on updated SEER and HSPF baselines of 14 and 8.2 respectively)
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)

PARAMETER VALUES

Measure	CAP_C	CAP_H	$SEER_{BASE}$	$SEER_{EE}$	$HSPF_{BASE}$	$HSPF_{EE}$	Life (yrs)	Cost ($)
Central ASHP	36[618]	36[618]	13[619]	18[620]	7.7[619]	10.0[621]	25[622]	2,000[623]

Measure	EER_{BASE}	EER_{EE}	$EFLH_{HEAT}$	$EFLH_{COOL}$	AHL	ACL
Central ASHP	11.2[624]	12[625]	2,706[626]	231[626]	92[627]	2.7[628]

IMPACT FACTORS

Measure	ISR	RR_E	RR_D	CF_{SP}	CF_{WP}	FR	SO
Central ASHP	100%[629]	100%[630]	100%[630]	25%[631]	50%[631]	25%[632]	0%[633]

[618] Assumed capacity.
[619] U.S. DOE Standard, effective in 2006: http://www1.eere.energy.gov/buildings/appliance_standards/product.aspx/productid/75. A grace period is in place for an amendment to the 2006 standard, which delays the updated code until June 30, 2016.
[620] NY TRM 2010 p. 42, ASHP measure, SEER correlated to HSPF of 9.2 (closest HSPF value to 10).
[621] Minimum program requirement.
[622] 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.
[623] Survey of standard and high-efficiency system costs at ecomfort.com.
[624] 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.
[625] 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.
[626] 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%).
[627] NMR Group, Maine Single-Family Residential Baseline Study, September 14, 2015.
[628] Ibid.
[629] EMT assumes that all purchased units are installed (i.e. ISR = 100%).
[630] The measure has not yet been evaluated. Until the next program impact evaluation, EMT assumes 100% realization rate.
[631] MA TRM 2013 TRM 2010, Air-source heat pump peak coincidence factor.
[632] Program not yet evaluated, assume default FR of 25%.
[633] Program not yet evaluated, assume default SO of 0%.

Central Geothermal (Ground source) Heat Pump (GCL, GOL)	
Last Revised Date	4/1/2017 (effective 3/1/2017)
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 = -0.152 ΔkW_{SP} = -0.015 ΔkW_H = -2.573 ΔkW_{WP} = -2.048
Annual energy savings	$\Delta kWh/yr$ = -6588 $\Delta kWh_C/yr$ = -11 $\Delta kWh_H/yr$ = -6577 $\Delta MMBTU_H/yr$ = 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	<u>Heating Savings:</u> $\Delta kWh_H/yr = AHL \times 1000 \times (-1 / COP_{EE}) / 3.412$ $\Delta MMBTU_H/yr = AHL / AFUE_{BASE}$ <u>Cooling Savings:</u> $\Delta kWh_C/yr = ACL \times 1000 \times [\%COOL_{FULL} \times (1/EER_B - 1/EER_E) + \%COOL_{NONE} \times (-1/EER_E)]$ *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)							
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 Tier 3 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[634]	36[635]	4.1[636]	16.2[637]	21.1[638]	25[639]	31,000[640]
Measure	$\%COOL_{FULL}$	$\%COOL_{NONE}$	$EFLH_H$	$EFLH_C$	$AFUE_{BASE}$	AHL	ACL
GSHP	40%[641]	21%[641]	2,706[642]	231[643]	84%[644]	92[645]	2.7[646]
IMPACT FACTORS							
Measure	ISR	RR_E	RR_D	CF_S	CF_W	FR	SO
GSHP	100%[647]	100%[648]	100%[648]	10.2%[649]	79.6%[649]	25%[650]	0%[651]

634 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.

635 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.

636 ENERGY STAR® Geothermal Heat Pumps Key Product Criteria Open Loop Water-to-air Tier 3.

637 ENERGY STAR® Geothermal Heat Pumps Key Product Criteria Open Loop Water-to-air Tier 1.

638 ENERGY STAR® Geothermal Heat Pumps Key Product Criteria Open Loop Water-to-air Tier 3.

639 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.

640 Average full cost of participant geothermal heat pump installation ($38,000) minus assumed cost of standard efficiency system ($7,000). Represents installations where geothermal heat pump was the sole upgrade installed.

641 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.

642 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%).

643 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.

644 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.

645 NMR Group, Maine Single-Family Residential Baseline Study, September 14, 2015

646 Ibid.

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

648 The measure has not yet been evaluated. Until the next program impact evaluation, EMT assumes 100 percent realization rate.

649 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.

650 Program not yet evaluated, assume default FR of 25%.

651 Program not yet evaluated, assume default SO of 0%.

On-Demand Natural Gas Water Heater (NGWH)	
Last Revised Date	4/1/2017 (effective 3/1/2017)
MEASURE OVERVIEW	
Description	This measure involves purchase and installation of new on-demand (instantaneous) natural gas-fired water heater rather than a new standard tank water heater. Energy savings are achieved by reducing the standby losses from the tank water heater.
Energy Impacts	Natural Gas
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	ΔkW = NA
Annual energy savings	ΔkWh/yr = 0 ΔMMBtu/yr = 5.37
GROSS ENERGY SAVINGS ALGORITHMS (UNIT SAVINGS)	
Demand savings	ΔkW = NA
Annual Energy savings	ΔkWh/yr = 0 $\Delta MMBtu/yr = GPD \times 365 \times 8.33 \times 1 \times (T_{WH} - T_{in}) \times (1/EF_{BASE} - 1/EF_{EE}) / 1{,}000{,}000$
Definitions	Unit = New on-demand natural gas water heater GAL = Average amount of hot water consumed annually per Maine household (gal/yr/home) 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 (%) 365 = Days per 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 a new standard-efficiency natural gas fired tank water heater.
Efficient Measure	The high-efficiency case is a new on-demand (instantaneous) natural gas fired water heater with energy factor of at least 0.93.

