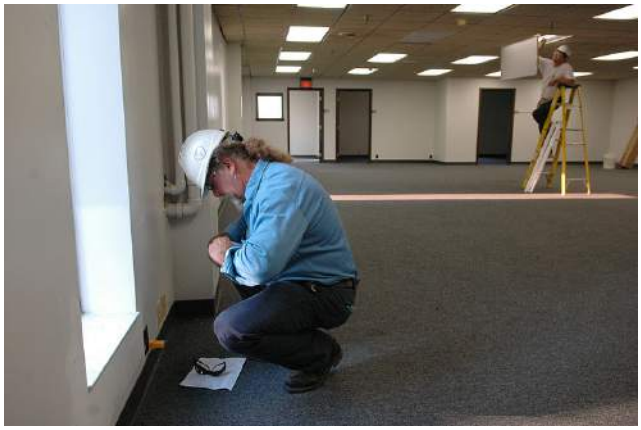
Northeast Energy Efficiency Partnerships



Early Replacement Measures Scoping Study: Phase I Research Report

August, 2014

About NEEP & the Regional EM&V Forum

REGIONAL EVALUATION,
MEASUREMENT & VERIFICATION FORUM

NEEP was founded in 1996 as a non-profit whose mission is to serve the Northeast and Mid-Atlantic to accelerate energy efficiency in the building sector through public policy, program strategies and education. Our vision is that the region will fully embrace energy efficiency as a cornerstone of sustainable energy policy to help achieve a cleaner environment and a more reliable and affordable energy system.

The Regional Evaluation, Measurement and Verification Forum (EM&V Forum or Forum) is a project facilitated by Northeast Energy Efficiency Partnerships, Inc. (NEEP). The Forum's purpose is to provide a framework for the development and use of common and/or consistent protocols to measure, verify, track, and report energy efficiency and other demand resource savings, costs, and emission impacts to support the role and credibility of these resources in current and emerging energy and environmental policies and markets in the Northeast, New York, and the Mid-Atlantic region.

About Evergreen Economics

EVERGREEN
ECONOMICS

Evergreen Economics is an economics research firm founded in 2011 by three principal economists formerly with the consulting firm ECONorthwest. Since then, Evergreen's staff has grown to include 17 members working on diverse energy program evaluation projects throughout the US and Canada. Evergreen specializes in using rigorous economic analysis techniques to evaluate energy efficiency programs, with particular expertise in sophisticated statistical modeling and sampling techniques.

About Michaels Energy

Michaels Energy is nationally recognized in energy efficiency consulting, providing technical, program management, evaluation, and administrative support for utility demand-side management programs. Michaels also provides services to commercial, institutional, and industrial end-users including investment grade feasibility studies, retro-commissioning studies, and LEED® consulting.

About PWP Inc.

PWP, Inc. is a small consulting firm located outside Washington DC that has completed numerous assignments in all parts of the country. PWP was incorporated in Maryland in 2004, but the firm's president, Dr. Philippus Willems, has been active in energy program evaluation for decades. PWP is thoroughly experienced in literature review, primary data collection and a variety of analytical techniques for market assessment and evaluation, having conducted hundreds of assessments of utility programs and other interventions in markets for energy-using structures and equipment.

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PWP Inc.

Early Replacement Measures Scoping Study

Final Phase I Research Report

A Report to the Regional Evaluation, Measurement and Verification Forum, facilitated by Northeast Energy Efficiency Partnerships

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1 Executive Summary

The Regional Evaluation, Measurement and Verification Forum (Forum) facilitated by Northeast Energy Efficiency Partnerships (NEEP) engaged the Evergreen team in November 2013 to conduct this Phase I Early Replacement Measure Scoping Study. The objectives for the scoping study include:

1. Compiling descriptive information about current energy efficiency retrofit programs with early replacement measures – with specific focus on eligibility criteria, measures savings baseline assumptions, and remaining useful life assumptions;
2. Identifying and summarizing common and contrasting program design elements, savings calculation approaches and technical assumptions;
3. Identifying challenges related to the promotion of early replacement measures, and soliciting Program Administrator (PA) desires for additional research to improve program performance and the accuracy of savings estimates; and
4. Providing preliminary recommendations on the prioritization of measures and program participant populations upon which to focus the early replacements Phase II research.

For this research, an "early replacement" program was defined as any program that promotes the replacement of equipment prior to the assumed time of normal replacement that would occur without the influence of the program. Early replacement measures are those that replace existing, operational equipment that is not at the end of its useful life (and therefore has a "remaining useful life", or RUL) or which is not scheduled for replacement for reasons independent of the program. In contrast, "normal replacement" measures are installed when equipment has reached the end of its useful life and has become non-operational or is being replaced for some other reason.

Research Methods

The data collection had two primary components. First the Evergreen team reviewed PA documents with early replacement measures information, including: Technical Reference Manuals (TRMs), program plans and implementation materials, and supporting savings and cost calculations tools/spreadsheets. In many cases we conferred with PA staff to identify information gaps and/or clarify specific information about early replacement measures. During this process, we populated and continuously updated a spreadsheet database to store detailed measure-level information (in Appendix B in this report, which is also available as an Excel spreadsheet).

The Evergreen team also conducted qualitative interviews with PA staff to report on actual program implementation issues that NEEP has interest in, such as:

- Programs progress relative to goals (e.g., lagging, exceeding) and key reasons
- Description of project tracking tools used
- How early replacement elements are handled in Custom projects
- Economic assumptions used (e.g., discount rates, if present value calculations are used to move purchases forward in time)
- How early replacement measure cost effectiveness is affected by program design assumptions such as RUL, dual baselines, etc.
- Feedback regarding early replacement program implementation and/or design successes and challenges
- Recommended research objectives for NEEP's Phase II study

NEEP staff and project advisors helped the Evergreen team to develop the sample frame of NEEP's constituent PAs to research, to include a range of states and jurisdictions while not including known duplicative programs. The final sample included 11 NEEP PAs (including two "statewide" surveys where multiple PAs adiminster similar programs – Connecticut and Massachussetts), and seven PAs in other parts of the U.S. Early replacement measures for all fuel types (e.g., oil, gas, electricity) and customer segements were researched.

Key Findings

In our research we identified 17 different types of early replacement measures among five end uses. The majority of early replacement measures is targeted to residential customers, and lighting and refrigerator/freezers make up almost half of early replacement measures across all sectors - with lighting being the clear leader. Half of the lighting measures were either general lighting retrofits or fluorescent replacements. Many of the most common early replacement measures (e.g., residential air conditioners and refrigerators, T12 lighting), however, could become less viable in coming years due to code changes, according the PA staffs we interviewed.

Measure eligibility requirements for early replacements are not particularly burdensome overall. About 75 percent of measures at least require that the existing equipment is functional, while almost one-quarter do not explicitly require functionality. In addition, age, efficiency, and cost requirements are used in fewer than 15 percent of the measures studied, and eligibility is verified for only 41 percent of measures. Not all programs with functionality (or age, efficiency, or cost) requirements use verification to ensure they are meeting those requirements.[1]

[1] For purposes of this study it is helpful to note that in the tables of results and in some of the discussion in the report each count of a measure generally represents one program administrator program. However, some of the measures data were combined where multiple program administrators offer the same measures throughout a state (e.g. Connecticut and Massachusetts).

Nearly two-thirds of our sampled measures use equipment RUL in some fashion. Only 52 percent of lighting measures use RUL, while over 80 percent of central air conditioner and refrigerator measures use it. RUL is used for nearly every early replacement measure type with the exception of ECMs, motors and drives, and boiler circulation pumps. Somewhat surprisingly, 81 percent of measures using RUL did not cite any sources for their RUL values, and only 13 percent of programs used field data to determine RUL.

Regarding savings calculation methods for early replacements, four methods are used: dual baselines, EUL-only, RUL-only and blended EUL/RUL values. Thirty-seven percent of programs use dual baselines (but no lighting programs), 25 percent use EUL-only and the rest are split evenly between RUL-only and blended EUL/RUL values. Regarding the RUL-only method, a few PAs reduce the EUL by a small amount to account for the reduced lifetime of the existing equipment (e.g., 13 years for retrofit lighting as opposed to 15 years for new construction).

Five of the sampled program administrators constitute most of the dual baseline use and use it extensively in their early replacement programs. Program administrators that use dual baselines use it in the vast majority of their programs. Two program administrators use an unusual dual baseline method where the full EUL of the new equipment is used after accounting for the RUL of the existing equipment, instead of using the difference (suggesting an error in their approach).

The majority of early replacement programs use total project costs (including labor) in their cost effectiveness calculations. Typically, rebate levels for early replacement measures are meant to cover 35 to 50 percent of total costs, including labor, while normal replacement incentives are intended to cover about 75 percent of incremental costs – usually to obtain equipment rated above minimum federal standards.

In custom projects, most utilities do not consider measures as part of a bundle; instead, each measure is treated individually for savings and rebate amounts. Savings tend to be calculated based on the energy consumption of the existing equipment compared to the calculated usage of the new, more efficient equipment and most prefer to use the full effective useful life (EUL) of the new measure – a few utilities reduce the EUL by a small amount to account for the reduced lifetime of the existing equipment (e.g., 15 years for new construction lighting as opposed to 13 years for retrofit lighting).

PAs tend to record data from early replacement projects slightly differently than normal replacement projects. Additional information – such as the age (where available and used for RUL), efficiency, and model number – of existing equipment is usually reported for early replacement projects. None of the PAs use the same tool to track participation and/or savings values for early replacement programs. About half stated that they use some kind of

proprietary or custom-built database, while others use a semi-customized, off-the-shelf product, including: eTrack, FoxPro, Microsoft Access, Nexant TrakSmart, and energyOrbit.

Challenges Reported by PAs

Several interviewed PA staff noted that determining cost-effectiveness for early replacement projects is a continual, key challenge. Many of the key inputs to calculating cost-effectiveness are difficult to capture, including the age, efficiency and condition of the existing equipment, the cost of new equipment, and the specific factors that drive customer replacement decisions. Another challenge mentioned by several PAs that limits the ability to offer ER programs is that regulatory requirements limit the amount of savings they can claim when customers switch fuels (e.g., replace a functional oil furnace with a gas furnace). "Stagnating" efficiency standards can also be challenge for early replacement programs. PA staff identified HVAC and refrigerators in particular as measures where there have been relatively few upgrades to efficiency standards in recent years, so that new equipment is sometimes not that much more efficient than what is being replaced.

Recommendations for Phase II Study

Based upon the research findings, the Evergreen team identified six topic areas that NEEP could consider for subsequent research:

1. What are the primary and secondary barriers to adopting the dual baseline approach to calculate savings? While the Evergreen team can speculate upon some of the reasons from our research (e.g., data collection costs, misunderstanding of the dual-baseline method), more focused, in-depth inquiry may yield additional answers.

2. What are current best practices for collecting existing equipment information (e.g., age, efficiency, degradation, salvage value) accurately and cost-effectively? Identifying ways that PAs can more easily capture this information may lead to additional and more defensible early replacement programs.

3. Related to #2, what additional information can customers provide to enhance and inform RUL assumptions used to calculate program impacts?

4. How accurate are current RUL assumptions for lighting measures? Are they often too generous if most customers are replacing lighting just before expected failure? How could RUL estimates for lighting in particular be improved?

5. How often is unitary HVAC equipment replaced "early" but not recognized as such in standard normal replacement programs? How large is the missed opportunity for larger early replacement savings? What best practice data collection and screening practices could other PAs implement?

6. What other measures could be good candidates for early replacement programs? As noted by one of the PA interviewees, "Since measures with stable efficiency standards and a long life make for bad early replacement programs, is there some other technology that has a long life left with a big efficiency improvement?"

2 Introduction

2.1 Study Objectives

Compared to other evaluation topics, issues related to early replacement retrofits, equipment remaining useful life (RUL), and the potential use of multiple baselines to calculate energy savings have received less systematic study, although they can potentially have large impacts for certain types of projects. In particular, there is a wide variety of practices and continuing uncertainty regarding baseline efficiencies in particular, and how to address early replacements in general.

The Regional Evaluation, Measurement and Verification Forum (Forum) facilitated by Northeast Energy Efficiency Partnerships (NEEP) engaged the Evergreen team in November 2013 to conduct this Phase I Early Replacement Measure Scoping Study. The detailed objectives for the scoping study include:

1. Compiling descriptive information, in a consistent format, about current energy efficiency retrofit programs with early replacement measures – with specific focus on eligibility criteria, measures baseline assumptions (e.g., dual baselines or not), measure life and remaining useful life assumptions, assumed savings from early replacement, and methodological approaches.
2. Identifying and summarizing common and contrasting program design elements, savings calculation approaches and technical assumptions;
3. Identifying challenges related to the promotion of early replacement measures, and soliciting Program Administrator (PA) desires for additional research to improve program performance and the accuracy of savings estimates; and
4. Providing preliminary recommendations on the prioritization of measures and program participant populations upon which to focus the early replacements Phase II research.

For this research, an "early replacement" program was defined as any program that promotes the replacement of equipment prior to the assumed time of normal replacement that would occur without the influence of the program. Early replacement measures are those that replace existing, operational equipment that is not at the end of its useful life (and therefore has a "remaining useful life", or RUL) or which is not scheduled for replacement for reasons independent of the program.

In contrast, "normal replacement" measures are installed when equipment has reached the end of its useful life and has become non-operational or is being replaced for some other reason. Early replacement measures are commonly called "retrofit" measures, and may be offered through separate energy efficiency (EE) programs, or they may be included with

normal replacement measures in a single program with different rebate levels for early and normal replacement measures.

2.2 Study Methods

Documents Reviews

To initiate the data collection, Evergreen requested the following types of documents from each Program Administrator in the research sample (described subsequently), and asked PA staff to identify specific early replacement measures they were aware of:

- Technical Reference Manuals
- Program implementation materials including rebate forms
- Supporting engineering documents or savings/cost calculation tools
- Program plans and annual reports
- Recent program evaluation reports
- Recent program participation/savings status reports

The Evergreen team then reviewed the documents that were received for early replacement measures information, and in many cases conferred with PA staff to identify information gaps and/or clarify specific information about early replacement measures. During this process, we populated and continuously updated a spreadsheet database to store detailed measure-level information (see Appendix B). Some of the specific measure details we inventoried include:

- Equipment end use (e.g., lighting, HVAC), measure name and fuel type
- Customer eligibility requirements (e.g., sector, size/rate class, location, etc.)
- Equipment eligibility requirements (e.g., efficiency, age, operating condition, site-specific usage, maximum repair costs)
- Equipment remaining useful life assumptions, and/or approaches to calculate
- Early replacement measure savings assumptions and/or approaches used (deemed amount, dual baseline or other calculations)
- Incentive amounts
- Cost calculation assumptions and/or approaches
- Data sources referenced

Evergreen also compiled the following data in a separate database where available from existing, published documents. Energy savings data broken out by early versus normal replacement or new construction, however, are often not readily available at the measure level, and instead are typically reported at the program (or sector) level.

- Annual program participation and savings data
- Early replacement program age or start date

PA Staff Interviews

The Evergreen team developed a qualitative questionnaire for PA staff to report on actual program implementation issues that NEEP has interest in. Some of the main topics of the questionnaire are:

- Programs progress relative to goals (e.g., lagging, exceeding) and key reasons
- Future program participation goals, and planned program changes
- Description of project tracking tools used
- How early replacement elements are handled in Custom and bundled multi-measures projects – what RUL questions are asked, what assumptions/calculations are used?
- For add-on measures (e.g., a VFD on a old motor, boiler controls, etc.), what assumptions are made regarding the existing equipment, which has remaining life less than the added equipment?
- Economic assumptions used for early replacements (e.g., discount rates, if net present value calculations are used to move purchases forward in time)
- Early replacement measure cost effectiveness, and how this is affected by program design assumptions such as RUL, dual baselines, etc.
- Feedback regarding early replacement program implementation and/or design successes and challenges
- Recommended research objectives for NEEP's Phase II study, and relevant study measures/populations

2.3 Research Sample

NEEP staff and project advisors helped the Evergreen team to develop the sample frame of NEEP's constituent PAs to research, to include a range of states and jurisdictions while not including known duplicative programs. Early replacement measures data were obtained from the following Forum PAs:

1) Liberty Utilities (New Hampshire)
2) Public Service of New Hampshire (PSNH - New Hampshire)
3) Unitil (New Hampshire)
4) Efficiency Vermont (Vermont)
5) DC Sustainable Energy Utility (DCSEU - Washington D.C.)

6) National Grid (Massachusetts)[2]
7) National Grid (New York)
8) Con Edison (New York)
9) Connecticut (Summary of statewide programs)[3]
10) Baltimore Gas and Electric (Maryland)
11) Pepco (Maryland)

The Evergreen team also identified several other PAs to include in the study, based on a literature review of previous early replacement measure studies and professional experience working with specific PAs and standards setting organizations. Data were obtained for the following non-Forum PAs:

1) Ameren (Illinois)
2) Dayton Power and Light (Ohio)
3) Tucson Electric Power Company (Arizona)
4) NorthWestern Energy (Montana)
5) Xcel Energy (Minnesota and Colorado)
6) Energy Trust of Oregon (Oregon)
7) Northwest Regional Technical Forum (which develops measures savings guidelines for several Northwest utilities, and does not offer its own programs or measures)

2.4 Notes on Study Scope

Normal Replacement Measures

Normal replacement measures were not the primary focus of this research, and the study excluded PA programs that only target normal replacements (i.e., no separate early replacement requirements or savings are documented). However, normal replacement measures data were included in the data collection when there is also a documented early replacement option for the same or similar measures at a given PA through the same or another program.

[2] Other PAs running programs similar to Massachussetts National Grid include: NSTAR, Cape Light Compact, WMECo, Columbia Gas, New England Gas, Blackstone Gas and Berkshire Gas. Rhode Island National Grid was also included in the research sample, and was subsequently dropped since its early replacement programs are very similar to those of National Grid Massachusetts.

[3] PAs implementing similar early replacement programs include but are not limited to Connecticut Light & Power, United Illuminating, Connecticut Natural Gas, Southern Connecticut Gas, Yankee Gas and Energize Connecticut.

Specific Measures

New building construction, fuel switching, lighting lamp replacements, weatherization, behavioral measures, and new controls on existing equipment were excluded from the research and measures database. Following is additional information about how specific measures and program designs were addressed:

1) Add-on measures - These new measures are added to existing measures or buildings (e.g., insulation, new economizers or other controls on HVAC systems, new VFDs), and were generally excluded from the measures database. We explored this topic in the PA interviews however, to learn what assumptions are made regarding measure life when a control or measure, for example when a Variable Frequency Drive (VFD) or economizer is added to existing equipment that has less remaining life than the add-on equipment.

2) Custom projects - These are often not well documented in TRMs and may include early replacement components. For retrofit custom measures, the primary focus was to determine if/how programs are defining remaining useful life (RUL) and baseline equipment, and this information can sometimes be obtained from custom project application worksheet templates.

3) Home Performance with ENERGY STAR programs – These and similar programs can have combined, "bulk" rebates for multiple installed measures but separate savings assumptions for individual measures. Where applicable, we looked for early replacement measures individually in other programs.

4) Appliance Recycling programs – Many PA programs only focus on the early *retirement* of old, inefficient secondary equipment (e.g., basement refrigerators) while some incentivize efficient *replacement* equipment and some utilities (e.g., Xcel Energy) incentivize both. This study only included programs where inefficient equipment is retired and replaced, to be consistent with the other measures this study prioritized.

Study Challenges

The Evergreen team experienced some challenges in collecting the required information from the sampled PAs, although in the end we were able to obtain most of the measure data and qualitative feedback we sought. These challenges included:

1) Difficulty scheduling interviews with PA staff most familiar with the early replacement programs, as PA staff are very busy with their regular non-research related workloads.

2) Lack of consistent terminology used across the PAs (e.g., some call programs "early replacement" while others call them "retrofit" or "early retirement," and some make no

obvious distinction from normal replacement measures in their customer-facing program information). In some cases, in-depth and repeated communications were required to distinguish early replacement/retrofit measures consistent with the study definition.

3) Often there was not a central "location" where the necessary early replacement information is recorded or available (e.g., website program information, TRM, plan documents, spreadsheets). This made it more challenging to account for all measures that were treated as early replacements. In particular, measure cost values or calculation methods are often not included TRMs.

4) Interview responses that were sometimes inconsistent with programs documentation (e.g., TRMs). This could reflect knowledge gaps about particular details among some PA staff, and/or that program documents are not always up to date. Notably, PAs often rely on consultants to design their programs, and sometimes the current designs are not well documented or readily available.[4]

5) Some PA staff were willing to conduct qualitative interviews, but were unresponsive to requests to review and confirm the measures data compiled for their programs by the Evergreen team.

[4] Without documentation of program impacts or other strategies to increase transparency around sources of program impacts, it is difficult for interested stakeholders to know how to interpret such program impact parameters as measure life.

3 Research Findings

In this section we summarize the early replacements information that was collected and highlight notable patterns and examples. Readers should also review Appendix B, which includes many additional details for the early replacements measures.

3.1 Types of Early Replacement Measures

The PAs surveyed in this study offer early replacement measures in seventeen different measure types covering five standard end uses. These end uses include: lighting, HVAC, motors and drives, compressed air, and appliances. In addition to these prescriptive programs, nine PAs offer custom early replacement programs. A total of 106 early replacement measures were analyzed from 17 different PAs.

Despite this diversity in offerings, PAs offer some measures much more frequently as early replacement measures than others, as illustrated in Table 1. This table shows the number of early replacement measures studied in this research, subdivided into Forum and non-Forum PAs and customer segment. In the table, each count of a measure (e.g., motors and drives) generally represents one PA program. However, some of the measures data, for Massachussetts and Connecticut in particular, were combined where multiple PAs in those states are offering the same measures. In Appendix B, common measures offered through these "statewide" programs are only documented in one table row (for recording efficiency), and counted once. Thus some of the measures in Table 1 are undercounts to the extent that they do not reflect *all* the unique PAs that offer the measures. A significant amount of the measure information was collected from statewide TRMs and thus reflects the measure descriptions, algorithms, program deliniations, program names, and measure types described in the corresponding TRM. Each measure defined here is listed as a separate entry in the TRM, when TRMs were used.

Lighting is the dominant measure type, followed distantly by refrigerator and freezer replacement and central air conditioning. Nearly every surveyed PA offers an early replacement lighting program. Most of these are commercial and industrial programs. High capital cost measures like central air conditioner replacement, boiler replacement, and air compressor replacement are significantly less common early replacement measures than low cost (per unit) options like lighting and refrigerator replacement. This is despite the fact that early replacement measures seem best suited to encouraging customers to replace capital-intensive equipment early. Further analysis shows that most of the measures listed in the table directly impact peak electric demand, especially the three most common measures.

Table 1: Early Replacement Measure Types

Measure Type	# of Measures (Total)	# of Measures (Forum)	# of Measures (non-Forum)	# of Measures Residential	# of Measures Comm. & Ind.
Lighting	27	25	2	2	25
Refrigerators and Freezers	15	12	3	15	0
Central A/C and Air-Source Heat Pumps	9	3	6	9	0
Custom	8	7	1	1	7
Room/Window A/C Units	7	6	1	5	2
Boilers	7	6	1	6	1
Air Compressors	6	4	2	0	6
Motors and Drives	5	3	2	0	5
Furnaces	5	3	2	4	1
Electrically Commutating Motors (ECMs)	5	5	0	1	4
Clothes Washers	4	4	0	4	0
Dehumidifiers	2	2	0	2	0
Ground-source Heat Pumps	2	0	2	2	0
Chillers	1	1	0	0	1
Dishwashers	1	1	0	1	0
Packaged Terminal Heat Pumps	1	1	0	1	0
Boiler Circulating Pump	1	1	0	1	0

It should be noted that Table 1 and Table 2 only reflect the number of measures offered by the PAs and are not weighted by the number of participants or energy savings achieved. Some of the measures may be not be popular or cost-effective, while others may contribute most of the energy savings and participation for the PA. Based on the available data, lighting measures do have the highest participation and highest energy savings of all of these measures.

Because lighting is the dominant measure type, it was further categorized into sub-types, as shown in Table 2.

Table 2: Early Replacement Lighting Measures

Measure	# of Measures (Total)	# of Measures (Forum)	# of Measures (non-Forum)	# of Measures Residential	# of Measures Comm. & Ind.
General Lighting Replacement	11	9	2	2	9
Fluorescent Fixtures	5	5	0	0	5
LED Fixtures	4	4	0	0	4
Lighting Controls	3	3	0	0	3
CFLs	2	2	0	0	2
HID Lighting	2	2	0	0	2

From Table 2, the general lighting measure is the most common. Many utilities have a standard lighting retrofit program that includes all fixture types to simplify analysis. These programs often use a lighting deemed wattage guide to assign wattages to a variety of potential fixture types. It should be noted that all of the LED measures come from the same two PAs: Liberty Utilities and Unitil. In general, PAs are promoting early replacement of fluorescent fixtures with either LEDs or more efficient fluorescent fixtures more than any other lighting measure after the "catch all" general early replacement lighting measure. It is also evident that there are few residential early replacement lighting programs (only two out of 27 total). CFL direct-install programs were not included in this study, so that likely reduces the numbers of residential lighting programs significantly. Residential lighting early replacement programs may be hindered by the reduced operating hours of residential lighting compared to commercial or industrial.

Based on the results of the interviews, some of the most popular early replacement measures may be in jeopardy of discontinuation and this program breakdown may change significantly. This includes: refrigerator and freezer replacement, T12 fluorescent lighting replacement, CFLs, air compressor replacement, and central air conditioner replacement. These measures are at risk either because the efficiencies of the stock of existing units are increasing relative to the new unit baselines and high-efficiency units or due to federal regulations, as is the case for T12 and CFL lighting measures. This leaves room for some of the under-represented measures like boilers, electrically commutated motors, and packaged terminal heat pumps to emerge and become part of more utility offerings.

Despite the fact that lighting is the dominant measure type and most of the lighting measures are part of commercial and industrial programs, residential early replacement programs are more common, in general. This occurs because nearly all of the non-lighting measures are covered in residential programs only, including: refrigerators and freezers, central air conditioners, boilers, room air conditioners, furnaces, and clothes washers. This, combined with the fact that some of the lighting and window air conditioner programs are residential, leads to residential programs representing the majority of early replacement programs. Furthermore, many of the commercial and industrial early replacement measures are handled under the custom measure category, which reduces the number of distinct measures offered.

Digging deeper, low income and/or multi-family programs make up about 30 percent of the residential programs. Clothes washers, refrigerators, freezers, and window air conditioners dominate the low income and multi-family sectors' early replacement programs. These programs are most commonly administered by a third-party contractor that visits a multi-family building and recommends several energy efficiency upgrades that can be applied to all of the units. One PA even uses different calculations for multi-family projects based on evaluation data that showed multi-family refrigerators are smaller than those in single-family homes.

Based on the interview results, many program administrators are concerned about the long-term viability of some of the top early replacement measures, due to energy code changes and cost-effectiveness issues. Currently, lighting and refrigerator replacements represent just under one half of all early replacement programs, but most of the innovations in program delivery, verification, and analysis are happening in other, more complex programs like central air conditioning and boiler replacement, perhaps due to the long-term viability issues described previously.

3.2 Eligibility Requirements

Early replacement programs offer larger incentives than their normal replacement counterparts, due to their increased cost to the customer and increased energy savings potential. Because these incentives are higher, customers can be motivated to take advantage of the program and apply for early replacement rebates when normal replacement rebates would be more appropriate. To counteract this tendency, some PAs implement eligibility requirements to ensure that the project in question is truly early replacement. These eligibility requirements include limits on the age of the existing equipment, its efficiency and condition, or repair and replacement costs. There can also be requirements on customer type, equipment quantities, and operational characteristics.

In this study, eligibility requirements were tabulated for the sampled PAs and programs. Table 3 shows the frequencies of the different eligibility requirements in the data. Efficiency requirements are limitations on maximum efficiency allowed for the existing equipment. Age requirements are limitations on the existing unit's age at time of replacement. These are sometimes tied to the remaining or original useful life of the equipment and prevent customers from replacing equipment that is too old to be considered for early replacement. Functionality requirements ensure that the existing equipment is operational at the time of replacement. Repair cost requirements set a maximum repair cost to bring the existing equipment up to a higher efficiency level or to make the equipment functional. Verification requirements dictate that the functionality, age, efficiency, or other requirements be verified prior to project completion. Functionality verification is by far the most common.

The other requirements include measure-specific requirements like: minimum refrigerator capacity, restrictions against front-load washing machines, lighting fixture type, fixture count, and hours of operation limits, water heating and clothes drying fuel restrictions, load diversity requirements for variable speed drive projects, and operational requirements for motor and

compressed air projects. One PA has also established incentive amount review thresholds, and projects that are expected to receive incentives greater than the threshold amount are required to get project pre-approvals prior to installation. The measure-specific requirements are justified because the cost-effectiveness of these measures depends on certain characteristics being present in the existing equipment. For example, refrigerators or freezers that are too small will not produce enough energy savings when replaced with an efficient model. Variable speed drives will not save much energy at all when applied to motors, fans, and pumps that do not have much load diversity (constant loading). These requirements have little to do with the early replacement eligibility of the measure, but were still considered in this study since they are requirements associated with early replacement programs.

Table 3: Early Replacement Eligibility Requirements Frequency

Eligibility Requirement	Number of Measures	%
Efficiency Requirement		
Yes	15	14%
No	91	86%
Age Requirement		
Yes	14	13%
No	92	87%
Functionality Requirement		
Yes	77	73%
No	29	27%
Repair Cost Requirement		
Yes	8	8%
No	98	92%
Verification Requirement		
Yes	43	41%
No	63	59%
Other Requirement		
Yes	22	21%
No	84	79%

Table 3 shows that a distinct minority of programs has prescribed efficiency, age, or repair cost requirements. Verification requirements (pre- and/or post-install inspections) are significantly more common, but not as common as functionality requirements, which are the only eligibility requirements involved in a majority of the programs. We note that 27 percent of programs do not explicitly require that the existing equipment be functional to qualify and 59 percent of programs do not appear to perform verification.