PARAMETER VALUES

Measure	GPD	T_{WH}	T_{in}	EF_{BASE}	EF_{EE}	Life (yrs)	Cost ($)
On-Demand Natural Gas Water Heater	51.1[652]	126.2[653]	50.8[654]	0.62[655]	0.87[656]	25[657]	242[658]

[652] 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.
[653] NMR Group, Inc., Efficiency Maine Appliance Rebate Program Evaluation Overall Report – FINAL, July 18, 2014.
[654] Standard Building America DHW Schedules, weighted average by population of all Maine water main sources.
[655] Weighted average based on assumed market share of readily available water heaters that meet Federal water heater standard, DOE Standard 10 CFR 430.32(d), EF of 0.615 effective 4/16/2015. EF assumes a 40-gallon storage tank (EF = 0.675-(0.0015*40)).
[656] Weighted average based on assumed program participation of eligible equipment (75% of measures with EF between 82 and 88% , 25% of measures with EF between 92-98%).
[657] 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.
[658] Difference of weighted averages based on assumed market share of readily available baseline water heaters ($474) and program eligible models ($716) using internet listed prices accessed on 12/21/2016.

On-Demand Natural Gas Water Heater (NGWH)							
IMPACT FACTORS							
Measure	ISR	RR_E	RR_D	CF_S	CF_W	FR	SO
On-Demand Natural Gas Water Heater	100%[659]	100%[659]	NA	NA	NA	25%[660]	0%[661]

[659] EMT assumes that all purchased units are installed (i.e. ISR = 100%).
[660] Program not yet evaluated, assume default FR of 25%.
[661] Program not yet evaluated, assume default SO of 0%.

Low-income Program

Air Sealing Direct Install (LNAS)	
Last Revised Date	7/1/2016 (effective 7/1/2015)
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[662]	ΔCFM50	EFF[663]		Life (yrs)	Cost ($)
Air Sealing	0.01362	actual	80.5		15[664]	$700[665]

IMPACT FACTORS

Measure	ISR	RR_E	RR_D	CF_S	CF_W	FR	SO
Air Sealing	100%[666]	100%[667]	100%[402]	N/A	N/A	25%[668]	0%[669]

662 Based on modeling of TMY3 data.
663 Representative heating system efficiency NMR Group, Maine Single-Family Residential Baseline Study, September 14, 2015.
664 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.
665 Average cost of sampled 2016 projects where attic insulation was itemized separately on contractor invoice (N=51).
666 ISR is 100 percent because deemed savings results are based on evaluated results that include installation verification.
667 The measure has not yet been evaluated. Until the next program impact evaluation, EMT assumes 100 percent realization rate.
668 Program not yet evaluated, assume default FR of 25%.
669 Program not yet evaluated, assume default SO of 0%.

Attic/Roof Insulation Direct Install (LNAI)	
Last Revised Date	7/1/2016 (effective 7/1/2015)
MEASURE OVERVIEW	
Description	This measure involves the insulation of the attic floor to decrease heating and cooling losses in homes heated with natural gas where the existing attic insulation is rated at R-8 or lower.
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	$\Delta MMBtu = HLF \times (1/ RVAL_{PRE} - 1/ RVAL_{POST}) \times SQFT / EFF$
Definitions	Unit = Attic/roof insulation project HLF = Heat loss factor as a function of change in insulation R-value SQFT = Area of attic insulation (ft^2) assumed in temperature bin analysis $RVAL_{PRE}$ = Pre-upgrade attic R-value (ft^2-°F-hr/Btu) assumed in temperature bin analysis $RVAL_{POST}$ = Post-upgrade attic R-value (ft^2-°F-hr/Btu) assumed in temperature bin analysis EFF = Efficiency factor of representative heating system (Btu/Btu)
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	HLF[670]	SQFT	$RVAL_{PRE}$	$RVAL_{POST}$	EFF[671]	Life (yrs)[672]	Cost ($)[673]
Attic/Roof Insulation	0.192138	actual	actual	actual	80.5	25	2,617

IMPACT FACTORS

Measure	ISR[674]	RR_E[675]	RR_D[676]	CF_S	CF_W	FR[677]	SO[678]
Attic/Roof Insulation	100%	100%	100%	N/A	N/A	0%	0%

670 Based on modeling of TMY3 data and average annual heat loss of 92 MMBtu per home.
671 Representative heating system efficiency based on preliminary results from NMR Group, Maine Single-Family Residential Baseline Study, September 14, 2015.
672 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.
673 Average cost of sampled 2016 projects where attic insulation was itemized separately on contractor invoice (N=58).
674 EMT assumes that all purchased units are installed (i.e. ISR = 100%).
675 The measure has not yet been evaluated. Until the next program impact evaluation, EMT assumes 100% realization rate.
676 The measure has not yet been evaluated. Until the next program impact evaluation, EMT assumes 100% realization rate.
677 Program assumes no free ridership for the low-income direct install program.
678 Program not yet evaluated, assume default SO of 0%.