Case Study:
Tucson Electric Power's (TEP) Residential Central Air Conditioner or Heat Pump Early Retirement with Quality Installation Program

This program stood out during this study for many reasons, but its most unique aspect is verification. It has an efficiency requirement of 8.5 EER for the existing unit (the unit must be less than or equal to this efficiency). To verify this requirement, contractors test each existing air conditioner and the diagnostic efficiency test data is uploaded in real time during the test to TEP to verify that the operational efficiency meets the requirements. This prevents contractors from providing false efficiency values to the utility and provides instant access to the efficiency, age, and size of the existing unit, as the contractors upload those values while on-site. Program requirements are examined annually to determine if changes are needed to improve cost-effectiveness.

TEP implemented (and subsequently, increased) on-site verification even though it resulted in a 90 percent drop in participation in the contractor-driven program. The program is now being directly marketed to consumers and the consumers will receive certificates demonstrating the performance and proper installation of their new unit compared to their existing unit. TEP also conducts random pre- and post-project inspections for further verification. This program also uses other early replacement analysis methods described throughout this report: discounted cost analysis, dual baselines, and remaining useful life. Cost information is collected to refine their cost analysis. Overall, this program showcases the most comprehensive verification and data collection process in the study and TEP is able to carefully monitor program performance and improve cost-effectiveness.

The data shows that, overall, the programs that do not have eligibility requirements beyond the basic functionality requirement outnumber those that do have more strenuous requirements. This presents an opportunity for many programs to change their eligibility requirements to reduce the potential risk of free-ridership, although these additional requirements have costs associated with them that must also be considered when weighing these changes. Furthermore, there are many opportunities for increased verification, which provides feedback to the PA to potentially improve the program's cost-effectiveness, participation, and delivery. Several PAs that have no eligibility requirements and no verification mentioned during interviews that they were considering adding some new requirements because they were aware that the program was encouraging free ridership and abuse of the higher incentives. This shows that more PAs are beginning to adopt eligibility guidelines and verification.

Several PAs also expressed interest in adding specific age and efficiency requirements due to feedback from evaluations. The data suggests that most PAs have room to add these limits, since only 14 percent of programs in this study have them. It is interesting to note that the number of programs with at least functionality requirements, if not age and efficiency requirements, is greater than the number of programs with verification. This indicates that some programs

have requirements but do not verify that the customer has met those requirements. The sidebar text box details one program that stood out among the programs in this study for its detailed and innovative verification process, cost-effectiveness testing, feedback, data collection, remaining useful life use, cost analysis, and overall program delivery.

Overall, more than two thirds of programs at least require that the existing equipment is functional, but fewer than 30 percent have further age or efficiency requirements. Verification that the existing equipment does meet the eligibility requirements is only present in 41 percent of programs.

Example Question Battery to Confirm Early Replacement Projects

Evaluators of EmPOWER MARYLAND programs reported that they use the following question battery to confirm that non-lighting retrofit projects are in fact early replacements:

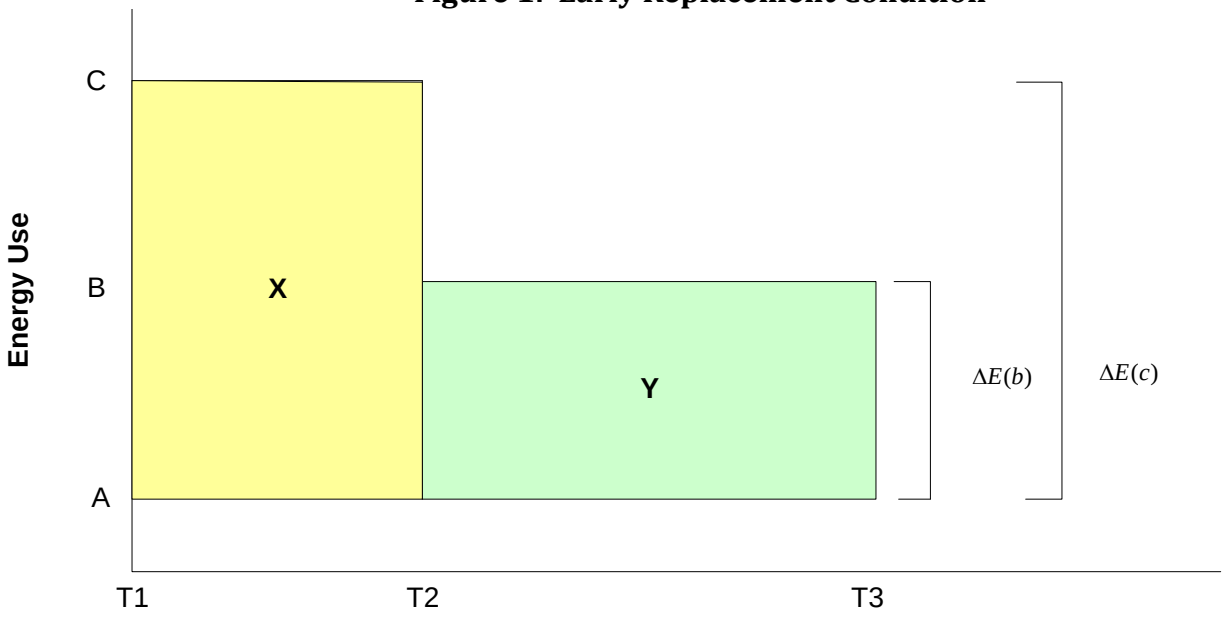
1) Was the equipment that was replaced through this project still functioning?
2) Was the replaced equipment at or near the end of its useful life?
3) Do you know the approximate age of the equipment that was replaced?
4) How much longer do you think that equipment would have operated if it hadn't been replaced by the project?
5) Do you think your [company/agency/organization] would have replaced this equipment if the utility program hadn't been available?
    a) If so, do you know what equipment would have been installed without the utility incentive?
6) (If company would have replaced the equipment without the program) Would the equipment have remained in place until it became inoperable?
7) (If equipment would have been replaced before it became inoperable) How many years from now would that likely have been?
8) Does your company/agency/organization typically replace this equipment on a regular basis or just when it fails?
    a) (If replaced on a regular basis) About how frequently?
9) How many years is the new equipment expected to last?

3.3 Remaining Useful Life (RUL)

In the standard dual baseline model for early replacement savings analysis, two separate equipment lifetime values are used. These are designated as effective useful life (EUL) and remaining useful life (RUL). Effective useful life is the assumed useful life, in years, of a piece of equipment before the majority of units have failed and need to be replaced, often based on laboratory testing. For boilers, as an example, this value is usually set to equal 20 years. Remaining useful life is commonly defined as the difference between the age of a piece of equipment and its EUL. In other words, it is a measure of how many years of useful life that equipment has left before it reaches the median age of failure. According to this definition, the RUL is set equal to zero if the equipment age is greater than or equal to the EUL. Boilers in one surveyed program are assumed to have 10 years of RUL.

EUL is used for new construction and normal replacement measures, while RUL is used for existing equipment and early replacement measures. Remaining useful life is used in early replacement programs because it accounts for the baseline assumption that the equipment being replaced would have been replaced at some future time, independent of the program. Thus, the program does not typically receive credit for energy savings (compared to the existing equipment efficiency) occurring over the entire EUL of the new equipment, but only for the period of time the existing equipment would have continued operating, that is, the RUL. After the RUL, the project is treated as a normal replacement project and all energy savings calculations assume a new construction, code-compliant baseline instead of the existing equipment's efficiency. Remaining useful life prevents over-estimating the energy savings associated with early replacement projects by incorporating a realistic limit on the life of the existing equipment. The following figure illustrates the concept of RUL and also the dual baseline method of calculating savings for early replacement measures (discussed more subsequently).

Figure 1: Early Replacement Condition



C = Energy use of pre-existing measure
B = Energy use of code/standard measure
A = Energy use of the new efficient measure
T1 = Date on which new efficient measure is installed
T2 = Date on which existing measure was expected to have failed
T3 = Date on which the new efficient measure is expected to fail
T3 – T1 = Expected effective useful life (EUL) of the new efficient measure
T2 – T1 = Expected remaining useful life (RUL) of the pre-existing measure
T3 – T2 = Expected remaining EUL of the new efficient measure
$\Delta E(c)$ =The full savings defined as C - A
$\Delta E(b)$ = The incremental savings defined as B - A

Source: New York TRM, Appendix M.

Table 4 shows the number of programs in this study that used a separate remaining useful life value in their calculations. This table also includes a breakdown of the number of measures using RUL in PAs that are members of NEEP and those who are not a part of NEEP, along with the numbers of measures in the study that used both RUL and the dual baseline method. Note that programs with no data about their analysis methods or whether they used RUL were assumed to not use RUL. The table shows that just under two thirds of the programs use some RUL value. PAs that do not use RUL instead simply apply all energy savings over the existing equipment for the full EUL of the new equipment.

Table 4: Remaining Useful Life Practices

Is RUL used?	# of Measures (Total)	# of Measures (Forum)	# of Measures (non-Forum)	Uses Dual Baseline	Does Not Use Dual Baseline
Yes	62	50	12	40	22
No/Unknown[5]	44	34	10	0	44

Not all of these programs use the dual baseline analysis method, however, as some simply use the RUL value with no EUL after the RUL has passed. In fact, 22 of the 62 measures using RUL do not use dual baselines, and none of the lighting measures use dual baselines. Also, for unknown reasons, five measures used RUL values higher than the normal replacement EUL values, and these measures also did not use dual baselines. Taking all of this into account, only 40 out of the 106 measures, or 38 percent, used remaining useful life and the dual baseline method.

The use of RUL appears to be roughly equally common among Forum and non-Forum PAs (60 percent of measures within Forum PAs use RUL, 55 percentnon-Forum). As RUL and dual baseline go hand-in-hand, none of the measures that do not use RUL use the dual baseline method. Well over half (65 percent) of the measures that do use RUL also use the dual baseline method.

Table 5 shows the types of measures that use RUL (with or without dual baselines). This list is very similar to the measure type breakdown in the Measure Type section above (also reproduced in Table 5 for comparison). The same measures are near the top of the list. The biggest change is that lighting moves from a clear leader with 27 programs, to a narrow leader with 14 RUL programs. The lighting measures were the least likely to involve the use of dual baselines and cost discounting analysis methods. The typical lighting early replacement measure consists of comparing the existing lighting to the new installed lighting power consumption, using the full lifetime of the new fixtures, and using the full cost of the new fixtures in the analysis. Many lighting early replacement measures do not use RUL. A high percentage of the non-lighting early replacement measures use RUL.

[5] With a few exceptions, such as the Liberty boiler program, we could not find any information about RUL from the New Hampshire PAs (Liberty Utilities, Unitil, PSNH), but we included them in the "No" category.

Table 5: Early Replacement Measure Types and Remaining Useful Life

Measure	Number of Measures Total	Number of Measures With RUL	% of Measures With RUL
Lighting	27	14	52%
Refrigerators and Freezers	15	12	80%
Central A/C and Heat Pumps	9	8	89%
Custom	8	4	50%
Room/Window A/C Units	7	3	43%
Boilers	7	6	86%
Air Compressors	6	1	17%
Motors and Drives	5	0	0%
Furnaces	5	4	80%
Electrically Commutating Motors	5	0	0%
Clothes Washers	4	4	100%
Dehumidifiers	2	2	100%
Ground-source Heat Pumps	2	2	100%
Chillers	1	1	100%
Dishwashers	1	1	100%
Boiler Circulating Pump	1	0	0%
Packaged Terminal Heat Pumps	1	1	100%

Overall, only three early replacement measure types are not using RUL: motors and drives, electrically commutated motors, and boiler circulating pumps. In addition, only 52 percent of lighting programs use RUL, although there is an abundance of information about lighting lifetimes from numerous studies. It is possible that determining the age of the existing lighting is the primary challenge in using RUL for lighting, if PAs do not want to use published values.[6] One interviewed PA staff explicitly noted that determining lighting age is difficult generally, and added that it is often not cost-effective for programs to conduct commercial building vintage assessments, since different tenants occupy individual floors and have different servicing contracts. Small business owners in particular are focused on "keeping the lights on" and often do not maintain records on lighting installations. In contrast, a 30-floor building maintained by one company is much easier to consider for lighting retrofits. An implementation contractor for a different PA stated that customers are often purchasing lighting for their facilities *in anticipation* that replacements are needed. Thus, "because the installed lighting is so close to failure, the project is assumed to be a replace-on-failure" and the full EUL of new lighting is used in the savings calculations.

This leads to a discussion on how the RUL values that these programs are using were developed. Table 6 shows the frequency of several different means of establishing RUL values for a measure. For 81 percent of the measures using RUL, the PAs either did not provide a

[6] Conversely, air conditioners, boilers, and refrigerators, for example, have nameplates and serial numbers that can be easily traced to their age.

source for their value or used an assumed value. In some cases, the assumed value was tied to a set fraction of the EUL for normal replacement. One half and one third of EUL were the most common, with two measures using one half of the EUL and five measures using one third. Despite the existence of publicly available equipment age and lifetime studies, only 19 percent of measures use a study or field data (collected from customers directly or from the PA's own studies of their customers) to establish RUL values. For example, the Cape Light Compact low-income dehumidifier early replacement measure's RUL is based, in part, on the average age of the old units turned in during a PA-sponsored turn-in event. New York National Grid's early replacement programs also use customer-supplied data to determine the RUL of the existing equipment and the existing equipment age is verified by a National Grid representative. It is unclear if the lack of use of studies or field data stems from concerns about the applicability of RUL values from other states' studies to their own state, variations in program design that make comparisons impossible, or some other cause.

Table 6: Information Sources for Measures Using RUL

Source	Number of Measures	% of Measures
Assumptions/No Source	50	81%
Field Data	8	13%
Studies	4	6%

Notably, the state of California uses a one-third of EUL approach for all of their early replacement programs and they are frequently and extensively evaluated.[7] While such stipulated RUL assumptions may appear reasonable, field data offers the most relevant and accurate measure of RUL for an individual measure. Programs that collect the age of the unit being replaced are able to refine their RUL estimates annually to reflect the age of existing units in their territory. The two PAs mentioned above (New York NGRID and Cape Light Compact) along with Xcel Energy in Colorado, ConEd in New York, Baltimore Gas and Electric, and Tucson Electric Power were the only PAs that explicitly take the observed age of the existing equipment into account when calculating RUL values (some for only one of their programs, however). One PA (Connecticut Energy Efficiency Fund) collects age data for two different measures, but does not appear to utilize this data in their RUL estimates. Equipment age, according to the interviews and program data, is most often verified by using the serial number, manufacturer, and model number to determine a year of manufacture. In New York NGRID's early replacement programs, the customer must supply the equipment age and an NGRID representative later confirms this value. The same is true for New York ConEd.

[7] See: Summary of EUL-RUL Analysis for the April 2008 Update to DEER. Prepared by KEMA, Inc. Moreover, the 2013-2014 (California) Statewide Customized Retrofit Offering requires early replacement measures to use the dual-baseline approach to savings calculations. The Evergreen team attempted to recruit a California PA into the study to obtain feedback regarding their specific early replacement programs and how the California RUL assumptions have helped or hindered their programs, however we could not maintain the PA's engagement throughout the study.

In total, ten measures collect age information: one central air conditioner measure, one custom measure, one compressed air measure, one lighting measure, and three refrigerator and freezer measures. These ten are offered by the six of the seven PAs described in the previous paragraph (Baltimore Gas & Electric uses customer-supplied ages verified against their own field research to determine age)

It is important to note that some of the "no RUL source" programs may, in fact, use studies or field data to determine their RUL values, but did not document this in their technical reference manuals or other program documentation. Regardless, a majority of programs rely on assumptions to determine RUL values. A commonly cited source for lifetime information is a report by GDS Associates in 2007 titled, "Measure Life Report, Residential and Commercial/Industrial Lighting and HVAC Measures."[8] It appears that despite the existing studies on measure life (from the U.S. Department of Energy, Utility Impact Evaluations, and third-party research like GDS), there is a need for more RUL studies in general to give utilities more options for sources to cite when establishing RUL values.

[8] The RULs developed in the GDS study are either full EULs or estimates of reduced EULs, versus "true" RULs. True RUL means the actual, calculated difference between the EUL and the estimated, measured, or assumed age of the existing equipment.

Regional Technical Forum Guidance on Remaining Useful Life (RUL)

The Regional Technical Forum (RTF) is an advisory committee established in 1999 to develop standards to verify and evaluate conservation savings for utilities in the Pacific Northwest. In particular, the RTF helps to develop and maintain a readily accessible list of eligible conservation resources (e.g., approved prototype measures), the estimated lifetime costs and savings associated with those resources, and the estimated regional power system value associated with those savings. Importantly, the Northwest Power and Conservation Council uses these savings to develop long-term demand forecasts and generation plans.

Starting in December 2013 the RTF dedicated a portion of three consecutive monthly meetings to discuss the potential for claiming larger savings from early replacements and different ways to consider RUL (the discussions did not address cost calculation methods). Historically, RTF work has primarily focused on informing *long-term* resource planning, while regional PAs also have high interest in short-term energy savings. Some of the RUL options initially considered were:

1) Set RUL = EUL
2) Generally assume RUL = EUL, but allow for exceptions
3) Apply a simple rule (e.g., RUL = 1/3 x EUL)
4) Apply a simple rule with exceptions
5) Calculate or forecast the average equipment RUL, periodically
6) Do not use RUL at all

Formal language is still being developed for the next update to the RTF's Roadmap and Guidelines documents (expected in mid-2014), but the main points of the current RTF current, adopted in February 2014, are:

"For all pre-conditions measures, the RTF estimates RUL based on best available information. If the RUL is likely to be longer than 10 years, then we set RUL equal to the measure lifetime.

When the RUL is expected to be 10 years or less, cost and savings should be estimated separately for the periods before and after expiration of the RUL over the entire EUL. Estimates should be based on the pre-conditions baseline for the period between implementation and the end of the RUL, and they should be based on the current-practice baseline for the period between the RUL and the remainder of the EUL. (Here, "current-practice" refers to practices anticipated at the end of the RUL period, based on likely changes to codes and standards.)"

3.4 Prevalence of Dual Baselines and Other Savings Approaches

The standard dual baseline approach to analyzing early replacement programs and measures was described briefly in the preceding section. In short, the efficiency and energy consumption of a new, high-efficiency piece of equipment is compared to the consumption of existing equipment for the remaining life of the old equipment and then compared to an established baseline efficiency for a new unit for the rest of the useful life of the high-efficiency equipment (see Figure 1). Thus, there are two "baselines" that the high-efficiency unit is compared against: one for the RUL of the existing unit and the other for the EUL of the new unit minus the RUL. This method accounts for the fact that the existing unit would have continued operating, had it not been replaced, for a certain period of time, without over-estimating the energy savings by comparing the new unit to the existing unit for the entire EUL of the new unit.

In this study, one program administrator was found to use a non-standard dual baseline approach: Connecticut Energy Efficiency Fund. They use the full EUL of the new equipment after the RUL of the existing equipment has passed. In other words, they do not subtract the RUL from the EUL for the baseline efficiency portion of the savings analysis. This means that they are creating a situation where the total life of the early replacement measure (EUL + RUL) is greater than the EUL of the new equipment being installed. This appears to occur in Connecticut's residential dishwasher, dehumidifier, refrigerator, and freezer measures, but could not be confirmed by Connecticut staff.

Ten of the 17 program administrators that provided information for this study use dual baselines in at least one of their programs. Five of those ten use dual baselines in all or almost all of their early replacement programs. Table 7 lists the program administrators that utilize the dual baseline method, along with the proportion of their programs that use it. This shows that some program administrators clearly favor this approach and use it whenever possible. Vermont, Connecticut, Dayton Power & Light (OH), Ameren (IL), and Tucson Electric Power (TEP) are the five that favor this approach. DC SEU (Washington, D.C.) had two dual baseline programs, but they have since been removed for budgetary reasons. Liberty (NH) has nine early replacement programs, but only uses dual baselines on one (residential boiler) and Massachusetts uses dual baselines for five programs out of their total of 13, which still indicates that they value this approach. Liberty is the exception in this study in that they only use dual baselines on one of their early replacement programs.

It seems that once a program administrator starts to use dual baselines, they apply it to all or most of their early replacement programs. Program administrators appear to take an all-or-nothing approach with applying dual baselines: either they use it extensively, or not at all. It is unclear why some program administrators implement dual baselines and others implement a single baseline approach.

Table 7: Dual Baseline Use By Program Administrator

Program Administrator	Dual Baseline Measures	Total PA Early Replacement Measures	% of PA Measures Using Dual Baselines
Tucson Electric Power	1	1	100%
Massachusetts	5	13	38%
DC SEU	2	3	67%
Connecticut	11	12	92%
Vermont	8	10	80%
Dayton Power and Light	3	3	100%
Ameren	5	5	100%
Liberty	1	9	11%
Baltimore Gas & Electric	1	2	50%
Con Edison	3	6	50%

Looking at the relationship between measure types and the prevalence of the dual baseline method in Table 8, several noteworthy trends are apparent. The two most common early replacement measures (refrigerators and freezers, and central air conditioners) are well represented, with the two highest numbers of dual baseline programs. Boiler, central air, and clothes washer measures stand out for their high percentage of dual baseline usage coupled with their higher number of total measures. Several of the most popular measures have a very low proportion of dual baseline measures compared to the total number of measures using RUL, including zero percent for lighting, 50 percent for custom measures, zero percent for air compressors, and zero percent for motors and drives. About 59 percent of the programs using RUL use dual baselines. This is apparent by looking at the differences in the numbers of measures in the first two columns of Table 8. Various factors may account for the higher prevalence of dual baseline use for refrigerators and freezers, central air conditioners, boilers, and clothes washers.These include more clearly defined baselines and existing efficiencies for these measures, more available data, or clearer incremental efficiency improvements over time.

Table 8 also includes the number of unique program administrators (with Massachusetts and Connecticut PAs each counted only as one for each state) using dual baselines for each measure type. In most cases, the number of PAs is equal to the number of measures, implying that each PA only offers one measure in that type. The largest deviation from this trend occurs in the refrigerator and freezer measures, where only four PAs offer nine different measures using dual baselines. Massachusetts and Connecticut PAs each offer a freezer measure and a separate refrigerator measure, while Vermont offers four different refrigerator and freezer measures (based on income, multi-family versus single family, etc.).

Table 8: Early Replacement Measure Types and Dual Baselines

Measure	Number of Measures with RUL	Number of Measures with Dual Baselines	Number of Unique PAs Using Dual Baselines	% of Measures with RUL with Dual Baselines
Lighting	14	0	0	0%
Refrigerators and Freezers	12	9	4	75%
Central A/C and Heat Pumps	8	7	5	88%
Custom	4	2	2	50%
Room/Window A/C Units	3	3	3	100%
Boilers	6	6	5	100%
Air Compressors	1	0	0	0%
Motors and Drives	0	0	0	0%
Furnaces	4	3	3	75%
Clothes Washers	4	4	2	100%
Electrically Commutating Motors	0	0	0	0%
Dehumidifiers	2	1	1	50%
Ground-source Heat Pumps	2	2	2	100%
Chillers	1	1	1	100%
Dishwashers	1	1	1	100%
Boiler Circulating Pump	0	0	0	0%
Packaged Terminal Heat Pumps	1	1	1	100%

Program administrators that do not use dual baselines use one of three other approaches to handling early replacement energy savings analysis. The first is to simply compare the new unit efficiency to the existing unit efficiency for the entire effective useful life of the new equipment. The second uses the remaining useful life in place of the effective useful life, but the energy use is still only compared to one baseline: the existing equipment. The third uses a blended value of the true remaining useful life[9] and effective useful life in place of the effective useful life.

From the results of this study, nearly half of the program administrators use one of these alternate methods exclusively. The first method is overly aggressive and in effect, assumes that the existing equipment would continue operating until the new equipment reaches the

[9] True remaining useful life here means the actual, calculated difference between the EUL and the estimated, measured, or assumed age of the existing equipment.

end of its life, which is generally not true. The third method is more conservative, but still likely too aggressive, because a blended value still counts energy savings against the existing equipment for a larger number of years than that equipment would have been operating. All of the lighting programs in this study use one of these two methods. Conversely, the single baseline approach that employs an unbiased estimate of the RUL (the second method) is more conservative than the other single baseline and dual baseline methods.

Table 9: RULs Used with Single Baselines

Analysis Method	# of Measures	%
Full EUL	27	41%
RUL	10	15%
Blended EUL/RUL Value	12	18%
No Information Provided	17	26%

Table 9 displays data about the frequency of use of these three alternate analysis methods. Method 1 is definitively used the most often of the three methods, with other two used about equally. Programs that listed an RUL value that was larger than the EUL value were placed into the Method 1 category. This could occur for measures that are assumed to have had repairs (or motor rewinds) that extend the life of the existing equipment. These data show that all three methods are common and are each used less often than the dual baseline method (41 measures). Method 1 is certainly the simplest, as only one EUL value is needed for both the normal replacement and early replacement programs. This may explain the significantly higher use of Method 1 compared to the other two.

Method 3, the "blended" approach, is explicitly used by the Massachussetts and Connecticut PAs and others may be using it, but provided no confirmation or details to verify. These Forum PAs use the blended approach for commercial and industrial early replacement programs, but not for residential. The CL&P and UI Connecticut Program Savings Documentation lays out the blended approach they use: "For retrofit/early retirement programs, the measure life will take into account both the expected remaining life of the measure being replaced and the expected changes in baselines over time." Specifics about how this is accomplished were not provided.

Table 10 identifies some of the pros and cons of the four analysis methods described in this section.

Table 10: Pros and Cons of Analysis Methods

Method	Pros	Cons
Dual Baseline	Can estimate accurate energy savings when future baselines are not expected to change, closely mimics customer decisions, recommended by several state governments	Future baseline efficiencies are unknown and can be hard to predict, data collection costs are higher, existing equipment age often unknown or hard to collect, different from normal replacement so no algorithm-sharing
EUL only	Simple, easy to use and apply, works well with existing normal replacement programs and algorithms, does not require equipment age information or RUL values	Potentially less accurate energy savings, does not mimic customer behavior, assumes existing equipment will last as long as new equipment
RUL only	Simple, accounts for limited life of existing equipment, more accurate energy savings estimate than EUL only, can yield more convervative and accurate savings than dual baseline if uncertain about future baselines, only small changes to normal replacement algorithms needed	May underestimate energy savings particularly for short RULs, age and/or RUL values often required
Blended EUL/RUL Value	Can be a "compromise" solution to increase savings savings from short-RUL measures without making explicit assumptions about future baselines	Does not mimic customer behavior, actual blending calculations may not be transparent, age and/or RUL values often required

In general, the dual baseline approach is used in over one third of early replacement programs. The number of single-baseline measures is divided roughly equally between those using the full EUL of the new measure and something less than EUL (RUL, or RUL/EUL blend) as shown in Table 9).

Those using single baselines are roughly indifferent between using the full EUL of the new measure and something less than EUL (RUL, or RUL/EUL blend) as shown in Table 9). Further research is needed to identify the reasons for the adoption of a particular method.

New York State Appendix M: Guidelines for Early Replacement Conditions

In 2010, the New York Energy Efficiency Portfolio Standard (EEPS), established by the New York Public Service Commission, requested an update to the New York TRM that included a consistent approach to analyzing "early replacements in individual projects." Additionally, the updated approach was to be based on dual baseline research, including a compilation of "lookup tables, which provide early replacement method energy savings consistent with the dual baseline concept" along with a cost method that "reflects the concept that the cost of making high efficiency early replacement will avoid an end-of-useful-life replacement with minimally code complaint equipment." As a solution, Appendix M was added to the New York TRM in an effort to clearly outline the process for PAs to manage early replacement measures in regards to both savings and costs.

In addition to providing the necessary lookup tables, Appendix M also outlines a nine-step process to calculate savings and costs using the provided tables. Among these tables is Table M-1, which outlines the EUL and normal replacement baseline for a set of early replacement measures (e.g., room air conditioner, refrigerators, heat pump water heaters – Appendix M does not apply to commercial lighting projects). Once the correct EUL is obtained, PAs can use the other tables to account for "Inflated Lifecycle Benefit Adjustment Factors", "Full-Cost Adjustment Factors", "Adjusted EULs", and "Inflated Lifecycle Benefit Adjustment Factors for PA-Supplied Ratios of Incremental Savings to Full Savings". Using the appropriate tables in combination with the outlined nine-step process allows PAs to estimate savings for their early replacement measures in a simplified and consistent manner across measures. The full document is available at:

http://www3.dps.ny.gov/W/PSCWeb.nsf/96f0fec0b45a3c6485257688006a701a/06f2fee55575bd8a852576e4006f9af7/$FILE/Appendix%20M%20final%205-05-2011.pdf

According to one surveyed PA, Appendix M was not available in final form (to correct initial algorithm errors and missing measures) until many New York PAs had already developed their current cycle programs. Moreover, while the guidance does help PAs to potentially capture larger savings for early replacement projects, requiring usage of full equipment costs often offsets these savings. Because the lookup tables can be "cumbersome" to use, few New York PAs are reportedly using Appendix M.

3.5 Cost Calculation Methods

For normal replacement projects, incremental costs are used to evaluate projects and set rebate levels, where costs are calculated as the cost of the new efficient equipment minus the cost of the current code/standard equipment.