Low-income Gas Heat (Modeled)							
Last Revised Date	3/1/2015						
MEASURE OVERVIEW							
Description	This measure involves the installation of a new natural gas heating system and building weatherization measures to replace the existing natural gas heating equipment.						
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	ΔkWh/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[679]	Actual
IMPACT FACTORS							
Measure	ISR	RR_E	RR_D	CF_S	CF_W	FR	SO
Multifamily Gas Heat	100%[680]	100%[681]	100%[681]	NA	NA	0%[682]	0%[683]

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

Furnace and Boiler Retrofit (Prescriptive)							
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, Home Energy Savings 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[684]	EF_{BASE}	EF_{EE}			Life (yrs)	Cost ($)
Furnace/Boiler Retrofit	92	Actual	Actual			25[685]	Actual [686]
IMPACT FACTORS							
Measure	ISR	RR_E	RR_D	CF_S	CF_W	FR	SO
Furnace/Boiler Retrofit	100%[687]	100%[688]	100%[688]	NA	NA	0%[689]	0%[690]

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

Ductless Heat Pump Retrofit (LIDHP, LCH)		
Last Revised Date	7/1/2016	
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. The new DHP equipment may have one (single-head) or multiple (multi-head) indoor units per outdoor unit.	
Energy Impacts	Electric, Heating Oil, Propane, Kerosene	
Sector	Residential	
Program(s)	Low-income Program	
End-Use	Cooling, Heating	
Decision Type	Retrofit	
DEEMED GROSS ENERGY SAVINGS ALGORITHMS (UNIT SAVINGS)		
Demand Savings	*If baseline electric heat* ΔkW_{max} = 1.912 ΔkW_{WP} = 1.330 ΔkW_{SP} = -0.011	*If baseline non-electric heat* ΔkW_{max} = -2.266 ΔkW_{WP} = -0.654 ΔkW_{SP} = -0.011
Annual Energy Savings	*If baseline electric heat* ΔkWh/yr = 6,481 *If baseline non-electric heat* *Electric energy savings (negative values indicate increased usage)* ΔkWh/yr = -2,954 Fuel energy savings ΔMMBtu/y = 40	
GROSS ENERGY SAVINGS ALGORITHMS (UNIT SAVINGS)		
Demand Savings	Modeled[691]	

[691] Based on Excel Workbook for Ductless Heat Pump

Ductless Heat Pump Retrofit (LIDHP, LCH)	
Annual Energy Savings	Modeled[691] 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).[692] Savings were calculated based on a model employing the following key assumptions: • Average annual Heat Loss is 92 MMBtu corresponding to an average UA of 493 MMBtu/h/deg F. • DHP's contribution to heating does not exceed 35 percent of the home's heating load in any temperature bin. Even in temperature bins in which 100 percent of the home's heating load can be supplied by the DHP, the DHP supplies 35 percent of the heating load, and the remaining 65 percent is supplied by the existing heating system to account for distribution and behavior effects.[693] • DHP heating output capacity and DHP heating efficiency (both baseline and efficient units) vary linearly with outside air temperature. • Heating is called for when outside air temperature is less than or equal to 65°F. • Cooling is called for when outside air temperature is greater than or equal to 70°F. • 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 ductless heat pump (DHP) system $HSPF_{EE}$ = Heating seasonal performance factor of the high-efficiency DHP (Btu/Watt-hr) CAP_{Cool} = Rated cooling capacity of the DHP (kBtu/h) CAP_{Heat} = Rated heating capacity of the DHP (kBtu/h) $SEER_{B}$ = Seasonal energy-efficiency ratio for baseline DHP (Btu/Watt-hr) $SEER_{E}$ = Seasonal energy-efficiency ratio for high-efficiency DHP (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
EFFICIENCY ASSUMPTIONS	
Baseline Efficiency	The baseline case assumes the home retains its existing electric resistance-, oil-, kerosene- or propane-heating system and uses a window air conditioning unit for cooling (or has no cooling). A weighted average of the blended baseline fuel-heating systems and electric resistance heating systems in Maine homes and single-package air conditioner are used in the model (see Table 5).
Efficient Measure	The high-efficiency case assumes the home retains its existing heating system and adds a new high-efficiency DHP that meets minimum efficiency requirements for program rebate: HSPF=13.0 Btu/W-h.

[692] Calculated based on population of each region; U.S. Census Bureau Census 2010 Summary File 1 population by census tract.
[693] Heat load offset of 35 percent is consistent with other findings. Ecotope, NEEA Final Summary Report for the Ductless Heat Pump Impact and Process Evaluation, February 19, 2014, reported savings were analyzed to be equivalent to 30%-40% heat load offset.

Ductless Heat Pump Retrofit (LIDHP, LCH)						
PARAMETER VALUES						
Measure	CAP_{Heat}	CAP_{Cool}	$HSPF_E$	$SEER_E$	$\%COOL_{FULL}$	$\%COOL_{NONE}$
DHP Retrofit	17.5[694]	14.2[694]	13.2[694]	25.6[694]	40%[695]	21%[695]
Measure	$SEER_B$	$AFUE_B$			Life (yrs)	Cost ($)
DHP Retrofit	9.8[696]	80.5[697]			18[698]	$Actual[699]

IMPACT FACTORS							
Measure	ISR	RR_E	RR_D	CF_S	CF_W	FR	SO
DHP Retrofit	100%[700]	100%[701]	100%[701]	100%[702]	100%[702]	0%[703]	0%[704]

[694] Weighted average values of the most popular units that have been incentivized under the Efficiency Maine program.
[695] 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.
[696] Minimum EER for code-compliant room air conditioner effective June 1, 2014.
[697] Representative heating system efficiency based on preliminary results from NMR Group, Maine Single-Family Residential Baseline Study, September 14, 2015.
[698] GDS Associates, Inc., Measure Life Report – Residential and Commercial/Industrial Lighting and HVAC Measures, June 2007, Table 1.
[699] Total cost to program which covers 100 percent of installation cost.
[700] EMT assumes that all purchased units are installed (i.e. ISR = 100%).
[701] This measure is new and has not yet been evaluated. Until the next program impact evaluation, EMT assumes 100 percent realization rate.
[702] See Appendix B.
[703] This measure is new and has not yet been evaluated. Until the next program impact evaluation, EMT assumes 100 percent NTG.
[704] Program not yet evaluated, assume default SO of 0%.

Table 5. 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
Gas	Gas-Fired Forced hot water boiler	AFUE	6%	75%
Gas	Gas-Fired Steam boiler	AFUE	3%	75%
Propane	Propane-Fired Forced hot water boiler	AFUE	8%	75%
Propane	Propane-Fired Steam boiler	AFUE	4%	75%
Oil	Oil-Fired Forced hot water boiler	AFUE	22%	75%
Oil	Oil-Fired Steam boiler	AFUE	22%	75%
Oil	Oil-Fired Ducted Furnace	AFUE * Duct Efficiency	22%	56%
Wood	Wood Stove	AFUE	12%	60%
Blended	Blended MMBtu Baseline	Blended Efficiency	100%	80.5%
		Duct Efficiency		*75%*
Cooling Baseline Assumptions				
Electric	Single-Package Air Conditioner	SEER	40%	14
Electric	Single-Package Air Conditioner	EER	40%	12

Sources

DOE standards for boilers manufactured on or after September 1, 2012 (http://www1.eere.energy.gov/buildings/appliance_standards/product.aspx/productid/72)
DOE standards for furnaces manufactured on or after May 1, 2013 (http://www1.eere.energy.gov/buildings/appliance_standards/product.aspx/productid/72)
US DOE: Better Duct Systems for Home Heating and Cooling (http://www.nrel.gov/docs/fy05osti/30506.pdf)
DOE standards for Central air conditioners and central air conditioning heat pumps manufactured on or after January 1, 2015 (http://www1.eere.energy.gov/buildings/appliance_standards/product.aspx/productid/75)
Maine Governor's Energy Office, SPACE HEATING FUEL COMPARISON CALCULATOR (http://www.maine.gov/energy/fuel_prices/heating-calculator.php)
DOE standards for AC and Heat Pump (on or after January 23, 2006, and before January 1, 2015) (http://www1.eere.energy.gov/buildings/appliance_standards/product.aspx/productid/75)

Heat Pump Water Heater Direct Install (LIHPWH)	
Last Revised Date	4/1/2017
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	$\Delta kW_{SP} = 0.197$ $\Delta kW_{WP} = 0.424$
Annual Energy Savings	$\Delta kWh/yr = 2{,}151$
GROSS ENERGY SAVINGS ALGORITHMS (UNIT SAVINGS)	
Demand Savings	$\Delta kW_{SP} = \Delta kW_{SP}/y_{Evaluated}$ *Scaling factor Demand - Summer Peak kW savings from a HPWH field-evaluation study scaled for a COP of 3.5 $\Delta kW_{WP} = \Delta kW_{WP}/y_{Evaluated}$ *Scaling factor Demand - Winter Peak kW savings from a HPWH Heater field-evaluation study scaled for a COP of 3.5
Annual Energy Savings	$\Delta kWh/yr = \Delta kWh/y_{Evaluated}$ *Scaling factor Energy - Annual kWh savings from a HPWH field-evaluation study scaled for a COP of 3.5 Key assumptions include: • Average tank size for EMT's in-program HPWHs is 50 gallons.[705] • Typical HPWH set-point temperature in Maine households is expected to be comparable to the set-point temperature in Massachusetts and Rhode Island households metered.[706] • All of EMT's in-program HPWHs will be installed in conditioned spaces or partially conditioned spaces (i.e. regulated temperature and/or humidity), as was the case for most HPWH units studied in the evaluation[707] • Realized energy savings scale by COP and water use as follows: Scaling factor energy = $(1/COP_{BASE} - 1/COP_{EE})/(1/COP_{BASE\_STUDY} - 1/COP_{STUDY}) * WU_{ME}/WU_{STUDY} =$ 1.275 • Realized demand savings scale by COP as follows: Scaling factor demand = $(1/COP_{BASE} - 1/COP_{EE})/(1/COP_{BASE\_STUDY} - 1/COP_{STUDY}) = 1.135$ Where ○ $COP_{BASE\_STUDY} = 0.904$ – coefficient of performance for standard 50 gallon water heater included in the study [708] ○ $COP_{STUDY} = 2.35$ – average rated coefficient of performance of water heaters included in the study[709] ○ $COP_{BASE} = 0.945$ – coefficient of performance for standard 50 gallon water heater ○ $COP_{EE} = 3.5$ – rated coefficient of performance of water heaters to be installed under this program

[705] NMR Group, Inc., Efficiency Maine Appliance Rebate Program Evaluation Overall Report – FINAL, July 18, 2014, Table 2-31; at least 89 percent of HPWH units in EMT program are 50 gallons units (with the remaining 11 percent with unknown tank size). Steven Winter Associates Inc., Heat Pump Water Heaters, Evaluation of Field Installed Performance, June 26, 2012 included 10 units with 50-gallon tanks; 1 unit with a 60-gallon tank; and 3 units with 80-gallon tanks.
[706] NMR Group, Inc., Efficiency Maine Appliance Rebate Program Evaluation Overall Report – FINAL, July 18, 2014, Table 2-35; the average set-point temperature in Maine is 126.2°F, compared to the average set-point temperature of 127.6°F found in Steven Winter Associates Inc., Heat Pump Water Heaters, Evaluation of Field Installed Performance, June 26, 2012.
[707] Considering Maine's climate (winter), it can be anticipated that most if not all properly installed HPWHs will be installed in fully or partially conditioned spaces.
[708] Federal Standard, Code of Federal Regulations, Title 10, Part 430, Subpart C.
[709] Steven Winter Associates Inc., Heat Pump Water Heaters, Evaluation of Field Installed Performance, June 26, 2012, Table 1.