For early replacement projects using an RUL to calculate savings, costs may be calculated differently to reflect the assumption that the existing equipment would have been replaced in the future (i.e., at the end of the RUL) had the program not existed. First, one has to use the full cost of the new efficient equipment (including installation labor) and the full cost of the future code/standard equipment. Early replacement costs are then calculated as the cost of the new efficient equipment minus the present value (PV) of the cost that is avoided in the future for the code/standard equipment.

As a simplified example, consider a homeowner that is replacing an 11-year old heat pump with an assumed EUL of 18 years (i.e., RUL equals seven years). Also assume that the homeowner would purchase a standard/code unit for $5,000 when the existing unit burns out. If replacement occurs in seven years, the cost's present value (at 5 percent interest) would be:

$$\textit{PV of Future Equipment Cost} = \$5{,}000/1.05^{7} = \$3{,}553$$

If the full cost of the new energy efficient equipment were $5,500, one-time early replacement project costs would be calculated as:

$$\textit{Project Cost} = \$5{,}500 - \$3{,}553 = \$1{,}947$$

More detailed permutations of this basic "RUL Discounted" method exist, and the following text box illustrates how deferred replacement costs can be calculated as the difference between two perpetuities, where one reflects an infinite series of normal replacements that would follow a retrofit, and the second one (subtracted from the first) is the infinite series of natural replacements that would happen if there was no retrofit.[10]

Table 11 displays the cost calculation methods that the PAs use for early replacement measure screening and rebates (cost methods were not obtained for all study measures).

[10] The difference in pertpetuities equals the present value of the levelized cost of the baseline equipment for the period beginning when the existing equipment would have been replaced (at the end of the RUL) until the end of the new equipment's EUL.

Table 11: Cost Calculation Methods, Early Replacement Measures

Calculation Method (Forum PAs)	# of Measures
RUL Discounted	16
Full Cost	31
Incremental Cost	2
Unknown	6
Calculation Method (Non-Forum PAs)	**# of Measures**
RUL Discounted	11
Full Cost	7
Incremental Cost	4
Unknown	0

As shown, costs for early replacement measures are most commonly based on the full (unadjusted) installed costs of the new efficient measure, followed closely by the discounting method that also considers foregone future costs. Currently, the PAs that discount future equipment purchases are using consumer-based discount rates of between 3.2 and 5 percent.

As an interesting example of an RUL/discounting approach, Xcel Energy in Colorado calculates costs for residential HVAC equipment by combining several values – the present value of a new 13 SEER A/C unit in 7 years ($3,199), the estimated repair cost of the existing unit ($750), the estimated cost of performing a quality installation ($200), and the cost of installing a standard new 14 SEER unit ($4,748) – arriving at a final cost of: $4,748 - ($3,199 + $750) + ($200) = $999. All of the values are constant except for the $4,748 value, which increases as the new unit efficiency varies up to 16 SEER. Interestingly, Xcel Energy in Minnesota calculates its early replacement costs for VFDs on air compressors using incremental costs - averaging the current equipment costs from three manufacturers and adding $1,500 installation cost, and then subtracts the baseline costs, all based on motor size. Among NEEP's PAs, DC SEU uses incremental costs for early replacement T12 lighting.

Typically, rebate levels for early replacement measures are set to cover a rough percentage of total costs of new measures, including installation labor, while normal replacement incentives are intended to cover a percentage of incremental costs – usually to obtain equipment rated above minimum federal standards. During the phone interviews, several PAs stated that rebates for early replacement measures tend to be between 35 and 50 percent of total measure screening costs, both equipment and labor included, compared to 75 percent of incremental costs for normal replacements.

A DC SEU representative stated that their rebates are roughly 70 percent of the total installed project cost for early replacement measures. This number was established based on customer and contractor feedback to drive participation – a 1.2 to 1.9 year payback for the customer was calculated to be the "sweet spot" to obtain a 60 to 65 percent market acceptance rate. Other PAs (e.g., Efficiency Vermont, Xcel Energy) try to estimate the percentage of total installed cost that must be rebated "to get the market to act" and replace old equipment.

Case Study:
Massachusetts National Grid Residential Early Replacement Boiler Program

This program stood out during this study for its innovative and well designed cost analysis. It involves replacing boilers over 30 years in age with new high-efficiency units. The early replacement cost is determined using an algorithm that uses the following inputs: discount rate, existing boiler age, new boiler lifetime, new boiler installation and material cost, baseline boiler installation and material cost, and remaining useful life of the existing boiler. The number of inputs and complexity of the algorithm are unique to this program.

The general form of this algorithm is shown below:

This calculation is performed by the following equation:

$$DRC = \frac{BIC \times (1+RDR)^{BML}}{((1+RDR)^{BML}-1) \times ((1+RDR)^{EML}) - (1+RDR)^{BML-BA}))}$$

where: DRC = deferred replacement credit,
BIC = baseline measure installation cost,
RDR = real discount rate,
BML = baseline measure life,
EML = efficient measure life,
BA = baseline (existing) measure age at time of retrofit.

In this paper, BML - BA is equivalent to RUL, EML is equivalent to EUL, and measure is equivalent to "equipment."

The methodology for this analysis was taken from "Retrofit Economics 201: Correcting Common Errors in Demand-Side Management Cost-Benefit Analysis," a paper by Brailove, Plunkett, and Wallach at Resource Insight, Inc. This paper outlines a clear process and impetus for performing a detailed early replacement cost analysis. It demonstrates the importance of including the time value of money, deferred replacement cost, and equipment age. Most programs simply use the total installed cost of the efficient equipment, but this artificially increases the total cost of the measure, hurting cost-effectiveness.

This program demonstrates an organized and efficient method for handling early replacement costs and this same system can be easily applied to other measures and programs.

3.6 Custom Projects

In custom projects in early replacement programs, most PAs do not consider measures as part of a bundle when determining cost effectiveness; instead, each measure is screened individually. For all PAs, the old equipment that is being replaced must still be functioning – either verified by an auditor or documented by the owner. Savings tend to be calculated based on the energy consumption of the existing equipment compared to the calculated usage of the new, more efficient equipment. Only one PA that offers custom early replacements uses a dual baseline savings calculation, if applicable, while the rest use the full effective useful life (EUL) of the new measure. A few PAs reduce the EUL by a small amount to account for the reduced lifetime of the existing equipment (e.g., 15 years for new construction lighting as opposed to 13 years for retrofit/early replacement, lighting).

For normal replacements in custom projects, rebates tend to be roughly 75 percent of the incremental cost of the new equipment (labor not included) – one PA aims for a one-year payback. This is interesting, as in the Evergreen team's experience, custom rebates are usually a fixed amount per kWh or kW saved. For early replacement custom projects, one PA offers rebates based on differences between equipment life – user supplied, but verified by a PA representative – and the rated measure life from a technical manual, while others calculate rebates based on estimated total costs, including labor. Similar to non-custom projects, these percentages range from 35 to 50 percent of the total estimated cost.

National Grid New York (like most PAs) is not allowed to rebate a custom measure if the benefit-cost ratio does not exceed 1.0. Benefits are computed from savings, converted to dollars using avoided costs. Costs are the costs of the measure or project with other things added in, such as administration costs and adjustment factors.

3.7 Early Replacement Measures Tracking by PAs

For the most part, the surveyed PAs record early replacement projects slightly differently than normal replacement projects. Additional information – such as the age (where available and used for RUL), efficiency, and model number – of existing equipment is typically stored in their information databases for early replacement projects. A common database is often used for both types of programs with an indicator for project type – early replacement as opposed to new equipment.

Among the two PAs that do not record anything different – aside from an indicator for new equipment or early replacement – one stated that they already include as much information as possible regardless of replacement type, while the other just started rebating and calculating savings differently for early replacements and currently has higher administrative priorities than making database changes.

None of the PAs use the same tool to track participation and/or savings values for early replacement programs. About half stated that they use some kind of proprietary or custom-

built database, while others use a semi-customized off-the-shelf product, including: eTrack, FoxPro, Microsoft Access, Nexant TrakSmart, and energyOrbit.

Most of these databases are updated every time a new project is started or rebate offer is made. Still, some only make updates once a month or even once a year when their filings are submitted.

3.8 Challenges Reported by PAs

As with most energy efficiency programs, the biggest challenge for administrators of ER programs is having sufficient resources to deliver cost-effective savings. Complicating this issue for ER programs is that while these measures can potentially deliver greater savings because of the larger incremental efficiency gains, determining cost-effectiveness – whether for prescriptive measures or for individual projects – is seen as a major challenge by PAs. Many of the key inputs to calculating cost-effectiveness are difficult to capture, including the age, efficiency and condition of the existing equipment, the cost of new equipment, and the specific criteria that drive customer replacement decisions. Among the comments offered by program managers regarding this challenge are the following:

- "It's hard to get the data you need to determine ER versus NR, including old equipment age and efficiency and RUL."
- "Early retirement measures can be elusive if you don't have a better system than a piece of paper to document that an existing system was really replaced…. Early retirement is more cost-effective than normal replacement due to lower efficiency baselines, but you need to know what you are really incenting."
- "In most states, if you have equipment and it's running, you don't have to capture the age of equipment for anything, but in New York that's a condition of whether it goes early or normal."
- "The hardest thing is getting costs for new measures…. It would seem that in the given state, there should be a database of savings and costs, every state should do things more collaboratively on things like costs for measures. It's really important to have a TRM (technical reference manual) that all of the participants in a state use in common, so that you don't have multiple utilities in the same state each using their own methodology."

Good data on equipment costs are essential to support design of ER programs. One respondent said that they need such information because "we have to keep incentives at a level that can accommodate a level of participation that they [program managers] think they can achieve. If budgets were unlimited, incentives could be set at 60-70 percent of cost and therein drive much greater volume and participation with trade allies. Additionally, relative free ridership would be much lower and this would drastically improve the Net-to-Gross ratio."

Another challenge mentioned by several PAs that limits the ability to offer ER programs is that regulatory requirements limit the amount of savings they can claim when customers switch fuels (e.g., replace a functional oil furnace with a gas furnace). A Northeast region furnace program manager said that, "a recently completed evaluation study showed that many heating equipment replacements were oil to gas, but we are not allowed to claim savings from oil to gas conversions." Related to this issue, another respondent explained that, "the Commission thinks that oil programs should pay for oil, electric for electric, etc."

Two interviewees mentioned baseline issues as key challenges to ER programs. They mentioned HVAC and refrigerators in particular as measures where there have been relatively few upgrades to efficiency standards in recent years, so that new equipment is sometimes not that much more efficient than what is being replaced. A recycling program manager said, "the refrigerator market has been transformed to the point where savings from recycling will be reduced as secondary units are more efficient." Another program manager in the Midwest generalized this challenge by noting that, "the longer you have stagnant baselines, the more often the equipment you take out is just as efficient as what you put in."

Finally, one program manager reported that it is challenging to deliver cost effective early replacement savings because their program was given other goals besides energy efficiency. He said that "this program helps meet local contractor spending goals, and we also have a green jobs requirement and workers must live in [the city] itself to count these [labor] hours [to meet those requirements]. This restricts us by not allowing us to use contractors outside of [the city] that may be more cost-effective or better."

3.9 Research Topics Recommended by PAs

In light of the challenges cited by program administrators, it is not surprising that suggestions for Phase II research reflected an interest in obtaining better information on the costs and returns associated with early replacement programs. In some cases this took the form of research into the process by which cost effectiveness is calculated, while in others it was expressed as a desire for more detailed technology-, measure- or market-specific information.

Process-focused research interests included how both costs and savings are estimated. One respondent said that he needed "better information on estimating labor and materials costs," noting that he could "estimate within 15 minutes for a total project time for lighting, but non-lighting measures are more difficult." With regard to savings from early replacement, one Northeast respondent said that they would like research to support being able to count oil savings for furnace conversions to increase their total savings numbers. In another instance, there was some skepticism whether a great deal of additional research would itself be cost effective. "Estimating the RUL of a piece of equipment and claiming only partial savings afterwards is very costly, and you need a crystal ball to know how much life is actually left."

Technology-specific suggestions for Phase II research centered on HVAC and lighting. One respondent said he would specifically like to know whether unitary HVAC systems in the Northeast are being replaced early and if there are associated opportunities that are being missed. Similarly, are assumptions regarding the remaining life of existing lighting "too generous?" On the residential side, it was noted that, "It's important to know how we can squeeze more energy savings out of a home when it's weatherized besides light bulbs and refrigerators. Can we identify some technologies – such as whole-house control systems, variable refrigerant flow heating and cooling systems – that offer early replacement opportunities?" A manager of an early replacement program for boilers expressed an interest in data to support a similar program for cooling equipment. He said that for them, heating is well covered, but they are lacking info on central AC costs and the size, age and efficiency of equipment that is currently installed. Another respondent echoed this interest in research on air conditioning equipment, pointing out that "AC usage has gone up in recent years, and the energy savings are probably being underestimated" so there may be potential in an AC early replacement program. The need for measure-focused research was also expressed more broadly with the question, "Since measures with a long-established standard and a long life make for bad early replacement programs, is there some other technology that has a long life left with a big efficiency improvement?"

With regard to market focused research needs, respondents expressed interest both in learning more about specific markets and in gaining a better understanding of customer decision making. Examples of the former include:

- A Midwestern utility interested in early replacement of PTAC units with heat pumps for hotels.
- A suggestion that "it should be relatively easy to identify households that had a gas meter set between 30 to 35 years ago, and send them a post card stating that if they still have the same furnace, it is probably time to replace it, and include a time limited incentive."
- The general comment that, "more work could be done on finding cost-effective ways to deliver programs to small C&I customers."
- Interest in identifying the big market players for gas savings (restaurants, etc.) in the Mid-Atlantic region.

Specific suggestions for customer research to support early replacement included one from a program administrator who wanted to know "if there is a correlation between customer segments that are most likely to participate and affluent customers in a utility territory. To correctly assess market potential, the utility should assess potential not based on the number of people in their territory, but the amount of home owners and those with disposable income." Also in the context of residential customer research, one respondent posed a series of researchable questions. "No one will replace a working AC with 10 years of life left, but when do customers want to replace something? When it breaks? How damaged is it? How

much money would the customer need to be incented to replace equipment instead of repairing it? What percent of the new equipment cost minus the repair cost would it take? And what technologies fit the mold described above? "

3.10 Summary of Findings

In our research we identified 17 different types of early replacement measures among five end uses. The majority of early replacement measures are targeted to residential customers, and lighting and refrigerator/freezers make up almost half of early replacement measures across all sectors - with lighting being the clear leader. Half of the lighting measures were either general lighting retrofits or fluorescent replacements. Many of the most common early replacement measures (e.g., residential air conditioners and refrigerators, T12 lighting), however, could become less viable in coming years due to code changes, according the PA staffs we interviewed.

Measure eligibility requirements for early replacements are not particularly burdensome overall. About 75 percent of measures at least require that the existing equipment is functional, while almost one-quarter do not explicitly require functionality. In addition, age, efficiency, and cost requirements are used in fewer than 15 percent of the measures studied, and eligibility is verified for only 41 percent of measures. Not all programs with functionality (or age, efficiency, or cost) requirements use verification to ensure they are meeting those requirements.

Nearly two-thirds of our sampled measures use equipment RUL in some fashion. Only 52 percent of lighting measures use RUL, while over 80 percent of central air conditioner and refrigerator measures use it. RUL is used for nearly every early replacement measure type with the exception of ECMs, motors and drives, and boiler circulation pumps. Somewhat surprisingly, 81 percent of measures using RUL did not cite any sources for their RUL values, and only 13 percent of programs used field data to determine RUL.

Regarding savings calculation methods for early replacements, four methods are used: dual baselines, EUL-only, RUL-only and blended EUL/RUL values. Thirty-seven percent of programs use dual baselines (but no lighting programs), 25 percent use EUL-only and the rest are split evenly between RUL-only and blended EUL/RUL values. Five of the sampled program administrators constitute most of the dual baseline use and use it extensively in their early replacement programs. Program administrators that use dual baselines use it in the vast majority of their programs. Two program administrators use an unusual dual baseline method where the full EUL of the new equipment is used after accounting for the RUL of the existing equipment, instead of using the difference.

The majority of early replacement programs use total project costs (including labor) in their cost effectiveness calculations. Typically, rebate levels for early replacement measures are meant to cover 35 to 50 percent of total costs, including labor, while normal replacement incentives are intended to cover about 75 percent of incremental costs – usually to obtain equipment rated above minimum federal standards.

In custom projects, most utilities do not consider measures as part of a bundle; instead, each measure is treated individually for savings and rebate amounts. Savings tend to be calculated based on the energy consumption of the existing equipment compared to the calculated usage of the new, more efficient equipment and most prefer to use the full effective useful life (EUL) of the new measure – a few utilities reduce the EUL by a small amount to account for the reduced lifetime of the existing equipment (e.g., 15 years for new construction lighting as opposed to 13 years for retrofit lighting).

PAs tend to record early replacement projects slightly differently than normal replacement projects. Additional information – such as the age (where available and used for RUL), efficiency, and model number – of existing equipment is usually reported for early replacement projects. None of the PAs use the same tool to track participation and/or savings values for early replacement programs. About half stated that they use some kind of proprietary or custom-built database, while others use a semi-customized, off-the-shelf product, including: eTrack, FoxPro, Microsoft Access, Nexant TrakSmart, and energyOrbit.

4 Recommendations for Phase II Study

Based upon the research findings, the Evergreen team identified six topic areas that NEEP could consider for subsequent research:

1. What are the primary and secondary barriers to adopting the dual baseline approach to calculate savings? While the Evergreen team can speculate upon some of the reasons from our research (e.g., data collection costs, misunderstanding of the dual-baseline method), more focused, in-depth inquiry may yield additional answers.

2. What are current best practices for collecting existing equipment information (e.g., age, efficiency, degradation, salvage value) accurately and cost-effectively? Identifying ways that PAs can more easily capture this information may lead to additional and more defensible early replacement programs.

3. Related to #2, what additional information can customers provide to enhance and inform RUL assumptions used to calculate program impacts?

4. How accurate are current RUL assumptions for lighting measures? Are they often too generous if most customers are replacing lighting just before expected failure? How could RUL estimates for lighting in particular be improved?

5. How often is unitary HVAC equipment replaced "early" but not recognized as such in standard normal replacement programs? How large is the missed opportunity for larger early replacement savings? What best practice data collection and screening practices could other PAs implement?

6. What other measures could be good candidates for early replacement programs? As noted by one of the PA interviewees, "Since measures with stable efficiency standards and a long life make for bad early replacement programs, is there some other technology that has a long life left with a big efficiency improvement?"

Appendix A: PA Staff Interview Guide

Early Replacement Phase I Study
PA Program Staff and Implementers Questionnaire

Target Audience: PA staff and third party program implementers/designers identified by the primary PA contacts during the initial study recruitment.

Read to interviewee before starting, to ensure everyone using the same terminology:

For our study purposes, an Early Replacement program is defined as any program that promotes the replacement of equipment prior to the assumed time of normal replacement that would occur without the influence of the program. "Early replacement" measures are those that replace existing, operational equipment that is not at the end of its useful life (and therefore has a "remaining useful life", or RUL) or which is not scheduled for replacement for reasons independent of the program. In contrast, "normal replacement" measures are installed when equipment has reached the end of its useful life and has become non-operational or is being replaced for some other reason. Early replacement measures are commonly called "retrofit" measures, and are sometimes offered through separate EE programs, or they may be included with normal replacement measures in a common program.

Early Replacement Measures and Methods Review

The first portion of the interview will be spent reviewing the spreadsheet data that has been compiled. For the measures and programs the interviewee is familiar with, the interviewer should discuss:

- Are any early replacement measures from the programs the interviewee works with missing from Evergreen's database spreadsheet? (If needed, tell them that we have only included measures where they claim different savings for early and normal replacements.)
- Are any of the field contents incomplete, inaccurate or misrepresentative, or in the process of being updated? (Our database should include the expected updates, with the information source noted in the Information Sources field.)
- Can the interviewee or others fill in any data gaps (i.e., missing measure field contents, programs participation/savings data)?

For any data gaps the respondent can fill, get this information in real-time or make arrangements to get this information and communicate potential schedule impacts to the study team.

Additional Questions

INTERVIEWER: RECORD PROGRAMS AND/OR MEASURES RESPONDENT IS ABLE TO ADDRESS IN NOTES.

1. First, how are measures qualified for early replacement incentives and distinguished from normal replacements? For instance, are there specific equipment age, efficiency or functionality requirements?

2. In your information systems, do you record early replacement projects differently than you do normal replacement projects?

   a) If YES: What are the key differences, what additional data is stored?
   b) If NO: Why is that?

3. What tools do you use to track participation and savings for early replacement programs?

4. How often are these data updated?

5. How are your rebate levels for early replacements established? For instance, are they set to cover a specific percentage of the total cost for the early replacement? Or are they linked to the rebates for normal replacements somehow?

6. How do you determine the age of the existing equipment for site-specific project analyses?

7. How are early replacement measures handled in custom and bundled-measures projects? Are estimates of remaining useful life (RUL) captured as part of the routine data collection?

   a) If YES: How is this done? (Probe to see how they determine equipment age, or what general assumptions are used)

   b) If RUL is not captured or estimated: How do the measure lives that are used for early replacements compare to normal replacements?

8. During retrofits, sometimes new "add-on" or "supplemental" measures are added to existing measures of buildings, like new economizers or other controls on unitary HVAC, or new VFDs on motors.

   What assumptions are made regarding measure life when an add-on measure like a VFD or economizer is added to existing equipment that has less remaining life than the new add-on equipment?

9. Do you use net present value calculations to discount the new equipment cost in your incremental cost calculations? (If YES, get details)

10. Regarding the cost-effectiveness of early replacement programs you currently run or wanted to run but were deemed not cost-effective - how has this been affected by program design assumptions or calculations? Specifically, which of your assumptions regarding equipment measure life, efficiency baselines or incremental measure cost hinder or enhance cost-effectiveness?

    a) Do these issues vary by the type of measure?

11. Are there any other program design or implementation issues, including regulatory decisions, that have been particularly beneficial or challenging for your existing or desired early replacement programs?

12. At a high level, how do your early replacement program achievements compare to 2012 or 2013 goals, in terms of customer participation and claimed savings? We don't need to know your actual quantitative goals and results – we would just like to get a sense of whether your various early replacement measures or programs are meeting, lagging or exceeding your goals.

    a) If lagging or exceeding goals: What are the key reasons for this? (RECORD YEAR OR PERIOD RESPONDENT IS DESCRIBING)

13. How do your participation and savings goals in future years compare to your current goals? (Probe for general increase, decrease or level – quantitative details welcome but not required.)

14. Are you planning any early replacement program changes?

Based on the results of our current study, NEEP will be designing future research so that programs with early replacements elements can potentially estimate savings more accurately and/or garner more participation.

15. Do you have any recommendations for NEEP regarding specific early replacement issues to study in-depth? In particular, what measures or customer populations are high priorities for study that will likely include some field-based research? Where do you think the greatest savings potential lies?

    a) What data could you provide to assist this Phase II research?

Those are all the questions I have for you today. Thank you very much for your time and good information!

Appendix B: Study Measures – Descriptive Information

EFFICIENT MEASURE DESCRIPTIVE INFORMATION					
State - PA	**Efficient Measure Description**	**End Use Category**	**Fuel Source**	**Eligible Customer Segments**	**Other Customer Requirements**
IL - Ameren	Air Source Heat Pump	HVAC	Electric	Residential	
OH - Dayton Power & Light	Air Source Heat Pump	HVAC	Electric	Residential	
CT - CL&P, UI, CNG, SCG, Yankeegas, Energize Connecticut	Boiler	HVAC	Gas, Oil	Residential	
MA - National Grid, NSTAR, Cape Light Compact, Unitil, WMECo, Columbia Gas, New England Gas, Blackstone Gas, Berkshire Gas	Boiler	HVAC	Natural Gas	Residential	
MA - National Grid, NSTAR, Cape Light Compact, Unitil, WMECo, Columbia Gas, New England Gas, Blackstone Gas, Berkshire Gas	Boiler	HVAC	Oil, Propane	Residential	
NH - Liberty	Boiler	HVAC	Natural Gas	Residential	
NY - ConEdison	Boiler	HVAC	Electric/gas	Commercial and Industrial	Large customers with monthly peak demand > 110 kW
IL - Ameren	Boiler	HVAC	Gas	Residential	
NH - PSNH	Boiler Circulating Pump	Water Heating	Electric	Residential	
CT - CL&P, UI, CNG, SCG, Yankeegas, Energize Connecticut	Central AC	HVAC	Electric	Residential	
NH - PSNH	Central AC	HVAC	Electric	Residential	
MA - National Grid, NSTAR, Cape Light Compact, Unitil, WMECo, Columbia Gas, New England Gas, Blackstone Gas, Berkshire Gas	Central AC or HP Early Replacement	HVAC	Electric	Residential	
IL - Ameren	Central AC	HVAC	Electric	Residential	
OH - Dayton Power & Light	Central AC	HVAC	Electric	Residential	
AZ - Tucson Electric Power	Central AC or HP Early Retirement with Quality Install	HVAC	Electric	Residential	Existing homes only, single-family or multi-family with 4 or fewer units.
CO - Xcel Energy (Public Service Company of Colorado)	Early Retirement AC	HVAC	Electric	Residential	
NY - ConEdison	Chiller	HVAC	Electric/gas	Commercial and Industrial	Large customers with monthly peak demand > 110 kW
CT - CL&P, UI, CNG, SCG, Yankeegas, Energize Connecticut	Clothes Washer	Appliances	Electric, Oil, Gas, Propane	Residential	
VT - Efficiency Vermont	Clothes Washer Retrofit	Appliances	Electric	Residential, Low Income	Single-family
VT - Efficiency Vermont	Clothes Washer Retrofit (In-Unit)	Appliances	Electric, Natural Gas, Propane, Oil, Water	Residential	Multifamily
VT - Efficiency Vermont	Common Area Clothes Washer Retrofit	Appliances	Electric, Natural Gas, Propane, Oil, Water	Residential	Multifamily
NY - NGRID	Compressed Air Systems	Compressed Air	Electric	Commercial and Small Business	
CT - CL&P, UI, CNG, SCG, Yankeegas, Energize Connecticut	Custom	Custom	Electric, Oil, Gas, Propane	Residential	
MA - National Grid	Custom	Custom	Electric, Gas, Oil, Propane	Commercial and Industrial	
MD - BGE	Custom	Custom	Electric, Gas	Commercial, industrial, government, institutional, and non-profit	
NH - Liberty	Custom	Custom	Electric	C&I	
NH - PSNH	Custom	Custom	Electric	C&I	
NH - Unitil	Custom	Custom	Electric	C&I	
NY - NGRID	Custom measures	Custom	All	Commercial and Small Business	
MT - NorthWestern Energy	Custom measures	Custom	All	Commercial, industrial, institutional, multifamily, and agricultural	
CT - CL&P, UI, CNG, SCG, Yankeegas, Energize Connecticut	Dehumidifier	Appliances	Electric	Residential	
MA - Cape Light Compact	Dehumidifiers	Appliances	Electric	Residential, Low Income	

EFFICIENT MEASURE DESCRIPTIVE INFORMATION					
State - PA	**Efficient Measure Description**	**End Use Category**	**Fuel Source**	**Eligible Customer Segments**	**Other Customer Requirements**
CT - CL&P, UI, CNG, SCG, Yankeegas, Energize Connecticut	Dishwasher	Appliances	Electric, Oil, Gas, Propane	Residential	
NH - Liberty	Electronically Commutated (EC) Motors	HVAC/Refrigeration	Electric	C&I	C&I
NH - PSNH	Electronically Commutated (EC) Motors	HVAC/Refrigeration	Electric	C&I	
NH - Unitil	Electronically Commutated (EC) Motors	HVAC/Refrigeration	Electric	C&I	C&I
NY - ConEdison	Electronically Commutated (EC) Motors	HVAC/Refrigeration	Electric	Commercial	Small Business
NH - PSNH	Fixtures	Lighting	Electric	Residential	Residential
NH - Unitil	Fixtures	Lighting	Electric	Residential	Residential
NH - Liberty	Fluorescent fixtures	Lighting	Electric	C&I	C&I
NH - PSNH	Fluorescent	Lighting	Electric	C&I	C&I
NH - Unitil	Fluorescent	Lighting	Electric	C&I	C&I
CT - CL&P, UI, CNG, SCG, Yankeegas, Energize Connecticut	Freezer Replacement	Appliances	Electric	Residential	
VT - Efficiency Vermont	Freezer Replacement	Appliances	Electric	Residential	Multifamily
VT - Efficiency Vermont	Freezer Replacement	Appliances	Electric	Residential, Low Income	Single-family
MA - National Grid, NSTAR, Cape Light Compact, Unitil, WMECo, Columbia Gas, New England Gas, Blackstone Gas, Berkshire Gas	Freezer Retrofit/Replacement	Refrigeration (Consumer Appliances)	Electric	Low Income	1-4 family, multi-family categories
MN - Xcel Energy	Freezer Replacement	Residential Appliances	Electric	Residential, Low Income	Low-income only
CT - CL&P, UI, CNG, SCG, Yankeegas, Energize Connecticut	Furnace	HVAC	Gas, Oil, Propane	Residential	
NY - ConEdison	Furnace	HVAC	Electric/gas	Commercial and Industrial	Large customers with monthly peak demand > 110 kW
NH - PSNH	Furnace Fan/ECM	HVAC	Electric	Residential	
NH - PSNH	Furnace w/ ECM Motor	HVAC	Electric	Residential	
IL - Ameren	Furnace	HVAC	Gas	Residential	
OR - Energy Trust of Oregon	Furnace	HVAC	Gas	Residential	Part of Clean Energy Works program
IL - Ameren	Ground Source Heat Pump	HVAC	Electric	Residential	
OH - Dayton Power & Light	Ground Source Heat Pump	HVAC	Electric	Residential	
NH - PSNH	Hardwired CFL	Lighting	Electric	C&I	
NH - Unitil	Hardwired CFL	Lighting	Electric	C&I	
MA - National Grid, NSTAR, Cape Light Compact, Unitil, WMECo, Columbia Gas, New England Gas, Blackstone Gas, Berkshire Gas	Heating System Replacement	HVAC	Oil, Propane	Residential, Low Income	Low Income, 1-4 family
NH - PSNH	HID Lighting	Lighting	Electric	C&I	
NH - Unitil	HID Lighting	Lighting	Electric	C&I	
NH - Liberty	High efficiency air compressor	Compressed Air	Electric	C&I	
NH - PSNH	High efficiency air compressor	Compressed Air	Electric	C&I	
NH - Unitil	High efficiency air compressor	Compressed Air	Electric	C&I	
VT - Efficiency Vermont	High Performance T8 Fixtures Re-lamp, Re-ballast	Lighting	Electric	Commercial and Industrial	
NH - PSNH	LED & LEC Exit Light	Lighting	Electric	C&I	
NH - Unitil	LED & LEC Exit Light	Lighting	Electric	C&I	
NH - Liberty	LED lighting	Lighting	Electric	C&I	
NH - Liberty	LED parking/roadway	Lighting	Electric	C&I	
NY - ConEdison	Lighting (Muliple types)	Lighting	Electric	Commercial	Small Business
NY - ConEdison	Lighting (Muliple types)	Lighting	Electric	Commercial and Industrial	Large customers with monthly peak demand > 110 kW
VT - Efficiency Vermont	Lighting (Muliple types)	Lighting	Electric	Commercial and Industrial	
NH - Liberty	Lighting controls	Lighting	Electric	C&I	
NH - PSNH	Lighting controls	Lighting	Electric	C&I	
NH - Unitil	Lighting controls	Lighting	Electric	C&I	
NY - NGRID	Lighting Systems/Lighting Controls	Lighting	Electric	Commercial and Small Business	
MA - National Grid	Commercial Lighting Retrofit	Lighting	Electric	Commercial and Industrial	