Heat Pump Water Heater Direct Install (LIHPWH)	
	• WU_{ME} = 51.1[710] ○ WU_{STUDY} = 45.5[711]
EFFICIENCY ASSUMPTIONS	
Baseline Efficiency	Standard 50-gallon residential water heater with an AHRI Energy Factor = 0.945[712]
Efficient Measure	ENERGY STAR®-certified model (EF = 3.5)
PARAMETER VALUES (DEEMED)	

Measure	$\Delta kWh/y_{Evaluated}$	$\Delta kW_{SP,\ Evaluated}$	$\Delta kW_{WP,\ Evaluated}$	Scaling factors (energy/demand)	Life (yrs)	Cost ($)
ENERGY STAR® HPWH	1,687	0.175	0.374	1.275/1.135	13[713]	Actual[714]

IMPACT FACTORS

Measure	ISR	RR_E	RR_D	CF_S	CF_W	FR	SO
ENERGY STAR® HPWH	100%[715]	100%[716]	100%[370]	100%[717]	100%[371]	0%[718]	0%[719]

[710] For Maine, 51.1 GPD is used 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.
[711] Average GPD found in the Steven Winter Associates Inc., Heat Pump Water Heaters, Evaluation of Field Installed Performance, June 26, 2012, was 45.5 GPD.
[712] Federal Standard, Code of Federal Regulations, Title 10, Part 430, Subpart C. EF = 0.945 value is calculated for 50-gallon water heater.
[713] NREL, National Residential Efficiency Measure Database.
[714] Total cost to program which covers 100 percent of installation cost.
[715] NMR Group, Inc., Efficiency Maine Appliance Rebate Program Evaluation Overall Report – FINAL, July 18, 2014, p. 60.
[716] Realization rates are 100 percent since savings estimates are based on evaluation results.
[717] Peak coincidence factors for this measure are embedded in the evaluated peak demand impacts.
[718] EMT assumes 0 percent free ridership and 0 percent spillover (i.e. NTG = 100%) for all measures implemented through the low-income program.
[719] Program not yet evaluated, assume default SO of 0%.

Domestic Water Heater Temperature Turn-Down							
Last Revised Date	7/1/2013						
MEASURE OVERVIEW							
Description	The hot water set-point temperature of the existing electric domestic water heater (DWH) is reduced by at least 10°F.[720] 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	ΔkW = 0.010						
Annual Energy Savings	ΔkWh/yr = 87						
GROSS ENERGY SAVINGS ALGORITHMS (UNIT SAVINGS)							
Demand Savings	ΔkW = ΔkWh/yr / Hours						
Annual Energy Savings	ΔkWh/yr = ΔkWh_{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) Hours = Annual operating hours for water heater (hrs/yr)						
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.[721]						
PARAMETER VALUES (DEEMED)							
Measure	ΔkWh_{EWHTD}	Hours	Life (yrs)	Cost ($)			
DWH Turn-Down	87[722]	8,760[723]	4[724]	0[725]			
IMPACT FACTORS							
Measure	ISR	RR_E	RR_D	CF_S	CF_W	FR	SO
DWH Turn-Down	100%[726]	100%[727]	100%[727]	9.6%[728]	13.3%[728]	0%[729]	0%[730]

[720] Engineering assumption, conservative compared to Illinois 2012 TRM which claims 15°F setback.
[721] 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
[722] 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.
[723] EMT assumes the water heater operates continuously to maintain the water heater set-point temperature.
[724] GDS Associates, Inc., Measure Life Report – Residential and Commercial/Industrial Lighting and HVAC Measures, June 2007, Table 1.
[725] Assumes temperature turn-down is performed as part of an audit or direct install program.
[726] EMT assumes that all purchased units are installed (i.e. ISR = 100%). This is consistent with the MA 2013-2015 TRM.
[727] This measure has not yet been evaluated. Until the next program impact evaluation, EMT assumes 100 percent realization rate.
[728] Appendix B: Coincidence and Energy Period Factors.
[729] EMT assumes 0 percent free ridership for all measures implemented through the low-income program.
[730] Program not yet evaluated, assume default SO of 0%.

Domestic Water Heater Pipe Insulation	
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.[731]

PARAMETER VALUES (DEEMED)

Measure	GPD	T_{WH}	T_{in}	RE_{EWH}	SF_{PI}	Hours	Life (yrs)	Cost ($)
DWH Pipe Insulation	51.1[732]	125[733]	50.8[734]	0.98[735]	0.03[736]	8,760[737]	15[738]	$70[739]

[731] Complies with International Residential Code 2009 section N1103.3: mechanical system piping insulation.
[732] 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.
[733] 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.
[734] Standard Building America DHW Schedules, weighted average by population of all Maine water main sources.
[735] NREL, Building America Research Benchmark Definition, 2009, p.12, http://www.nrel.gov/docs/fy10osti/47246.pdf
[736] 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".
[737] EMT assumes the water heater operates continuously to maintain the water heater set-point temperature.
[738] GDS Associates, Inc., Measure Life Report – Residential and Commercial/Industrial Lighting and HVAC Measures, June 2007, Table 1.
[739] NREL, National Residential Efficiency Measures Database, assuming R-5 insulation. The costs range from $44 to $92, with an average of $70.

Domestic Water Heater Pipe Insulation							
IMPACT FACTORS							
Measure	ISR	RR_E	RR_D	CF_S	CF_W	FR	SO
DWH Pipe Insulation	100%[740]	100%[741]	100%[741]	100%[742]	100%[742]	0%[743]	0%[744]

[740] EMT assumes that all purchased units are installed (i.e. ISR = 100%). This is consistent with the MA 2013-2015 TRM.
[741] This measure has not yet been evaluated. Until the next program impact evaluation, EMT assumes 100 percent realization rate.
[742] See Appendix B: Coincidence and Energy Period Factors.
[743] EMT assumes 0 percent free ridership for all measures implemented through the low-income program.
[744] Program not yet evaluated, assume default SO of 0%.