EFFICIENT MEASURE DESCRIPTIVE INFORMATION					
State - PA	**Efficient Measure Description**	**End Use Category**	**Fuel Source**	**Eligible Customer Segments**	**Other Customer Requirements**
MD - BGE	General Lighting (Lamp and Ballast Retrofits Commodity Fixtures Advanced Fixtures Fluorescent High Bay Fixtures Compact Fluorescent LED Exit Signs LED Strips LED Integral Replacement Lamps)	Lighting	Electric	Commercial, industrial, government, institutional, and non-profit	
CT - CL&P, UI, CNG, SCG, Yankeegas, Energize Connecticut	Lighting Retrofit	Lighting	Electric	Commercial, Industrial	
CO - Xcel Energy	Lighting Retrofit	Lighting	Electric	Commercial, Industrial	
MN - Xcel Energy	Lighting Retrofit	Lighting	Electric	Commercial, Industrial	
CT - CL&P, UI, CNG, SCG, Yankeegas, Energize Connecticut	Package Terminal Heat Pump	HVAC	Electric	Residential	
CT - CL&P, UI, CNG, SCG, Yankeegas, Energize Connecticut	Refrigerator Replacement	Appliances	Electric	Residential	
VT - Efficiency Vermont	Refrigerator Replacement	Appliances	Electric	Residential	Multifamily
VT - Efficiency Vermont	Refrigerator Replacement	Appliances	Electric	Residential, Low Income	Single-family
Washington, D.C. - DC SEU	Refrigerator Retrofit	Appliances	Electricity	Residential	
MA - National Grid, NSTAR, Cape Light Compact, Unitil, WMECo, Columbia Gas, New England Gas, Blackstone Gas, Berkshire Gas	Refrigerator Retrofit/Replacement	Refrigeration (Consumer Appliances)	Electric	Residential (Home Energy Services)	
MA - National Grid, NSTAR, Cape Light Compact, Unitil, WMECo, Columbia Gas, New England Gas, Blackstone Gas, Berkshire Gas	Refrigerator Retrofit/Replacement	Refrigeration (Consumer Appliances)	Electric	Low Income	1-4 family, multi-family categories
MA - National Grid, NSTAR, Cape Light Compact, Unitil, WMECo, Columbia Gas, New England Gas, Blackstone Gas, Berkshire Gas	Refrigerators/Freezer Replacement	Refrigeration (Consumer Appliances)	Electric	Residential, Low Income	Multi-family only
NH - PSNH	Refrigerators/Freezer Replacement	Appliances	Electric	Residential	
CO - Xcel Energy (Public Service Company of Colorado)	Refrigerator Replacement	Residential Appliances	Electric	Residential, Low Income	Low-income only
MN - Xcel Energy	Refrigerator Replacement	Residential Appliances	Electric	Residential, Low Income	Low-income only
CT - CL&P, UI, CNG, SCG, Yankeegas, Energize Connecticut	Room AC	HVAC	Electric	Residential	
NH - PSNH	Room AC	HVAC	Electric	Residential	Residential
VT - Efficiency Vermont	Room AC	HVAC	Electric	Commercial	
Washington, D.C. - DC SEU	Room AC	HVAC	Electricity	Commercial and Institutional	
Washington, D.C. - DC SEU	T12 Replacement	Lighting	Electricity, Gas	Commercial and Institutional	Small offices, retail, restaurants, churches, community centers, and lodging facilities.
CO - Xcel Energy (Public Service Company of Colorado)	Upgrade Motors with Premium or Enhanced Efficiency (1% above premium) Motors, 1 hp - 500 hp	Motors and Drives	Electric	Commercial, Industrial	
MN - Xcel Energy	Upgrade Motors with Premium or Enhanced Efficiency (1% above premium) Motors, 1 hp - 500 hp	Motors and Drives	Electric	Commercial, Industrial	
NH - Liberty	VFD	Motors and Drives	Electric	C&I	
NH - PSNH	VFD	Motors and Drives	Electric	C&I	
NH - Unitil	VFD	Motors and Drives	Electric	C&I	
CO - Xcel Energy	Factory-integrated VFDs on Air Compressors from 10 to 49 HP	Compressed Air	Electric	Commercial, Industrial	
MN - Xcel Energy	VFDs on Air Compressors from 10 to 40 HP	Compressed Air	Electric	Commercial, Industrial	

EFFICIENT MEASURE DESCRIPTIVE INFORMATION					
State - PA	**Efficient Measure Description**	**End Use Category**	**Fuel Source**	**Eligible Customer Segments**	**Other Customer Requirements**
MA - National Grid, NSTAR, Cape Light Compact, Unitil, WMECo, Columbia Gas, New England Gas, Blackstone Gas, Berkshire Gas	Window AC (Retrofit)	HVAC	Electric	Residential, Low Income	Low Income
MA - National Grid	Window AC Replacement	HVAC	Electric	Low Income	Multi-family only
MN - Xcel Energy	Window AC Replacement	HVAC	Electric	Residential, Low Income	Low-income only

Appendix C: Study Measures – Normal Replacements Information

NORMAL REPLACEMENTS INFORMATION							
State - PA	**Efficient Measure Description**	**EUL for Normal Replacements**	**Baseline Efficiency for Normal Replacements**	**Energy Savings for Normal Replacements**	**Baseline Cost for Normal Replacements**	**Efficient Equipment Cost for Normal Replacements**	**Rebates and Incentives for Normal Replacements**
IL - Ameren	Air Source Heat Pump	18 yrs	Federal minimum standard (SEER 13, EER 11, 7.7 HSPF)	Calculated (based on SEER, EER, HSPF and Climate Zone); Avg ex-ante per-unit savings of 1,061 kWh	Based on US DOE EERE data, dependent on tier	Based on US DOE EERE data, dependent on tier	SEER 14.5-14.9 $150; SEER 15.0-15.9 $200; SEER 16+ 300
OH - Dayton Power & Light	Air-Source Heat-Pump	18 yrs	Mimimum ENERGY STAR efficiency level standard (14.5 SEER & 12 EER)	Identified through annual review of customer billing data, program tracking data, draft Ohio TRM algorithms and assumptions, and primary and secondary data.	Actual cost of minimum federal efficiency level standards	Per-ton costs based on data provided in draft Ohio TRM	SEER 14-15 $200 SEER 16+ $300
CT - CL&P, UI, CNG, SCG, Yankeegas, Energize Connecticut	Boiler	20 years, from Appliance Magazine. U.S. Appliance Industry: Market Share, Life Expectancy & Replacement Market, and Saturation Levels. January 2010. Page 10.	80%	Calculated, based on area being heated, AFUE of new unit, and heating factor, which is based on the age of the home and has units of BTU/SF/Year			$750
MA - National Grid, NSTAR, Cape Light Compact, Unitil, WMECo, Columbia Gas, New England Gas, Blackstone Gas, Berkshire Gas	Boiler	20 yrs, from EPA study of Life Cycle Cost Estimate for ENERGY STAR Qualified Boilers	AFUE of 80% for steam, 82% for forced hot water, based on code	Deemed at 10.4 MMBTU for forced hot water, 3.5 MMBTU for steam. Values come from these two sources: The Cadmus Group, Inc. (2012) Memo to HEHE Program Administrators Re: Impacts of Upcoming Federal Standards on HEHE Gas Space and Water Heating Measures; June 8, 2012, GDS Associates, Inc. (2009). Natural Gas Energy Efficiency Potential in Massachusetts. Prepared for GasNetworks		2883 forced hot water incremental cost, 400 for steam, don't offer anymore for steam normal replacement	1000-1500
MA - National Grid, NSTAR, Cape Light Compact, Unitil, WMECo, Columbia Gas, New England Gas, Blackstone Gas, Berkshire Gas	Boiler	20 yrs, from EPA study of Life Cycle Cost Estimate for ENERGY STAR Qualified Boilers	AFUE of 80%, based on code	Deemed at 8.5, 3.5, 16, and 3.5 MMBtu for oil forced hot water, oil steam, propane forced hot water, and propane steam boilers, respectively		500 incremental, 2833 for propane	1000-1500, depending on efficiency
NH - Liberty	Boiler	20 yrs	82% AFUE boiler	Deemed at 10.4 or 13.1 MMBtu based on type	NO DETAILS AVAILABLE	NO DETAILS AVAILABLE	NO DETAILS AVAILABLE
NY - ConEdison	Boiler	Not researched	AFUE = 80% for hot water boilers AFUE = 75% for steam boilers	Calculated using NYS TRM method (see TRM for detailed formula)	Not researched	Not researched	ranges based on measures (https://www.conedci.com/HVAC.aspx)
IL - Ameren	Boiler	25 yrs	Federal minimum standard (AFUE <=75%)	Calculated (based on boiler/furnace load and Climate Zone); Avg ex-ante per-unit savings of 192 Therms	Based on US DOE EERE data, dependent on tier	Based on US DOE EERE data, dependent on tier	AFUE 90%+ $400 AFUE 95%+ $500
NH - PSNH	Boiler Circulating Pump	20 years	Current code efficiency	Deemed (9 kWh per year)	NO DETAILS AVAILABLE	NO DETAILS AVAILABLE	NO DETAILS AVAILABLE
CT - CL&P, UI, CNG, SCG, Yankeegas, Energize Connecticut	Central AC	25 years, from GDS Associates Inc. Measure Life Report, Residential and Commercial Industrial Lighting and HVAC Measures, June 2007, Table 1.	11 EER, from Residential Central AC Regional Evaluation, ADM Associates, Inc., November 2009. page 4-1. "Because there were no instances of early replacement of CAC units in the monitoring sample, the baseline for estimating savings is the minimum standard for new installations, namely 11 EER."	Calculated, based on capacity and EER of the proposed unit and a value of 357.6 kWh/year/ton, from an evaluation study. Residential Central AC Regional Evaluation, ADM Associates, Inc., November 2009. page 4-1.			$250
NH - PSNH	Central AC	14 years	Current code efficiency	Deemed (110.29 kWh per year)	NO DETAILS AVAILABLE	NO DETAILS AVAILABLE	NO DETAILS AVAILABLE
MA - National Grid, NSTAR, Cape Light Compact, Unitil, WMECo, Columbia Gas, New England Gas, Blackstone Gas, Berkshire Gas	Central AC or HP Early Replacement	18 yrs, from GDS Associates 2007 Measure Life Report for NE State Program Working Group	SEER 13, 11 EER, 7.6 HSPF, which is federal standard	Deemed at 103 kWh, 0.273 kW for AC, 519 kWh, 0.273 kW summer, 0.347 kW winter for heat pumps			150-500, depending on efficiency
IL - Ameren	Central AC	18 yrs	Federal minimum standard (SEER 13, EER 11)	Calculated (based on SEER, EER and Climate Zone); Avg ex-ante per-unit savings of 300 kWh	Based on US DOE EERE data, dependent on tier	Based on US DOE EERE data, dependent on tier	SEER 14.5-14.9 $150; SEER 15.0-15.9 $200; SEER 16+ 300
OH - Dayton Power & Light	Central AC -- Early replacement, New construction, and Replace on failure -- Multiple efficiency tiers	18 yrs	Mimimum ENERGY STAR efficiency level standard (14.5 SEER & 12 EER)	Identified through annual review of customer billing data, program tracking data, draft Ohio TRM algorithms and assumptions, and primary and secondary data.	Actual cost of minimum federal efficiency level standards	Per-ton costs based on data provided in draft Ohio TRM	SEER 14-15 $100, SEER 16+ $150

NORMAL REPLACEMENTS INFORMATION							
State - PA	**Efficient Measure Description**	**EUL for Normal Replacements**	**Baseline Efficiency for Normal Replacements**	**Energy Savings for Normal Replacements**	**Baseline Cost for Normal Replacements**	**Efficient Equipment Cost for Normal Replacements**	**Rebates and Incentives for Normal Replacements**
AZ - Tucson Electric Power	Central AC or HP Early Retirement with Quality Install	18 years, from "Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures" – GDS Associates.	13 SEER	1.1 kW, 1,349 kWh, based on energy simulations and includes effects of quality install, downsizing, and duct sealing	$2,683	$4,116	$500 for A/C or HP unit with quality installation, additional $150 for downsizing, additional $3/CFM@25 Pa reduced up to $450 or 50% of cost, whichever is lower, for performance duct sealing (pre- and post-installation measurement). Maximum incentive is $1,100.
CO - Xcel Energy (Public Service Company of Colorado)	Early Retirement AC	14 yrs	13 SEER	Deemed at 202 kWh for 14.5 SEER Efficient unit, 261 kWh for 15 SEER, 366 kWh for 16 SEER	$4,329	Ranges from $4,849 to $5,368 for SEER ranging from 14.5 to 16	$250, $350, $500, for 14.5 SEER, 15 SEER, 16 SEER
NY - ConEdison	Chiller	Not researched	Air Cooled Chiller; Avg baseline efficiency (COP) = 3.05 Water cooled Chiller; Avg baseline efficiency (COP) = 5.05 Water cooled screw and scrol Chiller; Avg baseline efficiency (COP) = 5.2-6.15 Water cooled centrifugal; Avg baseline efficiency (COP) = 5.25-6.4	Calculated using NYS TRM method (see TRM for detailed formula)	Not researched	Not researched	ranges based on measures (https://www.conedci.com/HVAC.aspx)
CT - CL&P, UI, CNG, SCG, Yankeegas, Energize Connecticut	Clothes Washer	11 years, from Appliance Magazine. U.S. Appliance Industry: Market Share, Life Expectancy & Replacement Market, and Saturation Levels. January 2010. Page 10.	MEF of 2 for new homes, 1.8 for others. WF of 6 for new homes, 7.5 for others. The MEF and WF of the baseline unit are at 2009 ENERGY STAR Version 5.1 Tier 1 level, which does not depend on any categories. New Construction is a special case, where the baseline must be current ENERGY STAR level	Calculated based on MEF of baseline and new units, unit capacity, water heating fuel, drying fuel, and some DOE assumptions			$50
VT - Efficiency Vermont	Clothes Washer Retrofit	14 years, Based on DOE Life-Cycle Cost and Payback Period Excel-based analytical tool, available online at: http://www1.eere.energy.gov/buildings/appliance_standards/residential/docs/rcw_dfr_lcc_standard.xlsm.	Federal standard efficiency (MEF of 1.26, WF of 7.93) inflated by 20% to 1.51 MEF to account for a transforming market, but WF is not inflated.	Deemed, based on efficiency level selected (ESTAR, CEE 2, CEE 3, Most Efficient, or Top Ten)	$600, based on weighted average of top loading and front loading units (based on available product from the CEC Appliance database) and cost data from Life-Cycle Cost and Payback Period Excel-based analytical tool, available online at: http://www1.eere.energy.gov/buildings/appliance_standards/residential/docs/rcw_dfr_lcc_standard.xlsm.	The efficient (ENERGY STAR, CEE, or Top Ten) unit costs are listed as $825, $850, $950, $1100, and $1110 with the cost increasing along with the efficiency.	$40 for CEE Tier 2, $75 for Tier 3
VT - Efficiency Vermont	In-Unit Clothes Washer Retrofit	14 years, Based on DOE Life-Cycle Cost and Payback Period Excel-based analytical tool, available online at: http://www1.eere.energy.gov/buildings/appliance_standards/residential/docs/rcw_dfr_lcc_standard.xlsm.	Federal standard efficiency (MEF of 1.26, WF of 7.93), with MEF inflated by 20% to 1.51 for the savings comparison to account for non-qualifying models that are higher than the federal baseline for MEF.	Deemed, based on efficiency level selected, water heating fuel, and drying fuel.	$600, based on weighted average of top loading and front loading units (based on available product from the CEC Appliance database) and cost data from Life-Cycle Cost and Payback Period Excel-based analytical tool, available online at: http://www1.eere.energy.gov/buildings/appliance_standards/residential/docs/rcw_dfr_lcc_standard.xlsm.	The efficient (ENERGY STAR, CEE, or Top Ten) unit costs are listed as $825, $850, $950, $1100, and $1110 with the cost increasing along with the efficiency.	$40 for CEE Tier 2, $75 for Tier 3
VT - Efficiency Vermont	Common Area Clothes Washer Retrofit	14 years, Based on DOE Life-Cycle Cost and Payback Period Excel-based analytical tool, available online at: http://www1.eere.energy.gov/buildings/appliance_standards/residential/docs/rcw_dfr_lcc_standard.xlsm.	Federal standard efficiency (MEF of 1.26, WF of 7.93), with MEF inflated by 20% to 1.51 for the savings comparison to account for non-qualifying models that are higher than the federal baseline for MEF.	Deemed, based on efficiency level selected, water heating fuel, and drying fuel.	$650, based on weighted average of top loading and front loading units (based on available product from the CEC Appliance database) and cost data from Life-Cycle Cost and Payback Period Excel-based analytical tool, available online at: http://www1.eere.energy.gov/buildings/appliance_standards/residential/docs/rcw_dfr_lcc_standard.xlsm.	The efficient (ENERGY STAR, CEE, or Top Ten) unit costs are listed as $1035, $1300, $1550, $1900, and $1950 with the cost increasing along with the efficiency.	$40 for CEE Tier 2, $75 for Tier 3
NY - NGRID	Compressed Air Systems	No Normal Replacement Program	No Normal Replacement Program	No Normal Replacement Program	No Normal Replacement Program	No Normal Replacement Program	No Normal Replacement Program
CT - CL&P, UI, CNG, SCG, Yankeegas, Energize Connecticut	Custom		Varies, this is a custom measure	Varies, this is a custom measure			

NORMAL REPLACEMENTS INFORMATION							
State - PA	**Efficient Measure Description**	**EUL for Normal Replacements**	**Baseline Efficiency for Normal Replacements**	**Energy Savings for Normal Replacements**	**Baseline Cost for Normal Replacements**	**Efficient Equipment Cost for Normal Replacements**	**Rebates and Incentives for Normal Replacements**
MA - National Grid	Custom	Varies, based on equipment, 15 years for lighting, for example	Varies	Varies	Varies	Varies	Calculated to be 75% of the incremental cost of the new equipment over baseline (labor costs excluded)
MD - BGE	Varies based on project	Varies by measure	Not researched	Not researched	Not researched	Not researched	Not researched
NH - Liberty	Custom	Custom analysis	Custom analysis	Custom analysis calculation	NO DETAILS AVAILABLE	NO DETAILS AVAILABLE	75% of incremental equipment cost or buy down to one-year payback
NH - PSNH	Custom	Custom analysis	Custom analysis	Custom analysis calculation	NO DETAILS AVAILABLE	NO DETAILS AVAILABLE	75% of incremental equipment cost or buy down to one-year payback
NH - Unitil	Custom	Custom analysis	Custom analysis	Custom analysis calculation	NO DETAILS AVAILABLE	NO DETAILS AVAILABLE	75% of incremental equipment cost or buy down to one-year payback
NY - NGRID	Custom measures	Technical Calculation in TRM	Current code efficiency	Calculated between existing equipment and code replacement	Current code cost	Actual costs	None provided
MT - NorthWestern Energy	Custom measures	Full EUL of the measure	Current code efficiency	"based on the energy consumption of the existing unit (calculated or data-logged) compared to the calculated usage froma new more efficient unit"	NO DETAILS AVAILABLE	NO DETAILS AVAILABLE	"based on the project's energy savings resource value to NorthWestern Energy of the incremental cost and savings between a standard efficiency and energy efficent unit.
CT - CL&P, UI, CNG, SCG, Yankeegas, Energize Connecticut	Dehumidifier	12 years, from GDS Associates Inc. Measure Life Report, Residential and Commercial Industrial Lighting and HVAC Measures, June 2007, Table 1.	2012 Federal Standard Energy Factor, based on size of new unit	Calculated, based on an algorithm that depends on an assumed capacity of 64 pints/day, 67.5 days per year, and the baseline and new unit energy factor values.			
MA - Cape Light Compact	Dehumidifiers (Early Retirement)	12 yrs, from EPA study of Life Cycle Cost Estimate for ENERGY STAR Dehumidifiers	1.3 L/kWh, which is federal standard for 35 pint/day units	Deemed at 73 kWh, 0.042 kW		250-320	
CT - CL&P, UI, CNG, SCG, Yankeegas, Energize Connecticut	Dishwasher	10 years, from Appliance Magazine. U.S. Appliance Industry: Market Share, Life Expectancy & Replacement Market, and Saturation Levels. January 2010. Page 10.	307 kWh used per year and 5 gallons/cycle, from 2013 Federal Standard and assumptions	Calculated, based on annual rated kWh use of the new installed unit, rated gallons of water per cycle of the installed unit, water heater fuel type, and assumptions about the number of loads per year, capacity, etc.			$50
NH - Liberty	Electronically Commutated (EC) Motors	20 years HVAC; 15 years refrigeration	NO DETAILS AVAILABLE	Calculated	NO DETAILS AVAILABLE	NO DETAILS AVAILABLE	$75 per motor
NH - PSNH	Electronically Commutated (EC) Motors	20 years HVAC; 15 years refrigeration	NO DETAILS AVAILABLE	Calculated	NO DETAILS AVAILABLE	NO DETAILS AVAILABLE	$75 per motor
NH - Unitil	Electronically Commutated (EC) Motors	20 years HVAC; 15 years refrigeration	NO DETAILS AVAILABLE	Calculated	NO DETAILS AVAILABLE	NO DETAILS AVAILABLE	$75 per motor
NY - ConEdison	Electronically Commutated (EC) Motors	Not researched	Not researched	Not researched	Not researched	Not researched	Not researched
NH - PSNH	Fixtures	8 years for Interior, 5 for exterior	Current code efficiency	Deemed (62.3 kWh per year)	NO DETAILS AVAILABLE	NO DETAILS AVAILABLE	$10 per unit
NH - Unitil	Fixtures	8 years for Interior, 5 for exterior	Current code efficiency	Deemed (62.3 kWh per year)	NO DETAILS AVAILABLE	NO DETAILS AVAILABLE	$10 per unit
NH - Liberty	Fluorescent fixtures	15 years	Lighting wattages table	Calculated	NO DETAILS AVAILABLE	NO DETAILS AVAILABLE	$15-35 based on wattage and type
NH - PSNH	Fluorescent	15 years	Current code efficiency	Calculated (based on fixture wattage and operating hours)	NO DETAILS AVAILABLE	NO DETAILS AVAILABLE	$15-35 based on wattage and type
NH - Unitil	Fluorescent	15 years	Current code efficiency	Calculated (based on fixture wattage and operating hours)	NO DETAILS AVAILABLE	NO DETAILS AVAILABLE	$15-35 based on wattage and type
CT - CL&P, UI, CNG, SCG, Yankeegas, Energize Connecticut	Freezer Replacement	11 years, from Appliance Magazine. U.S. Appliance Industry: Market Share, Life Expectancy & Replacement Market, and Saturation Levels. January 2010. Page 10.	The efficiency of a freezer model is rated on the annual energy usage in kWh, which varies according to size, configuration, and features. The ENERGY STAR 2008 values are used for new homes, while the current federal standard values are used for all others.	Savings are calculated as the difference in unadjusted rated annual energy usage between two efficiency levels. The savings depend on the freezer type and capacity.			$25

NORMAL REPLACEMENTS INFORMATION							
State - PA	**Efficient Measure Description**	**EUL for Normal Replacements**	**Baseline Efficiency for Normal Replacements**	**Energy Savings for Normal Replacements**	**Baseline Cost for Normal Replacements**	**Efficient Equipment Cost for Normal Replacements**	**Rebates and Incentives for Normal Replacements**
VT - Efficiency Vermont	Freezer Replacement	12 years, From ENERGY STAR calculator: http://www.energystar.gov/ia/business/bulk_purchasing/bpsavings_calc/appliance_calculator.xlsx?e678-f5e6&e678-f5e6	Minimum federal efficiency standard		The cost of a baseline freezer is $335. Based on review of data from the Northeast Regional ENERGY STAR Consumer Products Initiative; "2009 ENERGY STAR Appliances Practices Report", submitted by Lockheed Martin, December 2009. The calculated full costs ($465 for a baseline unit) are multiplied by the 72% size factor to account for the smaller units being installed in MF.	The full cost for an Energy Star freezer is $360. Based on review of data from the Northeast Regional ENERGY STAR Consumer Products Initiative; "2009 ENERGY STAR Appliances Practices Report", submitted by Lockheed Martin, December 2009. The calculated full costs ($500 for ENERGY STAR) are multiplied by the 72% size factor to account for the smaller units being installed in MF.	
VT - Efficiency Vermont	Freezer Replacement	12 years, From ENERGY STAR calculator: http://www.energystar.gov/ia/business/bulk_purchasing/bpsavings_calc/appliance_calculator.xlsx?e678-f5e6&e678-f5e6			The cost of a baseline freezer is $335. Based on review of data from the Northeast Regional ENERGY STAR Consumer Products Initiative; "2009 ENERGY STAR Appliances Practices Report", submitted by Lockheed Martin, December 2009. The calculated full costs ($465 for a baseline unit) are multiplied by the 72% size factor to account for the smaller units being installed in MF.	The full cost for an Energy Star freezer is $360. Based on review of data from the Northeast Regional ENERGY STAR Consumer Products Initiative; "2009 ENERGY STAR Appliances Practices Report", submitted by Lockheed Martin, December 2009. The calculated full costs ($500 for ENERGY STAR) are multiplied by the 72% size factor to account for the smaller units being installed in MF.	
MA - National Grid, NSTAR, Cape Light Compact, Unitil, WMECo, Columbia Gas, New England Gas, Blackstone Gas, Berkshire Gas	Freezer Retrofit/Replacement	11 yrs, from EPA study of Life Cycle Cost Estimate for ENERGY STAR Freezer	Federal minimum standard	Deemed at 0.006 kW and 49 kWh for ENERGY STAR units, 0.017 kW and 140 kWh for Top Ten Freezers. Estimated using demand allocation methodology described in: Cadmus Demand Impact Model (2012) Prepared for Massachusetts Program Administrators and Environmental Protection Agency (2012) Freezers Qualified Product List. July 18, 2012. Average of all units in category.			20-30 depending on efficiency
MN - Xcel Energy	Freezer Replacement	NA	NA	NA	NA	NA	NA
CT - CL&P, UI, CNG, SCG, Yankeegas, Energize Connecticut	Furnace	20 years, no source	78% for gas or propane, 80% for oil	Calculated, based on area being heated, AFUE of new unit, and heating factor, which is based on the age of the home and has units of BTU/SF/Year			$600 for gas furnace ($390 outside of CL&P and UI territory), $200 for propane or oil
NY - ConEdison	Furnace	Not researched	AFUE = 78%	Calculated using NYS TRM method (see TRM for detailed formula)	Not researched	Not researched	ranges based on measures (https://www.conedci.com/HVAC.aspx)
NH - PSNH	Furnace Fan	20 years	Current code efficiency	Deemed (86 kWh per year)	NO DETAILS AVAILABLE	NO DETAILS AVAILABLE	NO DETAILS AVAILABLE
NH - PSNH	Furnace w/ ECM Motor	20 years	Current code efficiency	Deemed (733 kWh per year)	NO DETAILS AVAILABLE	NO DETAILS AVAILABLE	NO DETAILS AVAILABLE
IL - Ameren	Furnace	20 yrs	Federal minimum standard (AFUE <=75%)	Calculated (based on boiler/furnace load and Climate Zone); Avg ex-ante per-unit savings of 137 Therms	Based on US DOE EERE data, dependent on tier	Based on US DOE EERE data, dependent on tier	AFUE 95%+ $200; AFUE 97%+ $300
OR - Energy Trust of Oregon	Furnace	25 years	Market Baseline = 90 AFUE	70.56 therms; calculated against the adjusted baseline of 80 AFUE	Incremental costs of $700	Actual costs	$150 - $550 depending on the recipient's income and geographical locations
IL - Ameren	Ground Source Heat Pump	18 yrs	Federal minimum standard (SEER 13, EER 11, 7.7 HSPF)	Calculated (based on SEER, EER, HSPF and Climate Zone); Avg ex-ante per-unit savings of 3,814 kWh	Cost of a 3 ton standard heat pump (SEER 13, EER 11) = $3,609	Actual cost	$600
OH - Dayton Power & Light	Ground Source Heat Pump	18 yrs	Mimimum ENERGY STAR efficiency level standard (multiple Tiers, table available p. 82)	Identified through annual review of customer billing data, program tracking data, draft Ohio TRM algorithms and assumptions, and primary and secondary data.	Actual cost of minimum federal efficiency level standards	Per-ton costs based on data provided in secondary sources	SEER 16-18 $800 SEER 19+ $1200
NH - PSNH	Hardwired CFL	15 years	Current code efficiency	Calculated (based on fixture wattage and operating hours)	NO DETAILS AVAILABLE	NO DETAILS AVAILABLE	NO DETAILS AVAILABLE
NH - Unitil	Hardwired CFL	15 years	Current code efficiency	Calculated (based on fixture wattage and operating hours)	NO DETAILS AVAILABLE	NO DETAILS AVAILABLE	NO DETAILS AVAILABLE

NORMAL REPLACEMENTS INFORMATION							
State - PA	**Efficient Measure Description**	**EUL for Normal Replacements**	**Baseline Efficiency for Normal Replacements**	**Energy Savings for Normal Replacements**	**Baseline Cost for Normal Replacements**	**Efficient Equipment Cost for Normal Replacements**	**Rebates and Incentives for Normal Replacements**
MA - National Grid, NSTAR, Cape Light Compact, Unitil, WMECo, Columbia Gas, New England Gas, Blackstone Gas, Berkshire Gas	Heating System Replacement	20 yrs, from EPA study of Life Cycle Cost Estimate for ENERGY STAR Qualified Boilers	AFUE of 80%, based on code	Deemed at 8.5, 3.5, 16, and 3.5 MMBtu for oil forced hot water, oil steam, propane forced hot water, and propane steam boilers, respectively			1000-1500, depending on efficiency
NH - PSNH	HID Lighting	15 years	Current code efficiency	Calculated (based on fixture wattage and operating hours)	NO DETAILS AVAILABLE	NO DETAILS AVAILABLE	NO DETAILS AVAILABLE
NH - Unitil	HID Lighting	15 years	Current code efficiency	Calculated (based on fixture wattage and operating hours)	NO DETAILS AVAILABLE	NO DETAILS AVAILABLE	NO DETAILS AVAILABLE
NH - Liberty	High efficiency air compressor	15 years	Typical modulating compressor with blow-down valve	Calculated	NO DETAILS AVAILABLE	NO DETAILS AVAILABLE	15-24 HP ($45-90 per HP); 25-49 HP ($45-140 per HP); 50-70 HP ($50-125 per HP)
NH - PSNH	High efficiency air compressor	15 years	Typical modulating compressor with blow-down valve	Calculated (based on HP)	NO DETAILS AVAILABLE	NO DETAILS AVAILABLE	Ranges from $0 to $140 based on type of compressor and hp
NH - Unitil	High efficiency air compressor	15 years	Typical modulating compressor with blow-down valve	Calculated (based on HP)	NO DETAILS AVAILABLE	NO DETAILS AVAILABLE	Ranges from $0 to $140 based on type of compressor and hp
VT - Efficiency Vermont	High Performance T8 Fixtures Re-lamp, Re-ballast	15 years	Selected from table of existing/baseline fixture types	Calculated based on table values for baseline and efficient fixture wattages and site-specific or tabulated hours of operation values.	None provided for re-lamp, re-ballast HP T8 measure	Deemed, depending on fixture type	Varies, based on fixture types
NH - PSNH	LED & LEC Exit Light	15 years	Current code efficiency	Calculated (based on fixture wattage and operating hours)	NO DETAILS AVAILABLE	NO DETAILS AVAILABLE	$0
NH - Unitil	LED & LEC Exit Light	15 years	Current code efficiency	Calculated (based on fixture wattage and operating hours)	NO DETAILS AVAILABLE	NO DETAILS AVAILABLE	$0
NH - Liberty	LED lighting	15 years	Lighting wattages table	Calculated	NO DETAILS AVAILABLE	NO DETAILS AVAILABLE	$15-100 based on wattage and type
NH - Liberty	LED parking/roadway	NO DETAILS AVAILABLE	NO DETAILS AVAILABLE	NO DETAILS AVAILABLE	NO DETAILS AVAILABLE	NO DETAILS AVAILABLE	NO DETAILS AVAILABLE
NY - ConEdison	Lighting (Muliple types)	Not researched	Not researched	Not researched	Not researched	Not researched	Not researched
NY - ConEdison	Lighting (Muliple types)	Not researched - Varies by lighting type	Not researched - Varies by lighting type	Not researched - Varies by lighting type	Not researched - Varies by lighting type	Not researched - Varies by lighting type	Not researched - Varies by lighting type
VT - Efficiency Vermont	Lighting (Muliple types)	15 years for most measures, but depends on fixture type	Selected from table of existing/baseline fixture types	Calculated based on table values for baseline and efficient fixture wattages and site-specific or tabulated hours of operation values.	Deemed, depending on fixture type	Deemed, depending on fixture type	Varies, based on fixture types
NH - Liberty	Lighting controls	10 years	No controls	Calculated	NO DETAILS AVAILABLE	NO DETAILS AVAILABLE	$25-50 based on wattage and type
NH - PSNH	Lighting controls	15 years	Current code efficiency	Calculated (based on fixture wattage and operating hours)	NO DETAILS AVAILABLE	NO DETAILS AVAILABLE	$25-50 based on wattage and type
NH - Unitil	Lighting controls	15 years	Current code efficiency	Calculated (based on fixture wattage and operating hours)	NO DETAILS AVAILABLE	NO DETAILS AVAILABLE	$25-50 based on wattage and type
NY - NGRID	Lighting Systems/Lighting Controls	No Normal Replacement Program	No Normal Replacement Program	No Normal Replacement Program	No Normal Replacement Program	No Normal Replacement Program	No Normal Replacement Program
MA - National Grid	Commercial Lighting Retrofit	15 years (10 years for Upstream programs), taken from: Energy & Resource Solutions (2005). Measure Life Study. Prepared for The Massachusetts Joint Utilities; Table 1-1 AND GDS Associates, Inc. (2007). Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures. Prepared for The New England State Program Working Group; Table 2	The baseline efficiency case is determined using assumed baseline wattages for each of the installed fixtures. Massachusetts Common Assumption: Baseline wattage per fixture type based on comparable code-compliant installations and standard practice.	Calculated using algorithm based on baseline and proposed fixture counts and wattages and hours of operation. If site-specific hours of operation are unavailable, default TRM hours based on facility type are used. Wattages by fixture type are tabulated in the TRM's appendix.			
MD - BGE	General Lighting (Lamp and Ballast Retrofits Commodity Fixtures Advanced Fixtures Fluorescent High Bay Fixtures Compact Fluorescent LED Exit Signs LED Strips LED Integral Replacement Lamps)	Varies by lighting measure	Not researched	Not researched	Not researched	Not researched	Not researched

NORMAL REPLACEMENTS INFORMATION							
State - PA	**Efficient Measure Description**	**EUL for Normal Replacements**	**Baseline Efficiency for Normal Replacements**	**Energy Savings for Normal Replacements**	**Baseline Cost for Normal Replacements**	**Efficient Equipment Cost for Normal Replacements**	**Rebates and Incentives for Normal Replacements**
CT - CL&P, UI, CNG, SCG, Yankeegas, Energize Connecticut	Lighting Retrofit	15 years, from GDS Associates Inc. Measure Life Report, Residential and Commercial Industrial Lighting and HVAC Measures, June 2007, Table 2.	Varies, based on fixture types	Varies, based on fixture types		Actual Project Costs	up to 75% of incremental costs
CO - Xcel Energy	Lighting Retrofit	Varies based on fixture type	Deemed based on proposed fixture type (normal replacements only offered for high-bay fluorescents, CFL pin fixtures, ceramic and pulse-start MH, and a few others, but not for low bay fluorescents	Calculated based on blended deemed baseline use and proposed fixture energy use and deemed hours based on facility type	Deemed, based on deemed baseline fixture type and contractor prices	Deemed, based on proposed fixture type and contractor prices	New cost minus baseline cost
MN - Xcel Energy	Lighting Retrofit	Varies based on fixture type	Deemed based on proposed fixture type (normal replacements only offered for high-bay fluorescents, CFL pin fixtures, ceramic and pulse-start MH, and a few others, but not for low bay fluorescents	Calculated based on blended deemed baseline use and proposed fixture energy use and deemed hours based on facility type	Deemed, based on deemed baseline fixture type and contractor prices	Deemed, based on proposed fixture type and contractor prices	New cost minus baseline cost
CT - CL&P, UI, CNG, SCG, Yankeegas, Energize Connecticut	Package Terminal Heat Pump	18 years, from GDS Associates Inc. Measure Life Report, Residential and Commercial Industrial Lighting and HVAC Measures, June 2007, Table 1.	COP = 3.2 - (0.026 * CAP * 0.001), EER = 12.3 - (0.213 * CAP * 0.001)	Calculated, based on EFLH heating, capacity (both cooling and heating), COP, cooling savings factor per ton, and EER			$150
CT - CL&P, UI, CNG, SCG, Yankeegas, Energize Connecticut	Refrigerator	12 years, from Appliance Magazine. U.S. Appliance Industry: Market Share, Life Expectancy & Replacement Market, and Saturation Levels. January 2010. Page 10.	Calculated from table of 2001 federal baseline standard equations that are based on adjusted volume. This is then multiplied by 0.8 to get to the 2008 ENERGY STAR level, which is the final new construction baseline. For existing homes, 0.85 is used in place of 0.8 to arrive at the 2004 ENERGY STAR level efficiency.	Calculated, based on annual energy use of the proposed unit subtracted from the annual baseline unit energy use, with a site/lab adjustment factor of 0.881 applied to the their difference. This factor comes from DOE test lab performance versus in situ refrigerator performance.			$50
VT - Efficiency Vermont	Refrigerator Replacement	17 years, no source provided	Minimum federal efficiency standard	Deemed, based on efficiency level of efficient refrigerator. 83.4 kWh for ENERGY STAR units, 104.2 kWh for CEE Tier 2, and 125.1 kWh for CEE Tier 3 units. Demand savings are: 0.0167 kW, 0.0208 kW, and 0.025 kW, respectively.	$490, based on review of data from the Northeast Regional ENERGY STAR Consumer Products Initiative; "2009 ENERGY STAR Appliances Practices Report", submitted by Lockheed Martin, December 2009. These calculated full costs ($700 for a baseline unit) are multiplied by the 70% size factor to account for the smaller units being installed in MF.	$539 for ENERGY STAR, CEE Tier 2 is $595, and CEE Tier 3 is $648, based on review of data from the Northeast Regional ENERGY STAR Consumer Products Initiative; "2009 ENERGY STAR Appliances Practices Report", submitted by Lockheed Martin, December 2009. The calculated full costs are multiplied by the 70% size factor to account for the smaller units being installed in MF.	$150-$250, depending on efficiency
VT - Efficiency Vermont	Refrigerator Replacement	12 years, From ENERGY STAR calculator: http://www.energystar.gov/ia/business/bulk_purchasing/bpsavings_calc/appliance_calculator.xlsx?e678-f5e6&e678-f5e6	Minimum federal efficiency standard	Deemed, based on efficiency level of efficient refrigerator. 83.4 kWh for ENERGY STAR units, 104.2 kWh for CEE Tier 2, and 125.1 kWh for CEE Tier 3 units. Demand savings are: 0.0167 kW, 0.0208 kW, and 0.025 kW, respectively.	$504, based on review of data from the Northeast Regional ENERGY STAR Consumer Products Initiative; "2009 ENERGY STAR Appliances Practices Report", submitted by Lockheed Martin, December 2009. See 2009 VT Appliance Data_TRMCostAnalysis.xlsfor data. ESTAR incremental cost reduced to $40 based on ENERGY STAR Calculator; http://www.energystar.gov/ia/business/bulk_purchasing/bpsavings_calc/appliance_calculator.xlsx?e678-f5e6&e678-f5e6 These calculated full costs ($740 for ENERGY STAR, $850 for CEE Tier 2, $930 for CEE Tier 3 and $700 for a baseline unit) are multiplied by the 72% size factor to account for the smaller units being installed in MF.	$533 for ENERGY STAR, CEE Tier 2 is $612, and CEE Tier 3 is $670, based on review of data from the Northeast Regional ENERGY STAR Consumer Products Initiative; "2009 ENERGY STAR Appliances Practices Report", submitted by Lockheed Martin, December 2009. See 2009 VT Appliance Data_TRMCostAnalysis.xlsfor data. ESTAR incremental cost reduced to $40 based on ENERGY STAR Calculator; http://www.energystar.gov/ia/business/bulk_purchasing/bpsavings_calc/appliance_calculator.xlsx?e678-f5e6&e678-f5e6 These calculated full costs ($740 for ENERGY STAR, $850 for CEE Tier 2, $930 for CEE Tier 3 and $700 for a baseline unit) are multiplied by the 72% size factor to account for the smaller units being installed in MF.	

NORMAL REPLACEMENTS INFORMATION							
State - PA	**Efficient Measure Description**	**EUL for Normal Replacements**	**Baseline Efficiency for Normal Replacements**	**Energy Savings for Normal Replacements**	**Baseline Cost for Normal Replacements**	**Efficient Equipment Cost for Normal Replacements**	**Rebates and Incentives for Normal Replacements**
Washington, D.C. - DC SEU	Refrigerator Retrofit	12 years, from ENERGY STAR calculator	2001 federal minimum standard	Deemed at 117 kWh for ENERGY STAR, 146 kWh for CEE Tier 2, based on data compiled by Efficiency Vermont that gives the average federal standard consumption for all units incentivized in their program. ENERGY STAR standards are 20% better than Federal Standard; CEE Tier 2 is 25% better.		$40 incremental cost	
MA - National Grid, NSTAR, Cape Light Compact, Unitil, WMECo, Columbia Gas, New England Gas, Blackstone Gas, Berkshire Gas	Refrigerator Retrofit/Replacement	12 yrs, from EPA study of Life Cycle Cost Estimate for ENERGY STAR Residential Refrigerator	Federal minimum standard	Deemed at 0.013 kW and 104 kWh for ENERGY STAR units, 0.019 kW and 154 kWh for Top Ten Refrigerators. Estimated using demand allocation methodology described in: Cadmus Demand Impact Model (2012) Prepared for Massachusetts Program Administrators and Environmental Protection Agency (2012) Refrigerators Qualified Product List. July 18, 2012. Average of all units in category.			30-75, depending on efficiency
MA - National Grid, NSTAR, Cape Light Compact, Unitil, WMECo, Columbia Gas, New England Gas, Blackstone Gas, Berkshire Gas	Refrigerator Retrofit/Replacement	12 yrs, from EPA study of Life Cycle Cost Estimate for ENERGY STAR Residential Refrigerator	Federal minimum standard	Deemed at 0.013 kW and 104 kWh for ENERGY STAR units, 0.019 kW and 154 kWh for Top Ten Refrigerators. Estimated using demand allocation methodology described in: Cadmus Demand Impact Model (2012) Prepared for Massachusetts Program Administrators and Environmental Protection Agency (2012) Refrigerators Qualified Product List. July 18, 2012. Average of all units in category.			30-75, depending on efficiency
MA - National Grid, NSTAR, Cape Light Compact, Unitil, WMECo, Columbia Gas, New England Gas, Blackstone Gas, Berkshire Gas	Refrigerators/Freezer Replacement	12 yrs, from EPA study of Life Cycle Cost Estimate for ENERGY STAR Residential Refrigerator	Federal minimum standard	Deemed at 0.013 kW and 104 kWh for ENERGY STAR units, 0.013 kW and 104 kWh for Top Ten Refrigerators. Estimated using demand allocation methodology described in: Cadmus Demand Impact Model (2012) Prepared for Massachusetts Program Administrators and Environmental Protection Agency (2012) Refrigerators Qualified Product List. July 18, 2012. Average of all units in category.		Low Income costs unknown, according to Kim Crossman	
NH - PSNH	Refrigerators/Freezer Replacement	12 years	Current code efficiency	Deemed (97 kWh per year)	NO DETAILS AVAILABLE	NO DETAILS AVAILABLE	$30
CO - Xcel Energy (Public Service Company of Colorado)	Refrigerator Replacement	13 yrs	Conventional (non-ENERGY STAR) new unit energy consumption from DOE and ENERGY STAR in 2008	Deemed at 93 kWh	ENERGY STAR refrigerator calculator baseline cost (conventional new unit: $1,070 in 2013)	ENERGY STAR refrigerator calculator new ENERGY STAR model cost ($1,100 in 2013)	$15 per unit
MN - Xcel Energy	Refrigerator Replacement	13 yrs	Conventional (non-ENERGY STAR) new unit energy consumption from DOE and ENERGY STAR in 2008	Deemed at 93 kWh	ENERGY STAR refrigerator calculator baseline cost (conventional new unit: $1,070 in 2013)	ENERGY STAR refrigerator calculator new ENERGY STAR model cost ($1,100 in 2013)	$15 per unit
CT - CL&P, UI, CNG, SCG, Yankeegas, Energize Connecticut	Room AC	9 years, from Appliance Magazine. U.S. Appliance Industry: Market Share, Life Expectancy & Replacement Market, and Saturation Levels. January 2010. Page 10.	2000 Federal Standard Efficiency, depending on whether it is a window or sleeve unit and depending on capacity. It ranges from 8.5 to 9.8 EER.	Calculated, based on capacity and EER of the proposed unit and a value of 272 EFLH, from LW Coincidence Factor Study: Room Air Conditioners, Prepared for: Northeast Energy Efficiency Partnerships' New England Evaluation and State Program Working Group, June 23, 2008, page iv.			
NH - PSNH	Room AC	20 years	Current code efficiency	Deemed (23 kWh per year)	NO DETAILS AVAILABLE	NO DETAILS AVAILABLE	NO DETAILS AVAILABLE
VT - Efficiency Vermont	Room AC	14 years					
Washington, D.C. - DC SEU	Room AC	9 years, from Measure Life Report, Residential and Commercial/Industrial Lighting and HVAC Measures, GDS Associates, June 2007. http://www.ctsavesenergy.org/files/Measure%20Life%20Report%202007.pdf					
Washington, D.C. - DC SEU	T12 Replacement	15 years, source unknown	Assumed, based on existing fixture type	Calculated, using an algorithm that depends on given hours of operation, HVAC interaction, in-service rates, and baseline and efficient fixture power consumption	Deemed value that varies, based on fixture type	Deemed value that varies, based on fixture type	

NORMAL REPLACEMENTS INFORMATION							
State - PA	**Efficient Measure Description**	**EUL for Normal Replacements**	**Baseline Efficiency for Normal Replacements**	**Energy Savings for Normal Replacements**	**Baseline Cost for Normal Replacements**	**Efficient Equipment Cost for Normal Replacements**	**Rebates and Incentives for Normal Replacements**
CO - Xcel Energy (Public Service Company of Colorado)	Upgrade Motors with Premium or Enhanced Efficiency (1% above premium) Motors, 1 hp - 500 hp	20 yrs	NEMA Premium	Calculated based on motor size, full load efficiency versus baseline, and quantity. Weighted average is 75 kWh	Varies based on motor size. Weighted average is $856	Varies based on motor size. Weighted average is $1,201	Ranges from $60 to $4,500 based on motor size, with a weighted average of $75
MN - Xcel Energy	Upgrade Motors with Premium or Enhanced Efficiency (1% above premium) Motors, 1 hp - 500 hp	20 yrs	NEMA Premium	Calculated based on motor size, application (pump, fan, commercial, industrial, etc.), full load efficiency versus baseline, and quantity. Weighted average is 439 kWh	Varies based on motor size. Weighted average is $2,434	Varies based on motor size. Weighted average is $3,467	Ranges from $30 to $2,250 based on motor size
NH - Liberty	VFD	15 years	Varies by equipment type	Calculated	NO DETAILS AVAILABLE	NO DETAILS AVAILABLE	$800-1,575 based on HP controlled by each VFD
NH - PSNH	VFD	15 years	Varies by equipment type	Calculated (based on HP)	NO DETAILS AVAILABLE	NO DETAILS AVAILABLE	$800-1,575 based on HP controlled by each VFD
NH - Unitil	VFD	15 years	Varies by equipment type	Calculated (based on HP)	NO DETAILS AVAILABLE	NO DETAILS AVAILABLE	$800-1,575 based on HP controlled by each VFD
CO - Xcel Energy	Factory-integrated VFDs on Air Compressors from 10 to 49 HP	20 yrs	New modulating or load/no-load air compressor without a VFD with 1 gal/cfm of storage	Calculated based on motor size, with assumptions for service factor, motor loading, hours of operation, EPAct motor efficiency, typical flow rates, and VFD efficiency. Weighted average is 19,659 kWh	$0 (Michaels has recommended that this be changed to a value based on motor size with a weighted average of $10,436. This data was available in their workbook, but not used)	Varies based on motor size. Weighted average is $5,140. However, this is really the incremental cost, since they reported $0 baseline cost, when the baseline cost should average $10,436, making the new cost $15, 576	Ranges from $1,000 to $4,000 based on motor size ($100/HP), with a weighted average of $2,245
MN - Xcel Energy	VFDs on Air Compressors from 10 to 40 HP	20 yrs	New modulating or load/no-load air compressor without a VFD with 3 gal/cfm of storage	Calculated based on motor size, with assumptions for service factor, motor loading, hours of operation, motor efficiency, typical flow rates, and VFD efficiency. Weighted average is 17,372 kWh	Varies based on motor size. Weighted average is $15,080	Varies based on motor size. Weighted average is $19,870	Ranges from $1,000 to $4,000 based on motor size ($100/HP)
MA - National Grid, NSTAR, Cape Light Compact, Unitil, WMECo, Columbia Gas, New England Gas, Blackstone Gas, Berkshire Gas	Window AC (Retrofit)	9 yrs, from EPA study of Life Cycle Cost Estimate for ENERGY STAR Room Air Conditioner	EER 9.8, which is federal standard	Deemed at 43 kWh, 0.123 kW			
MA - National Grid	Window AC Replacement	NA	NA	NA	NA	NA	NA
MN - Xcel Energy	Window AC Replacement	NA	NA	NA	NA	NA	NA

Appendix D: Study Measures – Eligibility Requirements for Early Replacement

ELIGIBILITY REQUIREMENTS FOR EARLY REPLACEMENT				
State - PA	**Efficient Measure Description**	**Old Equipment - Efficiency Requirement**	**Old Equipment - Age Requirement**	**Old Equipment - Other Requirements**
IL - Ameren	Air Source Heat Pump	SEER <=10	NONE	Cost of any repairs <$249 per ton
OH - Dayton Power & Light	Air-Source Heat-Pump	NONE	Less than 20 yrs if customer is applying for ER measure and equipment is non-functioning	Less than $1,000 repair cost if customer is applying for ER measure and equipment is non-functioning
CT - CL&P, UI, CNG, SCG, Yankeegas, Energize Connecticut	Boiler	NONE	NONE	Must be working, if found not to be working, it becomes a lost opportunity project
MA - National Grid, NSTAR, Cape Light Compact, Unitil, WMECo, Columbia Gas, New England Gas, Blackstone Gas, Berkshire Gas	Boiler	NONE	>=30 years	Must be functioning
MA - National Grid, NSTAR, Cape Light Compact, Unitil, WMECo, Columbia Gas, New England Gas, Blackstone Gas, Berkshire Gas	Boiler	NONE	>= 30 years	Must be functioning
NH - Liberty	Boiler	NONE	10 years	Non-condensing
NY - ConEdison	Boiler	NONE	NONE	Must be functioning.
IL - Ameren	Boiler	AFUE <=75%	NONE	Cost of any repairs <$709.
NH - PSNH	Boiler Circulating Pump	NONE	NONE	Contractor/owner must document that still operating
CT - CL&P, UI, CNG, SCG, Yankeegas, Energize Connecticut	Central AC	NONE	NONE	Must be working, if found not to be working, it becomes a lost opportunity project
NH - PSNH	Central AC	NONE	NONE	Contractor/owner must document that still operating
MA - National Grid, NSTAR, Cape Light Compact, Unitil, WMECo, Columbia Gas, New England Gas, Blackstone Gas, Berkshire Gas	Central AC or HP Early Replacement	NONE	NONE	Must be functioning
IL - Ameren	Central AC	SEER <=10	NONE	Cost of any repairs <$190 per ton
OH - Dayton Power & Light	Central AC -- Early replacement, New construction, and Replace on failure -- Multiple efficiency tiers	NONE	Less than 20 yrs if customer is applying for ER measure and equipment is non-functioning	Less than $1,000 repair cost if customer is applying for ER measure and equipment is non-functioning
AZ - Tucson Electric Power	Central AC or HP Early Retirement with Quality Install	<= 11 SEER	NONE	Contractors must attest that the equipment is operational and that any necessary repairs to improve performance would exceed $500. Random pre and post inspections will occur. Duct sealing is required unless the duct system tightness is <= 200 CFM @ 25 Pa after installation
CO - Xcel Energy (Public Service Company of Colorado)	Early Retirement AC	No higher than 12 SEER	New req't in 2014: Existing unit must be less than 2/3 of its EUL. Age of existing unit will be recorded to determine if it qualifies.	SEER information must be able to be determined from information on the condensing unit, unit must be operable or in need of repair of components to become operable.
NY - ConEdison	Chiller	NONE	NONE	Must be functioning.
CT - CL&P, UI, CNG, SCG, Yankeegas, Energize Connecticut	Clothes Washer	NONE	NONE	Must be working, if found not to be working, it becomes a lost opportunity project. It must be a top-loading unit. Front loading units do not qualify because according to the Engineering Analysis section of U.S. D.O.E. Energy Conservation Standards Rulemaking Framework Document for Residential Clothes Washers, August 21, 2009, "a survey of frontloading clothes washers in the CEC [California Energy Commission] appliance database shows that there are no frontloading washers with efficiencies at the existing Federal standards level, or, for that matter, any below the [January 2007] ENERGY STAR level (1.72 MEF/8.00 WF)." Therefore, if the existing unit is front-loading, the "retirement" portion may not be claimed
VT - Efficiency Vermont	Clothes Washer Retrofit	NONE	Must be made before 2004, must be over 8 years old	Must be functioning, customer must have electric DHW and electric dryer
VT - Efficiency Vermont	In-Unit Clothes Washer Retrofit	NONE	NONE, but it is assumed that average age is 11 years	Must be functioning
VT - Efficiency Vermont	Common Area Clothes Washer Retrofit	NONE	NONE, but it is assumed that average age is 11 years	Must be functioning
NY - NGRID	Compressed Air Systems	NONE	NONE	
CT - CL&P, UI, CNG, SCG, Yankeegas, Energize Connecticut	Custom	NONE	NONE	Varies, this is a custom measure
MA - National Grid	Custom	NONE	NONE	Must be functioning
MD - BGE	Varies based on project	NONE	NONE	User confirms that equipment is functioning and near end of useful life. See Other Information for more details.
NH - Liberty	Custom	NONE	NONE	Contractor/owner must document that still operating
NH - PSNH	Custom	NONE	NONE	Contractor/owner must document that still operating
NH - Unitil	Custom	NONE	NONE	Contractor/owner must document that still operating
NY - NGRID	Custom measures	NONE	NONE	User has to capture age of existing equipment
MT - NorthWestern Energy	Custom measures	Operational, or could operational w/ repairs	NONE	RUL confirmed in the field
CT - CL&P, UI, CNG, SCG, Yankeegas, Energize Connecticut	Dehumidifier	NONE	NONE	Must be functional. Capacity, energy factor, and make and model of the existing unit are recorded on site.
MA - Cape Light Compact	Dehumidifiers (Early Retirement)	NONE	NONE	Must be functioning
CT - CL&P, UI, CNG, SCG, Yankeegas, Energize Connecticut	Dishwasher	NONE	NONE	Must be working, if found not to be working, it becomes a lost opportunity project. Brand and model of the existing unit is verified on site.