Domestic Water Heater Wrap								
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	$\Delta kW = 0.010$							
Annual Energy Savings	$\Delta kWh/yr = 89$							
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.							
PARAMETER VALUES (DEEMED)								
Measure	GPD	T_{WH}	T_{in}	EF_{BASE}	EF_{EE}	Hours	Life (yrs)	Cost ($)
EWH with tank wrap	51.1[745]	125[746]	50.8[747]	0.86[748]	0.88[748]	8,760[749]	7[750]	$30[751]

[745] 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.
[746] 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.
[747] Standard Building America DHW Schedules, weighted average by population of all Maine water main sources.
[748] 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
[749] EMT assumes the water heater operates continuously to maintain the water heater set-point temperature.
[750] DEER 2008
[751] http://energy.gov/energysaver/projects/savings-project-insulate-your-water-heater-tank

Domestic Water Heater Wrap							
IMPACT FACTORS							
Measure	ISR	RR_E	RR_D	CF_S	CF_W	FR	SO
EWH with tank wrap	100%[752]	100%[753]	100%[753]	100%[754]	100%[754]	0%[755]	0%[756]

752 EMT assumes that all purchased units are installed (i.e. ISR = 100%). This is consistent with the MA 2013-2015 TRM.
753 This measure has not yet been evaluated. Until the next program impact evaluation, EMT assumes 100 percent realization rate.
754 See Appendix B: Coincidence and Energy Period Factors.
755 EMT assumes 0 percent free ridership for all measures implemented through the low-income program.
756 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:[757]

- **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:[758]

- **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 B-1 includes a listing of measure coincidence factors and energy period allocations.

757 http://www.iso-ne.com/markets-operations/markets/demand-resources/about
758 http://www.efficiencymaine.com/docs/2015-AESC-Report-With-Appendices-Attached.pdf, p. 2-71.

Table B-1. Retail and Residential Coincidence Factors and Energy Period Factors

Measure Name	End-Use	Measure Life	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		18.6%	14.4%	40.8%	29.0%	17.5%	12.8%	759	760
LED Bulb – Distributor	Lighting		48.7%	56.1%	48.1%	20.0%	22.5%	9.4%	761	762
LED Bulb – Food Pantry/Direct Install/Appliance Pack	Lighting		16.8%	11.8%	39.0%	31.1%	16.3%	13.6%	763	764
LED Lamp Commercial Interior	Lighting		63.0%	76.0%	50.0%	19.0%	23.0%	9.0%	765	766
LED Lamp Commercial Exterior	Lighting		70.2%	3.7%	20.5%	50.6%	6.1%	22.8%	767	768
Refrigerator	Refrigeration		100.0%	100.0%	33.1%	33.5%	16.6%	16.8%	769	770
Freezer	Refrigeration		100.0%	100.0%	33.1%	33.5%	16.6%	16.8%	769	771
Room AC	Cooling		0.0%	11.1%	0.7%	2.8%	53.3%	43.2%	772	
Room Air Purifier	Cooling		66.7%	66.7%	30.4%	36.2%	15.6%	17.9%	773	
Dehumidifier	Cooling		0.0%	37.1%	17.9%	15.5%	33.9%	32.7%	769	770
Dishwasher	Process		4.0%	2.2%	39.7%	26.8%	20.3%	13.1%	774	

[759] Composite summer coincidence factor: 96% of bulbs in residential sockets with summer CF at 11.8% and 4% of bulbs in commercial sockets with summer CF at 76%. Composite winter coincidence factor: 96% of bulbs in residential sockets with winter CF at 16.8% and 4% of bulbs in commercial sockets with winter CF at 63%. Residential Factors from NMR Group, Efficiency Maine Retail Lighting Program Overall Evaluation Report, April 16, 2015, page 19. Commercial Factors from Efficiency Maine Trust Commercial TRM, July 1, 2015.

[760] Composite Energy Period Factors for Residential (96%) and Commercial (4%). Residential energy period allocations are from NMR Group, Efficiency Maine Retail Lighting Program Overall Evaluation Report, April 16, 2015. Commercial energy period allocations from Central Maine Power, non-residential load profile for 3/1/08-2/28/09.

[761] Composite summer coincidence factor: 31 percent of bulbs in residential sockets with summer CF at 11.8 percent and 69 percent of bulbs in commercial sockets with summer CF at 76 percent. Composite winter coincidence factor: 31% of bulbs in residential sockets with winter CF at 16.8 percent and 69 percent of bulbs in commercial sockets with winter CF at 63 percent. Residential Factors from NMR Group, Efficiency Maine Retail Lighting Program Overall Evaluation Report, April 16, 2015, p. 19. Commercial Factors from Efficiency Maine Trust Commercial TRM, July 1, 2013.

[762] Composite Energy Period Factors for Residential (31%) and Commercial (69%). Residential energy period allocations are from NMR Group, Efficiency Maine Retail Lighting Program Overall Evaluation Report, April 16, 2015. Commercial energy period allocations from Central Maine Power, non-residential load profile for 3/1/08-2/28/09.

[763] NMR Group, Efficiency Maine Retail Lighting Program Overall Evaluation Report, April 16, 2015, p. 19.

[764] NMR Group, Efficiency Maine Retail Lighting Program Overall Evaluation Report, April 16, 2015.

[765] KEMA, C&I Lighting Load Shape Project FINAL Report, July 2011.

[766] Central Maine Power, Non-residential load profile for 3/1/08-2/28/09.

[767] Efficiency Vermont TRM 2012, Commercial Outdoor Lighting.

[768] Ibid.

[769] Peak coincidence factors for this measure are embedded in the evaluated peak demand impacts.

[770] Memo provided to supplement NMR Group, Inc., Efficiency Maine Appliance Rebate Program Evaluation Overall Report – FINAL, July 18, 2014.

[771] Assumed to be the same as refrigerator measure.

[772] RLW Analytics, Coincidence Factor Study, Residential Room Air Conditioners, June 2008. Values are based on TMY2 weather for Portland, Maine.

[773] Values developed based on annual hours of use and equipment operating assumptions.

[774] 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.

Measure Name	End-Use	Measure Life	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
Clothes Washer	Process		6.3%	4.8%	40.0%	26.6%	20.1%	13.3%	770	
Electric Water Heater	DHW		13.3%	9.6%	40.9%	25.7%	20.9%	12.5%	774	
Heat Pump Water Heater	DHW		100.0%	100.0%	35.8%	30.8%	17.9%	15.5%	769	770
Custom	Heating/Cooling		100.0%	100.0%	58.4%	33.7%	3.5%	4.5%	769	775
Air Sealing	Heating/Cooling		100.0%	100.0%	56.5%	34.3%	5.4%	3.8%	769	775
Insulation	Heating/Cooling		100.0%	100.0%	56.5%	34.3%	5.4%	3.8%	769	775
Ductless Heat Pump	Heating/Cooling		100.0%	100.0%	57.3%	36.8%	2.8%	3.1%	776	
Ductless Heat Pump Retrofit	Heating/Cooling		100.0%	100.0%	56.8%	36.5%	3.6%	3.1%	777	
Central Air-source Heat Pump (Ducted)	Heating/Cooling		50.0%	25.0%	56.5%	34.3%	5.4%	3.8%	778	775
Central Geothermal (Ground Source) Heat Pump	Heating/Cooling		79.6%	10.2%	56.5%	34.3%	5.4%	3.8%	769	775
Direct Install CFL Bulb	Lighting		16.8%	11.8%	39.0%	31.1%	16.3%	13.6%	779	
Low-flow Kitchen Aerator	DHW		1.2%	0.8%	39.7%	26.8%	20.3%	13.1%	774	
Low-flow Bathroom Aerator	DHW		0.4%	0.3%	39.7%	26.8%	20.3%	13.1%	774	
Low-flow Showerhead	DHW		0.8%	0.5%	35.5%	31.1%	18.1%	15.3%	774	
Thermostatic Shower Valve	DHW		0.8%	0.5%	35.5%	31.1%	18.1%	15.3%	774	
DHW Temperature Turn-Down	DHW		13.3%	9.6%	40.9%	25.7%	20.9%	12.5%	774	
DHW Pipe Insulation	DHW		100.0%	100.0%	30.4%	36.2%	15.6%	17.9%	773	
DHW Wrap	DHW		100.0%	100.0%	30.4%	36.2%	15.6%	17.9%	773	
Low-income Multifamily Gas Heat, Furnaces and Boilers (NC/Retrofit), Pellet/Wood Stove, Pellet Boiler, Air Sealing, Attic Insulation, On Demand Natural Gas Water Heater*	Heating, DHW		NA	NA	NA	NA	NA	NA	NA	NA

775 Values developed based on the bin analysis calculations for insulation savings using typical annual hours in each weather bin during each demand and energy period.
776 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.
777 Values developed based on the bin analysis calculations for DHP retrofit savings using typical annual hours in each weather bin during each demand and energy period.
778 MA TRM 2013 TRM 2010, Air-source heat pump peak coincidence factor.
779 NMR Group, Efficiency Maine Retail Lighting Program Overall Evaluation Report, April 16, 2015.

*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.

Appendix C: Carbon Dioxide Emission Factors

Table 6. Carbon Dioxide Emission Factors

Fuel	Emission Factor	Units
Coal by Rank		
Anthracite	103.69	kg CO_2 / MMBtu
Bituminous	93.28	kg CO_2 / MMBtu
Sub-bituminous	97.17	kg CO_2 / MMBtu
Lignite	97.72	kg CO_2 / MMBtu
Natural Gas		
Pipeline Natural Gas	53.06	kg CO_2 / MMBtu
	5.306	kg CO_2 / therm
Flared Natural Gas	54.71	kg CO_2 / MMBtu
	5.471	kg CO_2 / therm
Petroleum Fuels		
Middle Distillate Fuels (No. 1, No. 2, No. 4 fuel oil, diesel, home heating oil)	73.15	kg CO_2 / MMBtu
	10.15	kg CO_2 / gallon
Jet Fuel (Jet A, JP-8)	70.88	kg CO_2 / MMBtu
	9.57	kg CO_2 / gallon
Kerosene	72.31	kg CO_2 / MMBtu
	9.76	kg CO_2 / gallon
Heavy Fuel Oil (No. 5, 6 fuel oil), bunker fuel	78.80	kg CO_2 / MMBtu
	11.80	kg CO_2 / gallon
Ethane	59.59	kg CO_2 / MMBtu
	4.14	kg CO_2 / gallon
Propane	63.07	kg CO_2 / MMBtu
	5.74	kg CO_2 / gallon
Isobutane	65.07	kg CO_2 / MMBtu
	6.45	kg CO_2 / gallon
n-Butane	64.95	kg CO_2 / MMBtu
	6.69	kg CO_2 / gallon
Unspecified LPG	62.28	kg CO_2 / MMBtu
	-	kg CO_2 / gallon
Refinery (Still) Gas	64.20	kg CO_2 / MMBtu
	9.17	kg CO_2 / gallon
Crude Oil	74.54	kg CO_2 / MMBtu
	10.29	kg CO_2 / gallon
Petroleum Coke	102.12	kg CO_2 / MMBtu
	14.65	kg CO_2 / gallon
Other Fuels		
Tires/Tire Derived Fuel	85.97	kg CO_2 / MMBtu
Waste Oil	9.98	kg CO_2 / gallon
Waste Oil Blended with Residual Fuel Oil	66.53	kg CO_2 / MMBtu
Waste Oil Blended with Distillate Fuel Oil	71.28	kg CO_2 / MMBtu
Municipal Solid Waste	417.04	kg CO_2 / short ton
Municipal Solid Waste	41.70	kg CO_2 / MMBtu
Plastics Portion of MSW	2,539.80	kg CO_2 / short ton
Electricity[780]	1.029	Pounds per kWh

[780] From Avoided Energy Supply Cost in New England, 2015, Rick Hornby, et. al.