ELIGIBILITY REQUIREMENTS FOR EARLY REPLACEMENT				
State - PA	**Efficient Measure Description**	**Old Equipment - Efficiency Requirement**	**Old Equipment - Age Requirement**	**Old Equipment - Other Requirements**
NH - Liberty	Electronically Commutated (EC) Motors	NONE	NONE	Contractor/owner must document that still operating
NH - PSNH	Electronically Commutated (EC) Motors	NONE	NONE	Contractor/owner must document that still operating
NH - Unitil	Electronically Commutated (EC) Motors	NONE	NONE	Contractor/owner must document that still operating
NY - ConEdison	Electronically Commutated (EC) Motors	NONE	NONE	Equipment must be operating, as determined in field by implementation contractors.
NH - PSNH	Fixtures	NONE	NONE	Contractor/owner must document that still operating
NH - Unitil	Fixtures	NONE	NONE	Contractor/owner must document that still operating
NH - Liberty	Fluorescent fixtures	NONE	NONE	Must meet minimum wattage reduction requirements
NH - PSNH	Fluorescent	NONE	NONE	Contractor/owner must document that still operating
NH - Unitil	Fluorescent	NONE	NONE	Contractor/owner must document that still operating
CT - CL&P, UI, CNG, SCG, Yankeegas, Energize Connecticut	Freezer Replacement	NONE	NONE	Must be greater than 7.75 cu ft., must be functional. Existing unit energy consumption, total volume, year of manufacture, category (upright, chest, etc.), and brand and model are recorded on-site.
VT - Efficiency Vermont	Freezer Replacement	NONE	Must be made before 2001	Must be functioning
VT - Efficiency Vermont	Freezer Replacement	NONE	Must be made before 2001	Must be functioning
MA - National Grid, NSTAR, Cape Light Compact, Unitil, WMECo, Columbia Gas, New England Gas, Blackstone Gas, Berkshire Gas	Freezer Retrofit/Replacement	NONE	NONE	Must be functioning
MN - Xcel Energy	Freezer Replacement	NONE	NONE	Must be working and customer must meet income requirements
CT - CL&P, UI, CNG, SCG, Yankeegas, Energize Connecticut	Furnace	NONE	NONE	Must be working, if found not to be working, it becomes a lost opportunity project
NY - ConEdison	Furnace	Must be functioning.	NONE	NONE
NH - PSNH	Furnace Fan	NONE	NONE	Contractor/owner must document that still operating
NH - PSNH	Furnace w/ ECM Motor	NONE	NONE	Contractor/owner must document that still operating
IL - Ameren	Furnace	AFUE <=75%	NONE	Cost of any repairs <$528.
OR - Energy Trust of Oregon	Furnace	80-90% efficiency 65 - 78 AFUE based on Fed Standard	Avg. Age = 21 years - IS maximum measure lifetime of 70 years	
IL - Ameren	Ground Source Heat Pump	SEER <=10	NONE	Cost of any repairs <$249 per ton
OH - Dayton Power & Light	Ground Source Heat Pump	NONE	Less than 20 yrs if customer is applying for ER measure and equipment is non-functioning	Less than $1,000 repair cost if customer is applying for ER measure and equipment is non-functioning
NH - PSNH	Hardwired CFL	NONE	NONE	Contractor/owner must document that still operating
NH - Unitil	Hardwired CFL	NONE	NONE	Contractor/owner must document that still operating
MA - National Grid, NSTAR, Cape Light Compact, Unitil, WMECo, Columbia Gas, New England Gas, Blackstone Gas, Berkshire Gas	Heating System Replacement	NONE	NONE	Must be functioning
NH - PSNH	HID Lighting	NONE	NONE	Contractor/owner must document that still operating
NH - Unitil	HID Lighting	NONE	NONE	Contractor/owner must document that still operating
NH - Liberty	High efficiency air compressor	None	NONE	Must use modulating control
NH - PSNH	High efficiency air compressor	NONE	NONE	Contractor/owner must document that still operating
NH - Unitil	High efficiency air compressor	NONE	NONE	Contractor/owner must document that still operating
VT - Efficiency Vermont	High Performance T8 Fixtures Re-lamp, Re-ballast	Must be one of the options in the lighting wattage table (1-4 lamp T8 or T12 fixture)	NONE	NONE
NH - PSNH	LED & LEC Exit Light	NONE	NONE	Contractor/owner must document that still operating
NH - Unitil	LED & LEC Exit Light	NONE	NONE	Contractor/owner must document that still operating
NH - Liberty	LED lighting	NONE	NONE	Must meet minimum wattage reduction requirements
NH - Liberty	LED parking/roadway	NONE	NONE	Contractor/owner must document that still operating
NY - ConEdison	Lighting (Muliple types)	NONE	NONE	Lights must be functioning, as determined in field by implementation contractors.
NY - ConEdison	Lighting (Muliple types)	Must be functioning.	NONE	NONE
VT - Efficiency Vermont	Lighting (Muliple types)	Must be one of the options in the lighting wattage table	NONE	NONE
NH - Liberty	Lighting controls	NONE	NONE	Contractor/owner must document that still operating
NH - PSNH	Lighting controls	NONE	NONE	Contractor/owner must document that still operating
NH - Unitil	Lighting controls	NONE	NONE	Contractor/owner must document that still operating
NY - NGRID	Lighting Systems/Lighting Controls	NONE	NONE	
MA - National Grid	Commercial Lighting Retrofit	NONE	NONE	Must be functioning
MD - BGE	General Lighting (Lamp and Ballast Retrofits Commodity Fixtures Advanced Fixtures Fluorescent High Bay Fixtures Compact Fluorescent LED Exit Signs LED Strips LED Integral Replacement Lamps)	NONE	NONE	LED replacement lamps and LED luminaires must be listed on the Design Lights Consortium or ENERGY STAR Qualified Products list. Only retrofit lighting applications with incentives less than $5000 do not require pre-approval.

ELIGIBILITY REQUIREMENTS FOR EARLY REPLACEMENT				
State - PA	**Efficient Measure Description**	**Old Equipment - Efficiency Requirement**	**Old Equipment - Age Requirement**	**Old Equipment - Other Requirements**
CT - CL&P, UI, CNG, SCG, Yankeegas, Energize Connecticut	Lighting Retrofit	NONE	NONE	None
CO - Xcel Energy	Lighting Retrofit	NONE	NONE	None
MN - Xcel Energy	Lighting Retrofit	NONE	NONE	None
CT - CL&P, UI, CNG, SCG, Yankeegas, Energize Connecticut	Package Terminal Heat Pump	NONE	NONE	Must be working, if found not to be working, it becomes a lost opportunity project
CT - CL&P, UI, CNG, SCG, Yankeegas, Energize Connecticut	Refrigerator	NONE	NONE	Must be greater than 7.75 cu ft., must be functional. Existing unit energy consumption, total volume, year of manufacture, category (top freezer, side freezer, etc.), and brand and model are recorded on-site.
VT - Efficiency Vermont	Refrigerator Replacement	NONE	Must be made before 2001	Must be functioning
VT - Efficiency Vermont	Refrigerator Replacement	NONE	Must be made before 2001	Must be functioning
Washington, D.C. - DC SEU	Refrigerator Retrofit	NONE	Must be manufactured before 1993	Must be functional
MA - National Grid, NSTAR, Cape Light Compact, Unitil, WMECo, Columbia Gas, New England Gas, Blackstone Gas, Berkshire Gas	Refrigerator Retrofit/Replacement	NONE	NONE	Must be functioning
MA - National Grid, NSTAR, Cape Light Compact, Unitil, WMECo, Columbia Gas, New England Gas, Blackstone Gas, Berkshire Gas	Refrigerator Retrofit/Replacement	NONE	NONE	Must be functioning
MA - National Grid, NSTAR, Cape Light Compact, Unitil, WMECo, Columbia Gas, New England Gas, Blackstone Gas, Berkshire Gas	Refrigerators/Freezer Replacement	NONE	NONE	Must be functioning
NH - PSNH	Refrigerators/Freezer Replacement	NONE	NONE	Contractor/owner must document that still operating
CO - Xcel Energy (Public Service Company of Colorado)	Refrigerator Replacement	NONE	NONE	Must be working and customer must meet income requirements
MN - Xcel Energy	Refrigerator Replacement	NONE	NONE	Must be working and customer must meet income requirements
CT - CL&P, UI, CNG, SCG, Yankeegas, Energize Connecticut	Room AC	NONE	NONE	Must be working, if found not to be working, it becomes a lost opportunity project
NH - PSNH	Room AC	NONE	NONE	Contractor/owner must document that still operating
VT - Efficiency Vermont	Room AC	NONE	NONE, but units over 10 years old are targeted	Must be functioning
Washington, D.C. - DC SEU	Room AC	NONE	NONE	Must be functional
Washington, D.C. - DC SEU	T12 Replacement	T12 Fixture	NONE	Must be functional, must be replaced with HPT8 28 W lamps with low ballast factor. Facility must have between 20 and 200 T12 fixtures per utility account. Fixture must be operated at least 2000 hours per year
CO - Xcel Energy (Public Service Company of Colorado)	Upgrade Motors with Premium or Enhanced Efficiency (1% above premium) Motors, 1 hp - 500 hp	US EPAct (1992)	NONE	new motor must be same size or smaller or else it reverts to normal replacement rebate, old motor must be scrapped, rewound or repaired motors do not qualify
MN - Xcel Energy	Upgrade Motors with Premium or Enhanced Efficiency (1% above premium) Motors, 1 hp - 500 hp	US EPAct (1992)	NONE	new motor must be same size or smaller or else it reverts to normal replacement rebate, old motor must be scrapped, rewound or repaired motors do not qualify, old motor must be functional
NH - Liberty	VFD	NONE	NONE	Must demonstrate significant load diversity
NH - PSNH	VFD	NONE	NONE	Must demonstrate significant load diversity
NH - Unitil	VFD	NONE	NONE	Must demonstrate significant load diversity
CO - Xcel Energy	Factory-integrated VFDs on Air Compressors from 10 to 49 HP	No VFD	NONE	An existing load/unload (online/offline) compressor with less than two (2) gallons of wet storage receiver per CFM of capacity (compressor rating), or an existing inlet modulation compressor with or without blowdown control which is replaced with a compressor that has a factory installed/assembled motor and VFD/ASD combination is eligible for a rebate. Compressor with VFD must have equal or fewer horsepower.
MN - Xcel Energy	VFDs on Air Compressors from 10 to 40 HP	No VFD	NONE	Cannot be a backup compressor, must be a single rotary screw compressor less than 50 HP serving on a common header; An existing load/unload (online/offline) compressor with less than two (2) gallons of wet storage receiver per CFM of capacity (compressor rating), or an existing inlet modulation with or without blowdown control which is replaced with an integrated rotary screw compressor that has a factory installed/assembled motor and VFD/ASD combination is eligible for a rebate. Compressor with VFD must have equal horsepower.
MA - National Grid, NSTAR, Cape Light Compact, Unitil, WMECo, Columbia Gas, New England Gas, Blackstone Gas, Berkshire Gas	Window AC (Retrofit)	NONE	NONE	Must be functioning
MA - National Grid	Window AC Replacement	NONE	NONE	Must be functioning, must be used during peak periods
MN - Xcel Energy	Window AC Replacement	NONE	NONE	Customer must meet income requirements

Appendix E: Study Measures – Early Replacement Savings Methods

EARLY REPLACEMENT SAVINGS METHODS											
State - PA	**Efficient Measure Description**	**Early Replacement Savings**	**Early Replacement Rebates and Incentives**	**Dual Baselines Used?**	**Savings Calculations - Other Method Description**	**RUL?**	**RUL from Study/Field**	**Type of RUL (single baseline)**	**Old Equipment - Remaining Useful Life (RUL)**	**Old Equipment - Efficiency for Savings Calcs**	**Assumed Efficiency after RUL (if Dual Baselines)**
IL - Ameren	Air Source Heat Pump	Calculated (based on SEER, EER, HSPF and Climate Zone); Avg per-unit savings of 5,907 kWh	SEER 14.5-14.9 $450; SEER 15.0-15.9 $500; SEER 16+ 600	Yes	DUAL BASELINE - Savings are calculated between existing unit and efficient unit consumption during the remaining life of the existing unit, and between new baseline unit and efficient unit consumption for the remainder of the measure life.	Y			RUL=6 years (Assumed to be one third of EUL. EUL in turn is based on 2007 GDS Associates "Measure Life Report, Residential and Commercial/Industrial Lighting and HVAC Measures" study)	Determined from application info	Future federal efficiency standard
OH - Dayton Power & Light	Air-Source Heat-Pump	Identified through annual review of customer billing data, program tracking data, draft Ohio TRM algorithms and assumptions, and primary and secondary data.	SEER 14-15 $400 SEER 16+ $600	Yes		Y			5 yrs	Actual-from program tracking data	Minimum federal efficiency level standards
CT - CL&P, UI, CNG, SCG, Yankeegas, Energize Connecticut	Boiler	Calculated, based on heated area, heating load factor (based on home age), and the deemed value of the AFUE of the existing boiler (based on boiler age)	$1,000	Yes	The same algorithm is used for normal and early replacement. Only the AFUE values are changed. The existing boiler AFUE is determined from the boiler's age and deemed values from the PSD. These efficiency values come from: ENERGY STAR Microsoft Excel tool, "Life Cycle Cost Estimate for an ENERGY STAR Residential Furnace," http://www.energystar.gov/ia/business/bulk_purchasing/bpsavings_calc/Calc_Furnaces.xls, last updated July, 2009, last accessed August 6, 2012. The fossil fuel savings for this measure are calculated using the same methodology as the ENERGY STAR Boiler calculator, which is located on the ENERGY STAR Website. The calculator uses the home's year of construction, location, and area to determine the home's annual heating load. The age of the boiler is used to determine the efficiency.	Y			5 years, no source	Deemed, based on boiler age	Same as normal replacement (80%)
MA - National Grid, NSTAR, Cape Light Compact, Unitil, WMECo, Columbia Gas, New England Gas, Blackstone Gas, Berkshire Gas	Boiler	Deemed at 23.6 + 10.4 = 34 MMBTU for forced hot water, 43.9 + 3.5 = 47.4 MMBTU for steam. The first number for each is the savings for the RUL of the existing boiler. The second value is the savings for the efficient new boiler over baseline for the EUL-RUL (10 years) of the new boiler.	1900	Yes	Deemed values based on two different sources of information: #1: The Cadmus Group, Inc. (2012) Memo to HEHE Program Administrators Re: Impacts of Upcoming Federal Standards on HEHE Gas Space and Water Heating Measures; June 8, 2012 #2: GDS Associates, Inc. (2009). Natural Gas Energy Efficiency Potential in Massachusetts. Prepared for GasNetworks Savings are based on old equipment efficiency and code baseline for RUL of existing boiler and code baseline and AFUE values of 93% for forced hot water and 82% for steam for the new boiler's EUL	Y			10 yrs, based on agreed-upon value with EEAC consultants for the purpose of counting savings and adjusting costs	Assumed at 65% AFUE for forced hot water boilers, 55% for steam boilers, based on estimated efficiency of a 30 year old boiler	AFUE of 80% for steam, 82% for forced hot water, based on code
MA - National Grid, NSTAR, Cape Light Compact, Unitil, WMECo, Columbia Gas, New England Gas, Blackstone Gas, Berkshire Gas	Boiler	Deemed at 25.4, 26.3, 24, 26.3 MMBtu for Oil Forced Hot Water, Oil Steam, Propane Forced Hot Water, and Propane Steam boilers for the early retirement portion of the measure and 8.5, 3.5, 16, 3.5 MMBtu for the rest of the life of the new unit after the RUL of the existing unit. The total savings is the sum of the two corresponding values for each boiler type. (RUL (10 years) for new unit versus existing unit, then EUL-RUL (10 years) for new unit vs. baseline unit)	1750 for oil forced hot water, 3500 for propane	Yes	Savings calculated using information from *Natural Gas Energy Efficiency Potential in Massachusetts* by GDS Associates in 2009. For the first 10 years (RUL), the baseline is 65% efficiency and the efficient case is 80% efficiency. After RUL, the baseline efficiency is 80% and the efficient case is 82% for steam boilers, 85% for forced hot water oil boilers, and 90% for forced hot water propane boilers	Y			10 yrs, from agreed-upon value from EEAC consultants	Assumed to be 65% AFUE	Code-compliant AFUE 80% boiler

EARLY REPLACEMENT SAVINGS METHODS											
State - PA	**Efficient Measure Description**	**Early Replacement Savings**	**Early Replacement Rebates and Incentives**	**Dual Baselines Used?**	**Savings Calculations - Other Method Description**	**RUL?**	**RUL from Study/Field**	**Type of RUL (single baseline)**	**Old Equipment - Remaining Useful Life (RUL)**	**Old Equipment - Efficiency for Savings Calcs**	**Assumed Efficiency after RUL (if Dual Baselines)**
NH - Liberty	Boiler	Deemed at 39.96 MMBtu (Forced Hot Water); deemed at 47.4 MMBtu (Steam)	Forced hot water: 50% of cost, up to $3,000. Steam: 50% of cost, up to $1,900.	Yes	Savings are calculated between existing unit and efficient unit consumption during the remaining life of the existing unit, and between new baseline unit and efficient unit consumption for the remainder of the measure life.	Y			RUL = 10 years. Measure life of new equipment = 20 years.	80% AFUE forced hot water; 75% for steam	93% AFUE forced hot water; 82% for steam
NY - ConEdison	Boiler	Calculated using exising equipment baseline for RUL, then state code for remainder of EUL	ranges based on measures (https://www.conedci.com/HVAC.aspx)	Yes	Dual basline method, overall savings calculated using ratios in Appendix M.	Y	Field		RUL calculated with some type of documented age of existing equipment	Name plate info used; verifyed during pre inspection	Existing efficiency code
IL - Ameren	Boiler	Calculated (based on boiler/furnace load and Climate Zone); Avg ex-ante per-unit savings of 539 Therms	AFUE 90%+ $800 AFUE 95%+ $1000	Yes	Savings are calculated between existing unit and efficient unit consumption during the remaining life of the existing unit, and between new baseline unit and efficient unit consumption for the remainder of the measure life.	Y			RUL=8 years (Assumed to be one third of EUL. EUL in turn is based on the technical support documents for federal residential appliance standards)	Determined from application info	Future federal efficiency standard
NH - PSNH	Boiler Circulating Pump	Deemed at 9 kWh/year	NO DETAILS AVAILABLE	No	NO DETAILS AVAILABLE	N		EUL	20 years	NO DETAILS AVAILABLE	
CT - CL&P, UI, CNG, SCG, Yankeegas, Energize Connecticut	Central AC	Calculated, based on capacity and EER of the new unit, EER of the existing unit (if available), and the 357.6 kWh/year/ton savings factor used for normal replacements.	$500	Yes	If the existing unit efficiency is unknown, it is assumed to be 8 EER and the EER portion of the calculation can be combined with the savings factor to 97.53 kWh/ton. The same algorithm is used for both normal replacement and early retirement, but the baseline EER changes from the existing unit EER to the federal baseline EER after the RUL of the existing unit.	Y			5 years, no source	Observed on-site. If unknown, assumed to be 8 EER, based on average installed efficiency for an approximately 15 year old unit. ASHRAE/IESNA Standard 90.1-1999 Table 6.2.1A has a minimum requirement of 10 SEER for 2011. Note: Units of that vintage were only rated on SEER. EER is approximately 80% of SEER (Ref [1], page ES-1 gives the ratio 11 EER / 14 SEER). 8 EER is used as the estimated existing efficiency.	11 EER, same as normal replacement
NH - PSNH	Central AC	Deemed at 77 kWh/year	NO DETAILS AVAILABLE	No	NO DETAILS AVAILABLE	N		EUL	20 years	NO DETAILS AVAILABLE	
MA - National Grid, NSTAR, Cape Light Compact, Unitil, WMECo, Columbia Gas, New England Gas, Blackstone Gas, Berkshire Gas	Central AC or HP Early Replacement	Deemed at 299 kWh and 0.963 kW for AC for the RUL of the existing unit with 103 kWh and 0.273 kW for the next 11 years, 786 kWh and 0.963 kW summer, 0.406 kW winter for heat pumps for RUL, 519 kWh, 0.273 kW summer, 0.347 kW winter for the next 11 years.	850	Yes	Savings based on SEER 10, EER 8.5, HSPF 7 baseline for RUL of existing unit and then baseline becomes SEER 13, EER 11, HSPF 7.6 for EUL of new AC or heat pump unit (with efficient case being SEER 14.5, EER 12, 8.2 HSPF). 1200 heating EFLH and 360 cooling EFLH are used for all calculations	Y			7 yrs, found by subtracting the assumed age of the existing equipment (10-12 years) from the EUL of new AC units (18 years) to get 18-11=7 years.	SEER 10, EER 8.5, HSPF 7	SEER 13, EER 11, HSPF 7.6
IL - Ameren	Central AC	Calculated (based on SEER, EER and Climate Zone); Avg ex-ante per-unit savings of 1,235 kWh	SEER 14.5-14.9 $450; SEER 15.0-15.9 $500; SEER 16+ 500	Yes	Savings are calculated between existing unit and efficient unit consumption during the remaining life of the existing unit, and between new baseline unit and efficient unit consumption for the remainder of the measure life.	Y			RUL=6 years (Assumed to be one third of EUL. EUL in turn is based on 2007 GDS Associates "Measure Life Report, Residential and Commercial/Industrial Lighting and HVAC Measures" study)	Determined from application info	Future federal efficiency standard
OH - Dayton Power & Light	Central AC -- Early replacement, New construction, and Replace on failure -- Multiple efficiency tiers	Identified through annual review of customer billing data, program tracking data, draft Ohio TRM algorithms and assumptions, and primary and secondary data.	SEER 14-15 $200 SEER 16+ $300	Yes, for ER measures		Y			5 yrs	Actual-from program tracking data	Minimum federal efficiency level standards

EARLY REPLACEMENT SAVINGS METHODS											
State - PA	**Efficient Measure Description**	**Early Replacement Savings**	**Early Replacement Rebates and Incentives**	**Dual Baselines Used?**	**Savings Calculations - Other Method Description**	**RUL?**	**RUL from Study/Field**	**Type of RUL (single baseline)**	**Old Equipment - Remaining Useful Life (RUL)**	**Old Equipment - Efficiency for Savings Calcs**	**Assumed Efficiency after RUL (if Dual Baselines)**
AZ - Tucson Electric Power	Central AC or HP Early Retirement with Quality Install	Deemed, based on energy simulation results. Split-system HP with QI is 2220 kWh, Packaged HP with QI is 2011 kWh, Split-system A/C with QI is 1505 kWh, and Packaged A/C with QI is 1375 kWh. HP savings values include heating savings in addition to cooling savings	Variable, up to $1,450 for performance duct sealing (measured pre- and post-project) with ER, Quality Install, and downsizing. The early replacement alone is $850, with downsizing ($150) and duct sealing (up to $450) adding onto that rebate	Yes	An energy simulation is completed for a 1,750 sq. ft. home, which is the average size air-conditioned home in the TEP service territory. A 4 ton unit is assumed.	Y			5 years, based on the expected useful life for 50% of the units for that vintage or older minus the average age for the time period.	For the remaining useful life (RUL) of the existing system, an appropriate SEER for a 15-year-old packaged or split-system air conditioner or heat pump without QI, Manual J sizing and duct sealing is assumed. It is assumed that the existing unit has a SEER of 10 right now. A 5% derating factor is also applied to account for wear on the unit reducing efficiency. The estimated SEER is based on the federal minimum for the assigned vintage: Before 1992 = 8 SEER, 1992-2005 = 10SEER, 2005 on = 13 SEER	After the RUL, a code-compliant 13 SEER unit is assumed without duct sealing.
CO - Xcel Energy (Public Service Company of Colorado)	Early Retirement AC	Deemed at these values for SEER values of 14, 14.5, 15, and 16: 1,230, 1,275, 1,317, 1,393 kWh	$600, $850, $950, $1,100 for SEER range described in column R	No	Full load cooling hours and house cooling loads are determined from an energy simulation. These are then used with the appropriate efficiencies to calculate the energy savings without quality installation. The quality installation savings are determined by accounting for a reduction in various system losses such as duct leakage, refrigerant over-charging, etc. and applying those savings to the total HVAC system operation. Existing unit is assumed to have a SEER of 10. All units are assumed to have 3 tons of capacity.	Y		RUL	7 yrs, which is the value used for all quality installation measures, including normal replacements. It is simply 50% of the new unit EUL.	10 SEER	NA
NY - ConEdison	Chiller	Calculated using exising equipment baseline for RUL, then state code for remainder of EUL	ranges based on measures (https://www.conedci.com/HVAC.aspx)	Yes	Dual basline method, overall savings calculated using ratios in Appendix M.	Y	Field		RUL calculated with some type of documented age of existing equipment	Name plate info used; verifyed during pre inspection	Existing efficiency code
CT - CL&P, UI, CNG, SCG, Yankeegas, Energize Connecticut	Clothes Washer	Calculated using algorithms based on the existing unit capacity.		Yes	Based on ENERGY STAR Clothes Washer calculations and assumptions. Uses algorithms that are only a function of washer capacity once all other assumptions have been accounted for. Uses normal replacement savings after RUL of existing washer and early replacement savings for RUL of existing washer.	Y			4 years, no source	Observed on-site. If not available, MEF of 1.26 and WF of 9.5 are assumed, from 2010 Federal Standard. Taken from: Federal Register Part III, DOE Energy Conservation Program: Energy Conservation standards for Residential Water Heaters, Direct Heating Equipment, Pool Heater; (Final Rule, Table I.2). April 16, 2010.	Same as normal replacement
VT - Efficiency Vermont	Clothes Washer Retrofit	Deemed based on a set of assumptions and the efficiency level of the new unit. Includes dryer energy savings (electric), water heater energy savings (electric), water savings, and washer savings (electric). Calculations based on MEF and WF values of existing, baseline, and new units		Yes	Savings are calculated between the average energy usage of an existing unit and that of an efficient new unit for the remaining life of the existing unit, plus the savings between an average baseline unit and that of a efficient unit for the remainder of the measure life. Energy and water savings estimates are based on the weighted average MEF factor for qualifying models based on the models rebated during the previous calendar year, except Top Ten which is based upon averaging the units provided on the website (http://www.toptenusa.org/Top-Ten-Clothes-Washers) as of September 2012. It is assumed that there are 322 operating hours and cycles/year.	Y			3 years, based on the assumption that the existing unit is 11 years old and EUL of a new unit is 14 years.	Average of MEF values from pre-2004 federal baseline (0.817) and the average value of MEF from units tested in a 2001 DOE market assessment (1.164). The existing unit WF value comes from US DOE, Life Cycle Cost Model, spreadsheet dated December 1999 (http://www1.eere.energy.gov/buildings/appliance_standards/residential/docs/lcc_spreadsheet.xls), indicates 38.61 gallons of water per cycle. Assume average size of 3 cu ft gives 12.87 WF assumption. http://www1.eere.energy.gov/buildings/appliance_standards/residential/docs/lcc_spreadsheet.xls	Federal baseline MEF and WF values. The current baseline of 1.26 MEF is inflated to 1.51 (20%) to account for a transforming market. The federal baseline for WF is 7.93.