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 D-1. 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 D-2 describes the adjustments to baseline starting in 2012 due to the changing maximum wattages specified in EISA.

Table D-2. EISA Adjustments by Lumen Range (Evaluation, Table 25)[781]

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 D-3 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 D-3. 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

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

Appendix E: Standard Assumptions for Maine

Table E-1. Distribution of Heating Fuel for Maine Residential Customers

Heating Fuel	Percentage of Homes	Distribution Excluding Coal and Other	Distribution Excluding Natural Gas, Coal and Other	Distribution Excluding Natural Gas, Coal, Wood and Other
Natural Gas	9%	9%	N/A	N/A
Oil	65%	66%	72%	83%
Wood	8%	8%	9%	N/A
Propane	6%	6%	7%	8%
Kerosene	6%	6%	7%	8%
Pellet	4%	4%	4%	N/A
Electricity	0.80%	0.80%	0.9%	1%
Coal	0.40%	N/A	N/A	N/A
Other	0.30%	N/A	N/A	N/A

Table E-2. Minimum Efficiency Requirements for Furnaces and Boilers[782]

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.		

[782] 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,[783] 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 F-1 below).

Table F-1. 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

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

Table F-2. Baseline Bulb Replacement Schedule and Avoided O&M

Commercial Hours/Year	Residential Hours/Year	Real Discount Rate
3771	730	6.50%

	Retail		Residential		Distributor	
Life Category	>20,000 hr	<20,000 hr	>20,000 hr	< 20,000 hr	>20,000 hr	<20,000 hr
Rated Hours	25,000	15,000	25,000	15,000	25,000	15,000
% Commercial	4%	4%	0%	0%	69%	69%
Hours/Year	851.64	851.64	730	730	2828.29	2828.29
Rated Life (Years)	29	18	34	21	9	5
Baseline Rated Hours	2000	2000	2000	2000	2000	2000
Baseline Rated Life (Years)	2.35	2.35	2.74	2.74	0.71	0.71
Baseline bulbs per EE life	12	8	12	8	13	7
Check	12	8	12	8	13	7
NPV of Bulbs	5.24	4.39	4.68	4.01	9.66	5.87

	Baseline Replacement Schedule: Number of Bulbs Replaced per year					
Year	RetL	RetS	ResL	ResS	DisL	DisS
1	0	0	0	0	2	2
2	1	1	0	0	1	1
3	0	0	1	1	1	1
4	0	0	0	0	2	2
5	1	1	1	1	1	1
6	0	0	0	0	2	
7	1	1	0	0	1	
8	0	0	1	1	2	
9	1	1	0	0	1	
10	0	0	0	0		
11	0	0	1	1		
12	1	1	0	0		
13	0	0	0	0		
14	1	1	1	1		
15	0	0	0	0		
16	1	1	1	1		
17	0	0	0	0		
18	0	1	0	0		
19	1		1	1		
20	0		0	0		
21	1		0	1		
22	0		1			
23	1		0			
24	0		1			
25	0		0			
26	1		0			
27	0		1			
28	1		0			
29	0		0			
30			1			
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 7. 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	75%	[784]	46%	[785]	100%	[786]	400%	[787]	IE_{COOL_D}	1.085
Residential Cooling Energy	75%	[784]	46%	[785]	25%	[788]	400%	[787]	IE_{COOL_E}	1.021
Residential Heating	75%	[784]	86%	[789]	50%	[790]	80.5%	[791]	IE_{HEAT_E}	0.00137
Commercial Cooling Demand	75%	[784]	77%	[792]	100%	[786]	400%	[787]	IE_{COOL_D}	1.144
Commercial Cooling Energy	75%	[784]	77%	[792]	42%	[793]	400%	[787]	IE_{COOL_E}	1.060
Commercial Heating	75%	[784]	100%	[794]	50%	[790]	80.5%	[791]	IE_{HEAT_E}	0.00159

For Retail and Distributor programs, the interactive effect factors are calculated based on the portion of bulbs installed in residential and commercial settings as presented in the table below.

	Residential	Commercial		Retail	Distributor
			% Commercial	**4%**	**69%**
IE_cool_d	1.085	1.144		1.087	1.126
IE_cool_e	1.021	1.060		1.023	1.048
IE_heat_e	0.00137	0.00159		0.00138	0.00152

[784] Based on engineering judgment

[785] 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%)

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

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

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

[789] 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%)

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

[791] 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.

[792] 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%)

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

[794] 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%)

Free Ridership Rate Estimates

A lighting pricing trial was conducted where incentive levels were changed over time to determine the price elasticity of retail bulbs. Price elasticity is a measure of how demand for a product is related to the price of the product. It was determined that the demand for LED bulbs was strongly influenced by the customer facing price after the mark down (incentive) was applied.

The weekly sales of a particular bulb can be estimated with the following formula.

$$Weekly\ Sales = \ e^{C1+C2\times\ln(Price)}$$

Price is the customer facing price (what the bulb will cost at the register).

C1 and C2 are coefficients determined from the statistical analysis of the pricing trial results.

The trial found that the coefficients were different for standard LED bulbs and specialty LED bulbs as presented in Table 8.

Table 8. LED Bulb Price Elasticity Coefficients

Bulb Type	C1	C2
Standard LED	-1.54502	7.348561
Specialty LED	-0.75971	5.019844