EARLY REPLACEMENT SAVINGS METHODS											
State - PA	**Efficient Measure Description**	**Early Replacement Savings**	**Early Replacement Rebates and Incentives**	**Dual Baselines Used?**	**Savings Calculations - Other Method Description**	**RUL?**	**RUL from Study/Field**	**Type of RUL (single baseline)**	**Old Equipment - Remaining Useful Life (RUL)**	**Old Equipment - Efficiency for Savings Calcs**	**Assumed Efficiency after RUL (if Dual Baselines)**
VT - Efficiency Vermont	In-Unit Clothes Washer Retrofit	Deemed based on a set of assumptions. Includes dryer energy savings (gas or electric), water heater energy savings (gas or electric), water savings, and washer savings (electric). Calculations based on MEF and WF values of existing, baseline, and new units		Yes	Energy and water savings estimates are based on the weighted average MEF factor for qualifying models based on the models rebated during the previous calendar year, except Top Ten which is based upon averaging the units provided on the website (http://www.toptenusa.org/Top-Ten-Clothes-Washers) as of September 2012. It is assumed that there are 265 operating hours and cycles/apartment/year. Savings are based on this algorithm: number of apartments x deemed kWh saved / number of clothes washers.	Y			3 years, based on the assumption that the existing unit is 11 years old and EUL of a new unit is 14 years.	Average of MEF values from pre-2004 federal baseline (0.817) and the average value of MEF from units tested in a 2001 DOE market assessment (1.164). The existing unit WF value comes from US DOE, Life Cycle Cost Model, spreadsheet dated December 1999 (http://www1.eere.energy.gov/buildings/appliance_standards/residential/docs/lcc_spreadsheet.xls), indicates 38.61 gallons of water per cycle. Assume average size of 3 cu ft gives 12.87 WF assumption. http://www1.eere.energy.gov/buildings/appliance_standards/residential/docs/lcc_spreadsheet.xls	Federal baseline MEF and WF values. The current baseline of 1.26 MEF is inflated to 1.51 (20%) to account for a transforming market. The federal baseline for WF is 7.93.
VT - Efficiency Vermont	Common Area Clothes Washer Retrofit	Deemed based on a set of assumptions. Includes dryer energy savings (gas or electric), water heater energy savings (gas or electric), water savings, and washer savings (electric). Calculations based on MEF and WF values of existing, baseline, and new units		Yes	Energy and water savings estimates are based on the weighted average MEF factor for qualifying models based on the models rebated during the previous calendar year, except Top Ten which is based upon averaging the units provided on the website (http://www.toptenusa.org/Top-Ten-Clothes-Washers) as of September 2012. It is assumed that there are 265 operating hours and cycles/apartment/year. Savings are based on this algorithm: number of apartments x deemed kWh saved / number of clothes washers.	Y			3 years, based on the assumption that the existing unit is 11 years old and EUL of a new unit is 14 years.	Average of MEF values from pre-2004 federal baseline (0.817) and the average value of MEF from units tested in a 2001 DOE market assessment (1.164). The existing unit WF value comes from US DOE, Life Cycle Cost Model, spreadsheet dated December 1999 (http://www1.eere.energy.gov/buildings/appliance_standards/residential/docs/lcc_spreadsheet.xls), indicates 38.61 gallons of water per cycle. Assume average size of 3 cu ft gives 12.87 WF assumption. http://www1.eere.energy.gov/buildings/appliance_standards/residential/docs/lcc_spreadsheet.xls	Federal baseline MEF and WF values. The current baseline of 1.26 MEF is inflated to 1.51 (20%) to account for a transforming market. The federal baseline for WF is 7.93.
NY - NGRID	Compressed Air Systems	Calculated based on existing equipment vs. new equipment. TRM outlines savings	ranges from $180 to $280 based on measure	NO* Dual baseline method from Appendix M used to "pre-screen" prescriptive measures. Not used in actual ER	Savings calculated based on existing equipment as baseline; difference between tech manual efficiency and existing equipment. "savings you claim are 1st year annual savings in full"	Y	Field	RUL	EUL from tech manual - age of old equipment	user supplied; inspected by NGRID representative	
CT - CL&P, UI, CNG, SCG, Yankeegas, Energize Connecticut	Custom	Varies, this is a custom measure		Yes	This custom measure allows for early retirement savings calculations and dual baselines, if applicable.	Y				Varies, this is a custom measure	Varies, this is a custom measure
MA - National Grid	Custom	Varies	Calculated to be 50% of the total cost of the new equipment including labor	No	Based on comparing efficiency of the existing equipment to the new equipment for the entire adjusted lifetime. The adjusted EUL is lower than the normal replacement EUL by a small amount to account for the reduced lifetime of the existing equipment	Y		Blended	RUL is not used, but an adjusted EUL is used instead. This value is slightly lower than the normal replacement EUL. For example, the lighting ER lifetime is 13 years instead of 15 years for normal replacement	Varies but is based on the efficiency of the existing equipment without any adjustment	

EARLY REPLACEMENT SAVINGS METHODS											
State - PA	**Efficient Measure Description**	**Early Replacement Savings**	**Early Replacement Rebates and Incentives**	**Dual Baselines Used?**	**Savings Calculations - Other Method Description**	**RUL?**	**RUL from Study/Field**	**Type of RUL (single baseline)**	**Old Equipment - Remaining Useful Life (RUL)**	**Old Equipment - Efficiency for Savings Calcs**	**Assumed Efficiency after RUL (if Dual Baselines)**
MD - BGE	Varies based on project	Calculated using dual baselines	Incentives can cover up to 50% of the total cost for retrofit projects	YES	Savings calculated using dual baseline; existing equipment for RUL, then code baseline after RUL expires	Y	Field		Generally between 2-5 years; determined by asking the user and comparing their estimate to field research	User supplied	Future standard efficiency in market for the specific measure
NH - Liberty	Custom	Calculated	Calculated	No	Custom analysis calculation	N			NO DETAILS AVAILABLE	NO DETAILS AVAILABLE	
NH - PSNH	Custom	Calculated	Calculated (35% of estimated total cost, including labor)	No	Custom analysis calculation	N			NO DETAILS AVAILABLE	Determined from application info	
NH - Unitil	Custom	Calculated	Calculated (35% of estimated total cost, including labor)	No	Custom analysis calculation	N			NO DETAILS AVAILABLE	Determined from application info	
NY - NGRID	Custom measures	Calculated based on existing equipment vs. new equipment. TRM outlines savings	Rebates based on difference between equipment life and rated measure life from tech manual	NO	Savings calculated based on existing equipment as baseline; difference between tech manual efficiency and existing equipment	Y	Field	RUL	RUL must be captured by user	user supplied; inspected by NGRID representative	
MT - NorthWestern Energy	Custom measures	Calculated; based on the energy consumption of the existing unit (calculated or data-logged) compared to the calculated usage from a new more efficient unit	50% of the total project resource value to NorthWestern	NO	One baseline used; efficiency of the existing equpment. Determined using NorthWestern's TRC calculator. Savings are multiplied by the ful EUL of the new measure	N		EUL	Same as Normal Replacement	Some equipment can be metered but some cant and the existing efficiency is estimated with engineering calculations.	
CT - CL&P, UI, CNG, SCG, Yankeegas, Energize Connecticut	Dehumidifier	Calculated, based on capacity of the existing unit, assumed number of operating days, the baseline energy factor, and the existing unit energy factor for the RUL of the existing unit, with normal replacement savings for the EUL of the new unit.		Yes	Uses the same algorithm as the normal replacement measure for the early retirement portion of the savings, with the existing unit capacity used instead of the new unit capacity and the existing unit efficiency and federal baseline (based on existing capacity) used instead of the new unit efficiency and the federal baseline based on the new unit capacity for the RUL of the existing unit. After the RUL of the existing unit, the normal replacement savings are used.	Y			4 years, no source	Observed on site, if possible. If the Energy Factor of the existing unit is unknown, it shall be based on the 2007 Federal Standard EF for the existing unit's capacity. If the capacity of the existing unit is unknown, the capacity of the new unit shall be used.	Same as normal replacement
MA - Cape Light Compact	Dehumidifiers (Early Retirement)	Deemed at 34 kWh, 0.02 kW		No	Savings based on existing unit's assumed efficiency of pre-EPACT 2005, which is 1.2 L/kWh for a 35 pint/day unit, which is the assumed capacity and based on proposed unit having a baseline new unit efficiency fo 1.3 L/kWh, which is the federal standard for a 35 pint/day unit. It is assumed that these units operate 1,706 hours per year	Y	Field	RUL	5 yrs, based on subtracting the average age of old units (7) turned in to PA from the EUL of new units (12). The PA (Cape Light Compact) measured this average age at a turn-in event in May 2010.	1.2 L/kWh, pre-EPACT 2005 efficiency level	
CT - CL&P, UI, CNG, SCG, Yankeegas, Energize Connecticut	Dishwasher	**Deemed**, based on water heating fuel for RUL of existing unit and then **calculated** using the normal replacement algorithm for EUL of the new unit		Yes	Uses algorithms that are only a function of the new unit rated annual energy usage and water use per cycle once all other assumptions have been accounted for after RUL of existing unit. Deemed existing unit savings for its RUL are calculated for each hot water fuel type using a set of use assumptions. Uses normal replacement savings after RUL of existing dishwasher and early replacement savings for RUL of existing dishwasher.	Y			4 years, no source	0.58 EF, which translates to 371 kWh per year. Energy Factor (EF) was not rated until the 1994 Federal Standard. The Maximum Energy and Water Use criteria replaced the EF in the 2009 Energy Star criteria, and the 2010 Federal Standard followed suit. The annual kWh energy use criterion differs from the EF in that it also includes standby energy use. The typical existing unit is represented by the 2001 Energy Star level at 0.58 EF, based on high market penetration in 2004, with equivalent energy use of 371 kWh/yr. Because there was no specification for water use prior to 2009, the typical existing unit water usage is estimated to be the same as the 2009 Energy Star (5.8 Gal/cycle) level.	Same as normal replacement
NH - Liberty	Electronically Commutated (EC) Motors	Calculated	$100 per motor	No	Savings are calculated between existing unit and efficient unit consumption	N			NO DETAILS AVAILABLE	NO DETAILS AVAILABLE	
NH - PSNH	Electronically Commutated (EC) Motors	Calculated	$100 per motor	No	Savings are calculated between existing unit and efficient unit consumption	N			NO DETAILS AVAILABLE	Obtained from savings table	

EARLY REPLACEMENT SAVINGS METHODS											
State - PA	**Efficient Measure Description**	**Early Replacement Savings**	**Early Replacement Rebates and Incentives**	**Dual Baselines Used?**	**Savings Calculations - Other Method Description**	**RUL?**	**RUL from Study/Field**	**Type of RUL (single baseline)**	**Old Equipment - Remaining Useful Life (RUL)**	**Old Equipment - Efficiency for Savings Calcs**	**Assumed Efficiency after RUL (if Dual Baselines)**
NH - Unitil	Electronically Commutated (EC) Motors	Calculated	$100 per motor	No	Savings are calculated between existing unit and efficient unit consumption	N			NO DETAILS AVAILABLE	Obtained from savings table	
NY - ConEdison	Electronically Commutated (EC) Motors	Calculated using existing equipment as baseline	70% of installed total cost	No	Calculated between existing equipment and new equipment using the full EUL of new equipment	N		EUL	EUL=RUL. Do not collect this information. Too difficult.	Information not provided.	N/A
NH - PSNH	Fixtures	Deemed at 23 kWh/year	NO DETAILS AVAILABLE	No	Concrete calculation (unknown figures)	N		EUL	20 years	NO DETAILS AVAILABLE	
NH - Unitil	Fixtures	Deemed at 23 kWh/year	NO DETAILS AVAILABLE	No	Concrete calculation (unknown figures)	N		EUL	20 years	NO DETAILS AVAILABLE	
NH - Liberty	Fluorescent fixtures	Calculated	$15-90 based on wattage and type	No	Savings are calculated between existing unit and efficient unit consumption	N			NO DETAILS AVAILABLE	Determined from application info	
NH - PSNH	Fluorescent	Calculated (based on fixture wattage and operating hours)	$15-90 based on wattage and type	No	Savings calculated based on fixture wattage and operating hours	Y		Blended	13 years	Determined from application info	
NH - Unitil	Fluorescent	Calculated (based on fixture wattage and operating hours)	$15-90 based on wattage and type	No	Savings calculated based on fixture wattage and operating hours	Y		Blended	13 years	Determined from application info	
CT - CL&P, UI, CNG, SCG, Yankeegas, Energize Connecticut	Freezer Replacement	Calculated, based on existing unit volume and the corresponding federal baseline, along with the rated annual energy consumption of the existing unit		Yes	Uses existing unit volume to determine adjusted volume, which is then used with the freezer category to select the appropriate baseline energy use formula and annual 2001 federal baseline energy consumption. Finally, the difference between the annual energy use of the existing unit (from manufacturer data or observed) the baseline energy consumption determines the retirement energy savings. This savings is applied for the RUL of the existing unit and the normal replacement savings are applied for the EUL of the new unit. The normal replacement baseline is based on the new unit adjusted volume, while the early retirement baseline is based on the existing unit adjusted volume.	Y			4 years, no source	Either observed while on-site (from DOE sticker, or manufacturer and model number and CEC database) or, if not available, estimated based on an algorithm depending on volume and year of manufacture. Efficiency expressed as energy consumption per year. The algorithm for unknown existing unit efficiency is different if the unit was built before 1978 than if it was built after 1978. The algorithms depend on age and volume and are based on the average rated usage of full size standard freezers found in the CEC database	Same as normal replacement
VT - Efficiency Vermont	Freezer Replacement	Deemed at 231.8 kWh, 0.0275 kW		Yes	Original program savings based on pre-1993 freezers only and 1993-2001 freezers are 25% more efficient than pre-1993 ones and Eff. Vermont assumed that 30% of future replacements will be for 1993-2001 freezers, so original deemed savings values had to be adjusted accordingly. This 30% assumption will be reviewed annually for adjustment. Also, a 72% multiplier was used to convert single family deemed savings values to multifamily, since the multifamily units are smaller. This multiplier is calculated by comparing the average MF retrofitted energy savings per unit (525kwh) to the average single family residential retrofitted energy savings (726kWh) indicating a 72% savings factor. Existing energy use is used for RUL (3 years) and then the 2001 federal baseline is used as the baseline for the next 9 years (12 year new unit EUL - 3 years). Demand savings are simply the kWh savings divided by the full-load hours (8477)	Y			3 years, based on an assumption. No other information provided.	The existing pre-2001 freezer baseline efficiency is estimated by calculating the estimated kWh for an equivalent unit at the Federal Standard in 1990 and 1993 for all units incentivized through the Efficient Product program in 2009-2010	Federal 2001 minimum standard efficiency

EARLY REPLACEMENT SAVINGS METHODS											
State - PA	**Efficient Measure Description**	**Early Replacement Savings**	**Early Replacement Rebates and Incentives**	**Dual Baselines Used?**	**Savings Calculations - Other Method Description**	**RUL?**	**RUL from Study/Field**	**Type of RUL (single baseline)**	**Old Equipment - Remaining Useful Life (RUL)**	**Old Equipment - Efficiency for Savings Calcs**	**Assumed Efficiency after RUL (if Dual Baselines)**
VT - Efficiency Vermont	Freezer Replacement	Deemed at 321.5 kWh, 0.038 kW		Yes	Original program savings based on pre-1993 freezers only and 1993-2001 freezers are 25% more efficient than pre-1993 ones and Eff. Vermont assumed that 30% of future replacements will be for 1993-2001 freezers, so original deemed savings values had to be adjusted accordingly. This 30% assumption will be reviewed annually for adjustment. Existing energy use is used for RUL (3 years) and then the 2001 federal baseline is used as the baseline for the next 9 years (12 year new unit EUL - 3 years). Demand savings are simply the kWh savings divided by the full-load hours (8477)	Y			3 years, based on an assumption. No other information provided.	The existing pre-2001 freezer baseline efficiency is estimated by calculating the estimated kWh for an equivalent unit at the Federal Standard in 1990 and 1993 for all units incentivized through the Efficient Product program in 2009-2010	Federal 2001 minimum standard efficiency
MA - National Grid, NSTAR, Cape Light Compact, Unitil, WMECo, Columbia Gas, New England Gas, Blackstone Gas, Berkshire Gas	Freezer Retrofit/Replacement	Deemed at 239 kWh for all, 0.029 kW for 1-4 family, 0.033 kW for multi-family	20	No	Savings come from Cadmus 2012 Low Income Single Family Impact Evaluation for PAs of Mass.	N		EUL	12 yrs, from EPA Life Cycle Cost Estimate for ENERGY STAR Residential Refrigerator	Existing freezer efficiency, coming from impact evaluation. The baseline efficiency for both the replaced and baseline new freezer is represented by the existing freezer. It is assumed that low-income customers would otherwise replace their freezers with a used inefficient unit.	
MN - Xcel Energy	Freezer Replacement	Deemed at 82 kWh	$303 per unit	No	Savings calculated by using the ENERGY STAR Freezer Calculator's (2008) conventional new unit energy consumption with default assumptions for a compact upright freezer with auto-defrost and subtracting the ENERGY STAR-qualified unit (2008) energy consumption for the same freezer type	N		EUL	11 yrs, based on taking the EUL from the ENERGY STAR Freezer Calculator (2008)	Based on default assumptions for a conventional new compact upright freezer with auto-defrost from the ENERGY STAR freezer calculator	NA
CT - CL&P, UI, CNG, SCG, Yankeegas, Energize Connecticut	Furnace	Calculated, based on heated area, heating load factor (based on home age), and the deemed value of the AFUE of the existing boiler (based on furnace age)	$1,000	Yes	The same algorithm is used for normal replacement and early retirement. Only the AFUE values are changed. The existing furnace AFUE is determined from the furnace's age and deemed values from the PSD. These efficiency values come from: ENERGY STAR Microsoft Excel tool, "Life Cycle Cost Estimate for an ENERGY STAR Residential Furnace," http://www.energystar.gov/ia/business/bulk_purchasing/bpsavings_calc/Calc_Furnaces.xls, last updated July, 2009, last accessed August 6, 2012. The fossil fuel savings for this measure are calculated using the same methodology as the ENERGY STAR Furnace calculator, which is located on the ENERGY STAR Website. The calculator uses the home's year of construction, location, and area to determine the home's annual heating load. The age of the furnace is used to determine the efficiency.	Y			5 years, no source	Deemed, based on furnace age	Same as normal replacement (80%)
NY - ConEdison	Furnace	Calculated using exising equipment baseline for RUL, then state code for remainder of EUL	ranges based on measures (https://www.conedci.com/HVAC.aspx)	Yes	Dual basline method, overall savings calculated using ratios in Appendix M.	Y	Field		RUL calculated with some type of documented age of existing equipment	Name plate info used; verifyed during pre inspection	Existing efficiency code
NH - PSNH	Furnace Fan	Deemed at 86 kWh/year	NO DETAILS AVAILABLE	No	NO DETAILS AVAILABLE	N		EUL	20 years	NO DETAILS AVAILABLE	
NH - PSNH	Furnace w/ ECM Motor	Deemed at 733 kWh/year	NO DETAILS AVAILABLE	No	NO DETAILS AVAILABLE	N		EUL	20 years	NO DETAILS AVAILABLE	

EARLY REPLACEMENT SAVINGS METHODS											
State - PA	**Efficient Measure Description**	**Early Replacement Savings**	**Early Replacement Rebates and Incentives**	**Dual Baselines Used?**	**Savings Calculations - Other Method Description**	**RUL?**	**RUL from Study/Field**	**Type of RUL (single baseline)**	**Old Equipment - Remaining Useful Life (RUL)**	**Old Equipment - Efficiency for Savings Calcs**	**Assumed Efficiency after RUL (if Dual Baselines)**
IL - Ameren	Furnace	Calculated (based on boiler/furnace load and Climate Zone); Avg ex-ante per-unit savings of 337 Therms	AFUE 95%+ $400; AFUE 97%+ $500	Yes	Savings are calculated between existing unit and efficient unit consumption during the remaining life of the existing unit, and between new baseline unit and efficient unit consumption for the remainder of the measure life.	Y			RUL=6 years (Assumed to be one third of EUL. EUL in turn is based on the technical support documents for federal residential appliance standards)	Determined from application info	At time of writing [the TRM], the DOE had rescinded the next Federal Standard change for furnaces, however it is likely that a new standard will be in effect after the assumed remaining useful life of the existing unit. For the purposes of this measure- the new baseline is assumed to be 90%.
OR - Energy Trust of Oregon	Furnace	Calculated; "Early replacement calculated from 74 AFUE to 95 AFUE (150.8 Therms), normal calculated from 80 AFUE to 90 AFUE (70.56 Therms)"	NONE	NO	Savings calculated for 4 years (RUL = 4) based on existing equipment . New EE equipment assumed as 95% efficiency	Y		RUL	4 years	Assumed at weighted average of 74 AFUE	NA
IL - Ameren	Ground Source Heat Pump	Calculated (based on SEER, EER, HSPF and Climate Zone); Avg ex-ante per-unit savings of 3,814 kWh	$600	Yes	Savings are calculated between existing unit and efficient unit consumption during the remaining life of the existing unit, and between new baseline unit and efficient unit consumption for the remainder of the measure life.	Y			RUL=6 years (Assumed to be one third of EUL. EUL in turn is based on 2007 GDS Associates "Measure Life Report, Residential and Commercial/Industrial Lighting and HVAC Measures" study)	Determined from application info	Future federal efficiency standard
OH - Dayton Power & Light	Ground Source Heat Pump	Identified through annual review of customer billing data, program tracking data, draft Ohio TRM algorithms and assumptions, and primary and secondary data.	SEER 16-18 $1200 SEER 19+ $1600	Yes, for ER measures	Savings calculated using modified OH TRM ground-source heat pump (time of sale) energy savings algorithm: = (FLHcool * BtuH * (1/SEERexist – (1/(SEERee * 1.02)) / 1000 + (FLHheat * BtuH * (1/COPexist – (1/COPee * 3.412)) / 1000	Y			5 yrs	Actual-from program tracking data	Minimum federal efficiency level standards
NH - PSNH	Hardwired CFL	Calculated (based on fixture wattage and operating hours)	NO DETAILS AVAILABLE	No	Savings calculated based on fixture wattage and operating hours	Y		Blended	13 years	Determined from application info	
NH - Unitil	Hardwired CFL	Calculated (based on fixture wattage and operating hours)	NO DETAILS AVAILABLE	No	Savings calculated based on fixture wattage and operating hours	Y		Blended	13 years	Determined from application info	
MA - National Grid, NSTAR, Cape Light Compact, Unitil, WMECo, Columbia Gas, New England Gas, Blackstone Gas, Berkshire Gas	Heating System Replacement	Deemed at 132 kWh, 0.07 kW, 18.4 MMBtu		No	Deemed based on study results from Low Income Single Family Impact Evaluation by Cadmus in 2012 for PAs in Mass.	N		EUL	Same as Normal Replacement (18 years), from EPA Life Cycle Cost Estimate for ENERGY STAR furnace	Value not provided, only that it is the existing unit efficiency	
NH - PSNH	HID Lighting	Calculated (based on fixture wattage and operating hours)	NO DETAILS AVAILABLE	No	Savings calculated based on fixture wattage and operating hours	Y		Blended	13 years	Determined from application info	
NH - Unitil	HID Lighting	Calculated (based on fixture wattage and operating hours)	NO DETAILS AVAILABLE	No	Savings calculated based on fixture wattage and operating hours	Y		Blended	13 years	Determined from application info	
NH - Liberty	High efficiency air compressor	Calculated	15-24 HP ($170 per HP); 25-49 HP ($145-200 per HP); 50-70 HP ($120-180 per HP)	No	Savings are calculated between existing unit and efficient unit consumption	N			NO DETAILS AVAILABLE	Determined from application info	
NH - PSNH	High efficiency air compressor	Calculated (based on HP)	Ranges from $120 to $200 based on type of compressor and hp	No	Savings calculated using an adjustment factor and HP of new equipment	N			NO DETAILS AVAILABLE	Determined from application info	
NH - Unitil	High efficiency air compressor	Calculated (based on HP)	Ranges from $120 to $200 based on type of compressor and hp	No	Savings calculated using an adjustment factor and HP of new equipment	N			NO DETAILS AVAILABLE	Determined from application info	
VT - Efficiency Vermont	High Performance T8 Fixtures Re-lamp, Re-ballast	Calculated	Varies, based on fixture types	No	Savings are calculated in the exact same way as for normal replacements	N		EUL	Same as normal replacement	Same as normal replacement baseline	
NH - PSNH	LED & LEC Exit Light	Calculated (based on fixture wattage and operating hours)	$0 - Used to be $60 to $80	No	Savings calculated based on fixture wattage and operating hours	Y		Blended	13 years	Determined from application info	
NH - Unitil	LED & LEC Exit Light	Calculated (based on fixture wattage and operating hours)	$0 - Used to be $60 to $80	No	Savings calculated based on fixture wattage and operating hours	Y		Blended	13 years	Determined from application info	
NH - Liberty	LED lighting	Calculated	$15-150 based on wattage and type	No	Savings are calculated between existing unit and efficient unit consumption	N			NO DETAILS AVAILABLE	Determined from application info	
NH - Liberty	LED parking/roadway	Calculated	$145-250 based on type	No		N			NO DETAILS AVAILABLE	NO DETAILS AVAILABLE	

EARLY REPLACEMENT SAVINGS METHODS											
State - PA	**Efficient Measure Description**	**Early Replacement Savings**	**Early Replacement Rebates and Incentives**	**Dual Baselines Used?**	**Savings Calculations - Other Method Description**	**RUL?**	**RUL from Study/Field**	**Type of RUL (single baseline)**	**Old Equipment - Remaining Useful Life (RUL)**	**Old Equipment - Efficiency for Savings Calcs**	**Assumed Efficiency after RUL (if Dual Baselines)**
NY - ConEdison	Lighting (Muliple types)	Calculated using existing equipment as baseline	70% of installed total cost	No	Calculated between existing equipment and new equipment using the full EUL of new equipment	N				Based on lighting type and wattage	N/A
NY - ConEdison	Lighting (Muliple types)	Full savings using existing lighting efficiency calculated for the entire EUL of new equipment	$0.75 - $75 per linear foot/fixture/lamp depending on measure	No	Savings calculated for full EUL of new equipment using old equipment as baseline	N		EUL	Assumed to = EUL	Varies by lighting type and wattage	N/A
VT - Efficiency Vermont	Lighting (Muliple types)	Calculated	Varies, based on fixture types	No	Savings are calculated in the exact same way as for normal replacements	N		EUL	Same as normal replacement	Same as normal replacement baseline	
NH - Liberty	Lighting controls	Calculated	$25-50 based on wattage and type	No	Savings are calculated between existing unit and efficient unit consumption	N			No controls	No controls	
NH - PSNH	Lighting controls	Calculated (based on fixture wattage and operating hours)	$25-50 based on wattage and type	No	Savings calculated based on fixture wattage and operating hours	Y		Blended	13 years	Determined from application info	
NH - Unitil	Lighting controls	Calculated (based on fixture wattage and operating hours)	$25-50 based on wattage and type	No	Savings calculated based on fixture wattage and operating hours	Y		Blended	13 years	Determined from application info	
NY - NGRID	Lighting Systems/Lighting Controls	Calculated based on existing equipment vs. new equipment. TRM outlines savings	ranges from $10 to $200 depending on measure	NO* Dual baseline method from Appendix M used to "pre-screen" prescriptive measures. Not used in actual ER	Savings calculated based on existing equipment as baseline; difference between tech manual efficiency and existing equipment. "savings you claim are 1st year annual savings in full"	Y	Field	RUL	EUL from tech manual - age of old equipment	user supplied; inspected by NGRID representative	
MA - National Grid	Commercial Lighting Retrofit	Calculated using algorithm	Incentives are based on a % of the total costs	No	The existing fixture type is recorded and tracked and is used as the baseline for comparison to the proposed fixture. The savings are project-specific depending on what fixture was previously installed in the space. Wattages by fixture type are tabulated in the TRM's Appendix. The site-specific fixture counts and hours of operation are also used. If the hours of operation are not available, a value from Table 59 in Appendix A of the TRM is used based on fixture type.	Y		Blended	Early retirement measure life is 13 years for all fixtures except for CFL screw base bulbs, which are 5 years. This is used as the EUL for all retrofit projects in place of the normal replacement EUL. The lifetime for measures replacing T12s has been reduced for the years 2013-2015 to 5.52, 4.98, and 4.57 which accounts for the effects of EISA (Energy Independence and Security Act of 2007).	Site-specific, based on existing fixtures and counts.	
MD - BGE	General Lighting (Lamp and Ballast Retrofits Commodity Fixtures Advanced Fixtures Fluorescent High Bay Fixtures Compact Fluorescent LED Exit Signs LED Strips LED Integral Replacement Lamps)	Calculated using existing equipment as baseline	$15-$85 per fixture depending on measure	NO	Savings calculated by using full EUL of the new lighting	N		EUL	EUL of new measure	User supplied	
CT - CL&P, UI, CNG, SCG, Yankeegas, Energize Connecticut	Lighting Retrofit	Calculated, based on existing and proposed fixture wattages and hours of operation	35% of installed cost	No	Calculated, based on existing and proposed fixture wattages and hours of operation. Hours of operation collected from customer along with existing wattage	Y	Study	RUL	13 years, from GDS Associates Inc. Measure Life Report, Residential and Commercial Industrial Lighting and HVAC Measures, June 2007, Table 2.		
CO - Xcel Energy	Lighting Retrofit	Deemed, based on deemed existing fixture type's wattage and proposed fixture wattage	Varies, depends on fixture types involved. It is not a standard % of incremental cost	No	Calculated based on deemed existing fixture type and proposed fixture type wattages, deemed hours of operation based on building type, and quantity	N		EUL	No RUL used, only the normal replacement EUL	Based on a deemed existing fixture type	NA
MN - Xcel Energy	Lighting Retrofit	Deemed, based on deemed existing fixture type's wattage and proposed fixture wattage	Varies, depends on fixture types involved. It is not a standard % of incremental cost	No	Calculated based on deemed existing fixture type and proposed fixture type wattages, deemed hours of operation based on building type, and quantity	N		EUL	No RUL used, only the normal replacement EUL	Based on a deemed existing fixture type	NA

EARLY REPLACEMENT SAVINGS METHODS											
State - PA	**Efficient Measure Description**	**Early Replacement Savings**	**Early Replacement Rebates and Incentives**	**Dual Baselines Used?**	**Savings Calculations - Other Method Description**	**RUL?**	**RUL from Study/Field**	**Type of RUL (single baseline)**	**Old Equipment - Remaining Useful Life (RUL)**	**Old Equipment - Efficiency for Savings Calcs**	**Assumed Efficiency after RUL (if Dual Baselines)**
CT - CL&P, UI, CNG, SCG, Yankeegas, Energize Connecticut	Package Terminal Heat Pump	Calculated, based on EFLH heating, capacity (both cooling and heating), COP, cooling savings factor per ton, and EER. Also, if the baseline has electric resistance supplemental heat, a seasonal adjustment factor is also used.		Yes	The same algorithm is used for both normal replacement and early retirement, but the baseline EER and COP changes from the existing unit EER and COP to the federal baseline EER and COP after the RUL of the existing unit. An 80% seasonal adjustment factor is applied to the baseline COP if it has electric resistance heating , from Hartford bin analysis results below 47 degrees. Also, a heat adjustement factor of 60% is applied to account for the amount of time the backup electric resistance heating is not needed, based on a bin analysis for Hartford.	Y			5 years, no source	Observed on-site	Same as normal replacement, calculated based on capacity
CT - CL&P, UI, CNG, SCG, Yankeegas, Energize Connecticut	Refrigerator	Calculated, based on existing unit volume and the corresponding federal baseline, along with the rated annual energy consumption of the existing unit		Yes	Uses existing unit volume to determine adjusted volume, which is then used with the refrigerator category to select the appropriate baseline energy use formula and annual federal baseline energy consumption. This value is then multiplied by 0.85 to bring the 2001 federal standard up to 2004 ENERGY STAR levels. Finally, the difference between the annual energy use of the existing unit (from manufacturer data or observed) and 0.881 (DOE lab adjustment factor) multiplied by the adjusted baseline energy consumption (2004 ENERGY STAR level) determines the retirement energy savings. This savings is applied for the RUL of the existing unit and the normal replacement savings are applied for the EUL of the new unit. The normal replacement baseline is based on the new unit adjusted volume, while the early retirement baseline is based on the existing unit adjusted volume.	Y			5 years, no source	Either observed while on-site (from DOE sticker, or manufacturer and model number and CEC database) or, if not available, estimated based on an algorithm depending on volume and year of manufacture. Efficiency expressed as energy consumption per year. The algorithm for unknown existing unit efficiency is different if the unit was built before 1978 than if it was built after 1978. The algorithms depend on age and volume and are based on the average rated usage of full size standard refrigerators found in the CEC database	Same as normal replacement
VT - Efficiency Vermont	Refrigerator Replacement	Deemed, based on efficiency level of efficient refrigerator (ENERGY STAR, CEE Tier 1, CEE Tier 2), ranging from 591 kWh to 672 kWh and 0.07 kW to 0.079 kW		Yes	Original program savings based on pre-1993 refrigerators only and 1993-2001 refrigerators are 43% more efficient than pre-1993 ones and Eff. Vermont assumed that 30% of future replacements will be for 1993-2001 refrigerators, so original deemed savings values had to be adjusted accordingly. Also, a 72% multiplier was used to convert single family deemed savings values to multifamily, since the multifamily units are smaller. This multiplier is calculated by comparing the average MF retrofitted energy savings per unit (525kwh) to the average single family residential retrofitted energy savings (726kWh) indicating a 72% savings factor. Existing energy use is used for RUL (3 years) and then the 2001 federal baseline is used as the baseline for the next 9 years (12 year new unit EUL - 3 years). Demand savings are simply the kWh savings divided by the full-load hours (8477)	Y			3 years, based on an assumption. No other information provided.	The existing pre-2001 refrigerator baseline consumption is estimated using actual meter measurements from replacements installed through EVT from 2008-2009	Federal 2001 minimum standard efficiency

EARLY REPLACEMENT SAVINGS METHODS											
State - PA	**Efficient Measure Description**	**Early Replacement Savings**	**Early Replacement Rebates and Incentives**	**Dual Baselines Used?**	**Savings Calculations - Other Method Description**	**RUL?**	**RUL from Study/Field**	**Type of RUL (single baseline)**	**Old Equipment - Remaining Useful Life (RUL)**	**Old Equipment - Efficiency for Savings Calcs**	**Assumed Efficiency after RUL (if Dual Baselines)**
VT - Efficiency Vermont	Refrigerator Replacement	Deemed, based on efficiency level of efficient refrigerator (ENERGY STAR, CEE Tier 1, CEE Tier 2), ranging from 705 kWh to 816 kWh and 0.083 kW to 0.096 kW		Yes	Original program savings based on pre-1993 refrigerators only and 1993-2001 refrigerators are 35% more efficient than pre-1993 ones and Eff. Vermont assumed that 30% of future replacements will be for 1993-2001 refrigerators, so original deemed savings values had to be adjusted accordingly. Existing energy use is used for RUL (3 years) and then the 2001 federal baseline is used as the baseline for the next 9 years (12 year new unit EUL - 3 years). Demand savings are simply the kWh savings divided by the full-load hours (8477)	Y			3 years, based on an assumption. No other information provided.	The existing pre-2001 refrigerator baseline efficiency is estimated according to a combination of Association of Home Appliance Manufacturers (AHAM) estimated usage data and actual meter measurements from replacements installed thru EVT from 2006-2008	Federal 2001 minimum standard efficiency
Washington, D.C. - DC SEU	Refrigerator Retrofit	Deemed at 859, 886 kWh for ENERGY STAR and CEE Tier 2, respectively for RUL of existing, then 113, 141 kWh for the rest of the EUL of the new unit	N/A, program not active	Yes	Uses deemed savings values for both the RUL of the existing unit and the rest of the EUL from that point forward.	Y			3 years, assumed	The existing pre-1993 refrigerator baseline efficiency is estimated using actual meter measurements from replacements installed through Efficiency Vermont from 2006-2008. The efficient and new baseline usage are based on the mix of products sold through Efficiency Vermont's retail program. A 70% scaling factor, based on Efficiency Vermont data showing that units installed in multifamily buildings are smaller than in single family homes is applied.	2001 federal minimum standard
MA - National Grid, NSTAR, Cape Light Compact, Unitil, WMECo, Columbia Gas, New England Gas, Blackstone Gas, Berkshire Gas	Refrigerator Retrofit/Replacement	Deemed at 714 kWh, 0.086 kW for remaining life of existing unit, 104 kWh, 0.013 kW for full life of new ENERGY STAR refrigerator. The total savings is the sum of the savings for the RUL and new unit EUL.	150	Yes	Savings calculated using The Cadmus Group, Inc. (2012). Home Energy Services Impact Evaluation. Prepared for the Electric and Gas Program Administrators of Massachusetts, and the normal refrigerator replacement savings (104 kWh)	Y			1 year	Existing refrigerator efficiency, coming from impact evaluation	Efficiency of full-sized refrigerator (7.75 cubic feet) that meets the Federal minimum standard
MA - National Grid, NSTAR, Cape Light Compact, Unitil, WMECo, Columbia Gas, New England Gas, Blackstone Gas, Berkshire Gas	Refrigerator Retrofit/Replacement	Deemed at 762 kWh, 0.092 kW for 1-4 family customers, 645 kWh, 0.092 kW for multi-family customers (NSTAR, WMECO)	30	No	Savings come from Cadmus 2012 Low Income Single Family Impact Evaluation for PAs of Mass., with savings adjusted down by 15.3% for multi-family customers because historical PA data showed that the average Low Income Multi-Family refrigerator is 84.7% of the size of a low-income 1-4 family refrigerator	N		EUL	Same as Normal Replacement for 1-4 Family, 1 year for Multi-Family (but no dual baseline, so it is unclear why RUL is used at all)	Existing refrigerator efficiency, coming from impact evaluation. It is assumed that low-income customers would otherwise replace their refrigerators with a used inefficient unit.	
MA - National Grid, NSTAR, Cape Light Compact, Unitil, WMECo, Columbia Gas, New England Gas, Blackstone Gas, Berkshire Gas	Refrigerators/Freezer Replacement	Calculated using algorithm	75	Yes	Calculated using formula based on EUL of new unit, RUL of existing unit, kWh values for existing, baseline, and new efficient units, occupant adjustment factor, and average kW/kWh reduction factor. Savings are based on existing-baseline kWh for this portion of the savings:(EUL-RUL)/EUL and baseline-ENERGY STAR kWh for this portion: (RUL/EUL).	Y			4 yrs, based on assumption that existing refrigerator is 8 years old and EUL of new refrigerator is 12 years, leading to a difference of 4 years.	Existing unit efficiency, as determined by either metering or the AHAM database (using existing unit manufacturer and model), which provides the annual kWh use. If the model number is not found in the database, metering is performed for 1.5 hours.	Annual kWh consumption of a refrigerator meeting federal standards. Calculated by dividing the kWhES by 0.8 (i.e., the Energy Star units are assumed to be 20% more efficient than the kWhstd units).
NH - PSNH	Refrigerators/Freezer Replacement	Deemed at 586 kWh/year	Calculated (based on cubic foot of old refrigerator)	No	Convert Mbtu to kWh and convert by given figure	Y		RUL	7 years	NO DETAILS AVAILABLE	

EARLY REPLACEMENT SAVINGS METHODS											
State - PA	**Efficient Measure Description**	**Early Replacement Savings**	**Early Replacement Rebates and Incentives**	**Dual Baselines Used?**	**Savings Calculations - Other Method Description**	**RUL?**	**RUL from Study/Field**	**Type of RUL (single baseline)**	**Old Equipment - Remaining Useful Life (RUL)**	**Old Equipment - Efficiency for Savings Calcs**	**Assumed Efficiency after RUL (if Dual Baselines)**
CO - Xcel Energy (Public Service Company of Colorado)	Refrigerator Replacement	Deemed at 584 kWh	$631 per unit	No	Savings calculated using the energy consumption of a weighted average of various ages and efficiency levels (from DOE standards and LBNL studies) of refrigerator based on past participation (existing unit) and an efficient unit that meets ENERGY STAR efficiency requirements (2008) for a top-mount frost-free freezer refrigerator unit.	Y	Study	RUL	Weighted average of 7.27 yrs, based on estimated distribution of different ages of existing refrigerator and the RUL of those different ages. RULs range from 4.5 yrs for a 1993 refrigerator to 10.5 yrs for a 2000 model.	Efficiency calculated using the weighted average of various ages and efficiency levels (from DOE standards and LBNL studies) of refrigerator based on persistence of savings data and assumptions done by Linda Wooderson, The CO Governor's Energy Office, Russ Shaber, LBL research, and 1995 DOE TSD for Energy Efficiency Standards p. B-5. Discount rates, RUL values, and efficiency all change based on model year of the existing refrigerator and are compared to a 2008 Energy Star unit	NA
MN - Xcel Energy	Refrigerator Replacement	Deemed at 599 kWh	$574 per unit	No	Savings calculated using the energy consumption of a weighted average of various ages and efficiency levels (from DOE standards and LBNL studies) of refrigerator based on past participation (existing unit) and an efficient unit that meets ENERGY STAR efficiency requirements (2008) for a top-mount freezer unit with through-the-door ice dispensation	N		EUL	Same as Normal Replacement	Efficiency calculated using the weighted average of various ages and efficiency levels (from DOE standards and LBNL studies) of refrigerator based on past participation	NA
CT - CL&P, UI, CNG, SCG, Yankeegas, Energize Connecticut	Room AC	Calculated using same algorithm as normal replacement with existing unit capacity and efficiency used during RUL of existing unit and new unit capacity with federal baseline efficiency used during the EUL of the new unit.		Yes	The same algorithm is used for both normal replacement and early retirement, but the baseline EER changes from the existing unit EER to the federal baseline EER after the RUL of the existing unit. If the existing unit efficiency is unknown, it is assumed to be 8.86 EER.	Y			4 years, no source	Observed on-site. The EER and capacity of the existing unit should be looked up in the CEC database or equivalent source by brand and model number. If unknown, assumed to be 8.86 EER. This is based on: KEMA, Inc. Ductless Mini Pilot Study: Final Report. June, 2009, page vi.	Same as normal replacement
NH - PSNH	Room AC	Deemed at 23 kWh/year	NO DETAILS AVAILABLE	No	NO DETAILS AVAILABLE	N		EUL	20 years	NO DETAILS AVAILABLE	
VT - Efficiency Vermont	Room AC	Deemed based on a set of assumptions. They are organized into four classes based on capacity (BTU/h). They range from 235 kWh to 1068 kWh and from 0.235 kW to 1.17 kW	Based on capacity. $150, $250, $400, and $400	Yes	Savings algorithm for kWh in first four years: kWh = kBTU/hr x [1/EERexist* 1/Degrade(14 years) - 1/EEReff * 1/Degrade(2 years)] x FLH. For the rest of the new unit's EUL after that (10 years), the Degrade terms change to 5 and 9 years, respectively and the existing EER changes to base EER, with all else the same. The demand savings use the same formulas without the FLH values. Degradation is assumed to be 1% per year, based on personal communications with Harvey Sachs (ACEEE) and Michael Pilat (NYSERDA/Lockheed Martin), both dated 10/09/09. Also, the "NYSERDA Keep Cool Report 2000-2003" (Aspen Systems Corporation, 2003) page A-2 describes testing of old AC units which found EER degredation of 16% in units average 15 years of age.	Y	Study		4 years, based on a Lawrence Berkeley Laboratories study on air conditioner survival rates: http://www.osti.gov/bridge/servlets/purl/829989-lK2zOw/native/829989.pdf (page 26)	EER, ranging from 7.53 to 6.68, based on capacity. Based on average efficiencies of units from 1994-1999, or 10-15 years from present. Source: Association of Home Appliance Manufacturers provided information for the 8,000-13,999 size class, EERs for other size classes were calculated assuming the same ratios between size classes as for efficient equipment. Note that in the savings algorithms, degradation is applied to all EER values.	EER, ranging from 8.72 to 9.93, based on capacity. These come from averages of new unit efficiencies from 2008. The same source was used for these efficiencies as for the existing equipment: Association of Home Appliance Manufacturers. Note that in the savings algorithms, degradation is applied to all EER values.
Washington, D.C. - DC SEU	Room AC	Calculated, based on assumed run hours, capacity, and EER values	N/A, program not active	Yes	Uses an algorithm based on 1000 hours of annual run time (assumed, based on EE Investment Impacts for PJM DRSC, 2008), capacity of the replaced unit (12,000 BTU/h if unknown), EER of the existing unit (7.6 if unknown, from an Association of Home Appliance Manufacturers report), EER of the new ENERGY STAR unit, and the baseline federal standard EER (based on unit type, 9.8 if unknown).	Y			3 years, Based on Connecticut TRM; Connecticut Energy Efficiency Fund; CL&P and UI Program Savings Documentation for 2008 Program Year	Collected on-site; If unknown, EER of 7.6 is assumed, based on an Association of Home Appliance Manufacturers report	Federal standard baseline, based on unit type (louvered sides, casement-only, etc.) and capacity

EARLY REPLACEMENT SAVINGS METHODS											
State - PA	**Efficient Measure Description**	**Early Replacement Savings**	**Early Replacement Rebates and Incentives**	**Dual Baselines Used?**	**Savings Calculations - Other Method Description**	**RUL?**	**RUL from Study/Field**	**Type of RUL (single baseline)**	**Old Equipment - Remaining Useful Life (RUL)**	**Old Equipment - Efficiency for Savings Calcs**	**Assumed Efficiency after RUL (if Dual Baselines)**
Washington, D.C. - DC SEU	T12 Replacement	Calculated, based on the existing and proposed fixture type and wattage, hours of use, in-service rate, and HVAC interaction factors	$20 per fixture	No	Uses an algorithm based on existing fixture wattage and type (ballast, number of lamps), and the same information for the proposed fixture, the site-specific hours of use, the in-service rate of 0.97 (from a Maryland evalulation study), and calculated waste heat factors for HVAC interaction	Y	Study	RUL	Deemed, based on fixture type. Standard four-foot T12 fixture shows 20,000 hours of remaining lamp life and 40,000 hours of remaining ballast life. The lamp life varies from 9000 to 20000 hours.	Collected on rebate application, based on lamp type, ballast type, and number of lamps.	
CO - Xcel Energy (Public Service Company of Colorado)	Upgrade Motors with Premium or Enhanced Efficiency (1% above premium) Motors, 1 hp - 500 hp	Calculated based on motor size, full load efficiency versus baseline (NEMA Premium or Enhanced), and quantity. Weighted average is 1,006 kWh	Ranges from $200 to $8,000 based on motor size and efficiency level	No	Savings caculated using only the EPAct baseline for the entire measure life	N		EUL	Same as Normal Replacement	From motors lookup tables, confirmed by customer application and model number	NA
MN - Xcel Energy	Upgrade Motors with Premium or Enhanced Efficiency (1% above premium) Motors, 1 hp - 500 hp	Calculated based on motor size, application (pump, fan, commercial, industrial, etc.), full load efficiency versus baseline (NEMA Premium or Enhanced, and quantity. Weighted average is 1,210 kWh. Baseline is a repair/rewind of existing motor.	Ranges from $200 to $13,500 based on motor size and efficiency level	No	Savings caculated using only the EPAct baseline for the entire measure life	N		EUL	Same as Normal Replacement	From motors lookup tables, confirmed by customer application and model number	NA
NH - Liberty	VFD	Calculated	$1,050-4,400 based on HP controlled by each VFD	No	Savings are calculated between existing unit and efficienct unit consumption	N			NO DETAILS AVAILABLE	Determined from application info	
NH - PSNH	VFD	Calculated (based on HP)	$1,050-4,400 based on HP controlled by each VFD	No	Savings are calculated between existing unit and efficienct unit consumption	N			NO DETAILS AVAILABLE	Determined from application info	
NH - Unitil	VFD	Calculated (based on HP)	$1,050-4,400 based on HP controlled by each VFD	No	Savings are calculated between existing unit and efficienct unit consumption	N			NO DETAILS AVAILABLE	Determined from application info	
CO - Xcel Energy	Factory-integrated VFDs on Air Compressors from 10 to 49 HP	Calculated based on motor size, with assumptions for service factor, motor loading, hours of operation, pre-EPAct motor efficiency, typical flow rates, and VFD efficiency. Weighted average is 22,537 kWh	Ranges from $4,000 to $7000 based on motor size. Rebate is $3,000 + $100/HP	No	Savings calculated using identical baseline as for normal replacement except that the motor efficiency is decreased to pre-EPAct values	N		EUL	Same as Normal Replacement	Motor efficiencies assumed to be pre-EPAct levels (roughly 3% lower than EPAct based on motor size)	NA
MN - Xcel Energy	VFDs on Air Compressors from 10 to 40 HP	Calculated based on motor size, with assumptions for service factor, motor loading, hours of operation, motor efficiency, typical flow rates, and VFD efficiency. Weighted average is 17,372 kWh	Ranges from $4,000 to $7,000 based on motor size. Rebate is $3,000 + $100/HP	No	Savings calculated using identical baseline as for normal replacement	N		EUL	Same as Normal Replacement	Not needed, old equipment efficiency is no VFD	NA
MA - National Grid, NSTAR, Cape Light Compact, Unitil, WMECo, Columbia Gas, New England Gas, Blackstone Gas, Berkshire Gas	Window AC (Retrofit)	Deemed at 204 kWh, 0.582 kW	25	No	Savings come from Cadmus 2012 Low Income Single Family Impact Evaluation for PAs of Mass.	N		EUL	Same as Normal Replacement	Value not provided, only that it is the existing unit efficiency	
MA - National Grid	Window AC Replacement	Calculated using algorithm		No	Calculated using formula based on capacity of existing and new units, efficiency of existing and new units, and assumed EFLH of 200	N		EUL	9 yrs, from EPA Life Cycle Cost Estimate for ENERGY STAR Room Air Conditioner	Existing unit efficiency	
MN - Xcel Energy	Window AC Replacement	Deemed at 63 kWh	$368 per unit	No	Savings calculated by assuming the baseline/existing unit is a 10,000 BTU/h, 9.8 EER window unit with 662 full-load cooling hours. All of the assumptions were taken from defaults in the ENERGY STAR Room Air Conditioner Calculator, 2008 edition, with Minneapolis selected as the location. The efficient unit is an ENERGY STAR-qualified unit with an EER of 10.8	N		EUL	9 yrs, based on taking the EUL from the ENERGY STAR Room Air Conditioner Calculator (2008)	Efficiency assumed to be 9.8 EER, based on default conventional unit efficiency in ENERGY STAR Calculator (2008)	NA

Appendix F: Study Measures – Early Replacement Costs Methods

EARLY REPLACEMENT COST METHODS			
State - PA	**Efficient Measure Description**	**Early Replacement Cost - Fixed Amount or Calculated**	**Early Replacement Cost - Calculation Method**
IL - Ameren	Air Source Heat Pump	Fixed Amount (per SEER & tonnage)	NPV of New Equipment Cost moved forward by RUL
OH - Dayton Power & Light	Air-Source Heat-Pump	Calculated	Methodology articulated in draft OH TRM; SEER 14=$137/ton, SEER 15=$274/ton, SEER 16=$411/ton, SEER 17=$4548/ton, SEER 18=$685/ton; discount rate of 5%
CT - CL&P, UI, CNG, SCG, Yankeegas, Energize Connecticut	Boiler		
MA - National Grid, NSTAR, Cape Light Compact, Unitil, WMECo, Columbia Gas, New England Gas, Blackstone Gas, Berkshire Gas	Boiler	4127 for forced hot water, 2046 for steam	Uses method described in "Correcting Common Errors in Demand-Side Management Cost-Benefit Analysis". It is determined using a discount rate, the existing boiler age, the new boiler lifetime, the high efficiency boiler cost, the baseline boiler cost, and the remaining useful life of the existing boiler and putting them into an alogrithm that takes into account the time value of money.
MA - National Grid, NSTAR, Cape Light Compact, Unitil, WMECo, Columbia Gas, New England Gas, Blackstone Gas, Berkshire Gas	Boiler	1766 for oil, 4127 for propane	Uses method described in "Correcting Common Errors in Demand-Side Management Cost-Benefit Analysis". It is determined using a discount rate, the existing boiler age, the new boiler lifetime, the high efficiency boiler cost, the baseline boiler cost, and the remaining useful life of the existing boiler and putting them into an alogrithm that takes into account the time value of money.
NH - Liberty	Boiler	Calculated	NO DETAILS AVAILABLE
NY - ConEdison	Boiler	Calculated	Full costs adjusted using Appendix M tables
IL - Ameren	Boiler	Fixed Amount (per AFUE)	AFUE 85%=$725, AFUE 90%=$1,272, AFUE 95%=$1,785
NH - PSNH	Boiler Circulating Pump	NO DETAILS AVAILABLE	NO DETAILS AVAILABLE
CT - CL&P, UI, CNG, SCG, Yankeegas, Energize Connecticut	Central AC		
NH - PSNH	Central AC	NO DETAILS AVAILABLE	NO DETAILS AVAILABLE
MA - National Grid, NSTAR, Cape Light Compact, Unitil, WMECo, Columbia Gas, New England Gas, Blackstone Gas, Berkshire Gas	Central AC or HP Early Replacement	1000 cost adjusted for deferred replacement	Don't know
IL - Ameren	Central AC	Fixed Amount (per SEER & tonnage)	SEER 14=$119/ton, SEER 15=$238/ton, SEER 16=$357/ton, SEER 17=$476/ton, SEER 18=$596/ton, SEER 19=$715/ton, SEER 20=$834/ton SEER 21=$908/ton
OH - Dayton Power & Light	Central AC -- Early replacement, New construction, and Replace on failure -- Multiple efficiency tiers	Calculated	Methodology articulated in draft OH TRM; SEER 14=$119/ton, SEER 15=$238/ton, SEER 16=$357/ton, SEER 17=$476/ton, SEER 18=$596/ton, SEER 19=$715/ton, SEER 20=$834/ton SEER 21=$908/ton; discount rate of 5%
AZ - Tucson Electric Power	Central AC or HP Early Retirement with Quality Install	Calculated. $1920 for split-system HP or A/C and $1749 for packaged HP or A/C units.	Average participant cost for high-efficiency packaged or split-system air conditioners or heat pumps represents the cost per unit. The participant cost is based on the fully installed cost of a standard efficiency unit versus a high-efficiency unit that has been downsized by ½ ton due to quality install plus the cost for duct sealing and discounted by the present value for replacement five years prior to burn-out. An 8.42% discount rate is assumed on the cost of a $1600 baseline new unit.
CO - Xcel Energy (Public Service Company of Colorado)	Early Retirement AC	Fixed amounts, $999, $1,154, $1,308, $1,616 for SEER=14, 14.5, 15, 16	Incremental cost is calculated by combining several values. The first value is the present value of a new 13 SEER A/C unit in 7 years ($3,199). The second value is the estimated repair cost of the existing unit ($750). The third value is the estimated cost of performing a quality installation ($200). The fourth value is the cost of installing a standard new 14 SEER unit ($4,748). These values are combined like this: $4,748 - ($3,199 + $750) + ($200) = $999. All of the values are constant except for the $4,748 value, which varies as the new unit efficiency varies up to 16 SEER, where it is the highest.
NY - ConEdison	Chiller	Calculated	Full costs adjusted using Appendix M tables
CT - CL&P, UI, CNG, SCG, Yankeegas, Energize Connecticut	Clothes Washer		
VT - Efficiency Vermont	Clothes Washer Retrofit	Fixed. The efficient (ENERGY STAR, CEE, or Top Ten) unit costs are listed as $825, $850, $950, $1100, and $1110 with the cost increasing along with the efficiency. The deferred (for 3 years) baseline replacement cost is assumed to be $600.	No source provided for efficient unit costs. Deferred baseline replacement cost based on weighted average of top loading and front loading units (based on available product from the CEC Appliance database) and cost data from Life-Cycle Cost and Payback Period Excel-based analytical tool
VT - Efficiency Vermont	In-Unit Clothes Washer Retrofit	Fixed. The efficient (ENERGY STAR, CEE, or Top Ten) unit costs are listed as $825, $850, $950, $1100, and $1110 with the cost increasing along with the efficiency. The deferred (for 3 years) baseline replacement cost is assumed to be $600.	No source provided for efficient unit costs. Deferred baseline replacement cost based on weighted average of top loading and front loading units (based on available product from the CEC Appliance database) and cost data from Life-Cycle Cost and Payback Period Excel-based analytical tool
VT - Efficiency Vermont	Common Area Clothes Washer Retrofit	Fixed. The efficient (ENERGY STAR, CEE, or Top Ten) unit costs are listed as $1035, $1300, $1550, $1900, and $1950 with the cost increasing along with the efficiency. The deferred (for 3 years) baseline replacement cost is assumed to be $650.	Efficient costs based on EVT field study of clothes washer costs, see 2013 MF Common Clothes Washer Savings_retrofit.xls. Measure cost is higher than in-unit clothes washers since the common units are larger commercial and more expensive models. Deferred baseline replacement cost based on weighted average of top loading and front loading units (based on available product from the CEC Appliance database) and cost data from Life-Cycle Cost and Payback Period Excel-based analytical tool
NY - NGRID	Compressed Air Systems	Calculated based on new equipment	New equipment cost
CT - CL&P, UI, CNG, SCG, Yankeegas, Energize Connecticut	Custom		
MA - National Grid	Custom	Varies	Varies
MD - BGE	Varies based on project	Calculated	To discount back future replacement costs, installed cost of the new equipment is converted into a series of annual payments. The PV of the series of annual equipment payments is then calculated for the time between when the equipment gets replaced and the time it would otherwise have been replaced (i.e., equal to the RUL number of years). Discount rate is weighted average cost of capital for custom measures.
NH - Liberty	Custom	Calculated	35% of total cost
NH - PSNH	Custom	Calculated	35% of total cost
NH - Unitil	Custom	Calculated	35% of total cost
NY - NGRID	Custom measures	Calculated based on new equipment	New equipment cost
MT - NorthWestern Energy	Custom measures	Fixed (Full purchase price in today's dollars)	
CT - CL&P, UI, CNG, SCG, Yankeegas, Energize Connecticut	Dehumidifier		
MA - Cape Light Compact	Dehumidifiers (Early Retirement)		

EARLY REPLACEMENT COST METHODS			
State - PA	**Efficient Measure Description**	**Early Replacement Cost - Fixed Amount or Calculated**	**Early Replacement Cost - Calculation Method**
CT - CL&P, UI, CNG, SCG, Yankeegas, Energize Connecticut	Dishwasher		
NH - Liberty	Electronically Commutated (EC) Motors	Fixed	NO DETAILS AVAILABLE
NH - PSNH	Electronically Commutated (EC) Motors	Fixed	NO DETAILS AVAILABLE
NH - Unitil	Electronically Commutated (EC) Motors	Fixed	NO DETAILS AVAILABLE
NY - ConEdison	Electronically Commutated (EC) Motors	Fixed	Full cost of new measures (equipment + labor)
NH - PSNH	Fixtures	NO DETAILS AVAILABLE	NO DETAILS AVAILABLE
NH - Unitil	Fixtures	NO DETAILS AVAILABLE	NO DETAILS AVAILABLE
NH - Liberty	Fluorescent fixtures	Calculated	35% of total cost
NH - PSNH	Fluorescent	Calculated	35% of total cost
NH - Unitil	Fluorescent	Calculated	35% of total cost
CT - CL&P, UI, CNG, SCG, Yankeegas, Energize Connecticut	Freezer Replacement		
VT - Efficiency Vermont	Freezer Replacement	The full cost for an Energy Star freezer is $360. The cost of a baseline replacement freezer is $335	Based on review of data from the Northeast Regional ENERGY STAR Consumer Products Initiative; "2009 ENERGY STAR Appliances Practices Report", submitted by Lockheed Martin, December 2009. These calculated full costs ($500 for ENERGY STAR and $465 for a baseline unit) are multiplied by the 72% size factor to account for the smaller units being installed in MF.
VT - Efficiency Vermont	Freezer Replacement	The full cost for an Energy Star freezer is $500. The cost of a baseline replacement freezer is $465	Based on review of data from the Northeast Regional ENERGY STAR Consumer Products Initiative; "2009 ENERGY STAR Appliances Practices Report", submitted by Lockheed Martin, December 2009.
MA - National Grid, NSTAR, Cape Light Compact, Unitil, WMECo, Columbia Gas, New England Gas, Blackstone Gas, Berkshire Gas	Freezer Retrofit/Replacement		
MN - Xcel Energy	Freezer Replacement	Fixed amount ($303), presumably to pay for the removal cost and the cost of the new ENERGY STAR unit.	Deemed value, it appears to be from their vendor, but they determined the vendor cost to be too high, so it was scaled down by multiplying the vendor cost by the ratio of the deemed air conditioner replacement measure cost to the vendor air conditioner cost to estimate vendor mark-up.
CT - CL&P, UI, CNG, SCG, Yankeegas, Energize Connecticut	Furnace		
NY - ConEdison	Furnace	Calculated	Full costs adjusted using Appendix M tables
NH - PSNH	Furnace Fan	NO DETAILS AVAILABLE	NO DETAILS AVAILABLE
NH - PSNH	Furnace w/ ECM Motor	NO DETAILS AVAILABLE	NO DETAILS AVAILABLE
IL - Ameren	Furnace	Fixed Amount (per AFUE)	AFUE 90%=$725, AFUE 91%=$716, AFUE 92%=$802, AFUE 93%=$1,014, AFUE 94%=$1,226, AFUE 95%=$1,438, AFUE 96%=$1,650
OR - Energy Trust of Oregon	Furnace	calculated at $802. NPV of cost of furnace 4 or 5 years with a discount rate and subtract from cost of furnace. In addition, same process done for potential replacement costs in Year 25 and Year 30. Tax credit also factored in.	Discount rate of 3.2%; equals NWPPC "consumer discount rate" set each 5 years
IL - Ameren	Ground Source Heat Pump	Calculated	NPV of New Equipment Cost moved forward by RUL
OH - Dayton Power & Light	Ground Source Heat Pump	Calculated	Methodology articulated in draft OH TRM;"The average cost of a geothermal installation was $14,278 for a total system."; discount rate of 5%
NH - PSNH	Hardwired CFL	NO DETAILS AVAILABLE	NO DETAILS AVAILABLE
NH - Unitil	Hardwired CFL	NO DETAILS AVAILABLE	NO DETAILS AVAILABLE
MA - National Grid, NSTAR, Cape Light Compact, Unitil, WMECo, Columbia Gas, New England Gas, Blackstone Gas, Berkshire Gas	Heating System Replacement		
NH - PSNH	HID Lighting	NO DETAILS AVAILABLE	NO DETAILS AVAILABLE
NH - Unitil	HID Lighting	NO DETAILS AVAILABLE	NO DETAILS AVAILABLE
NH - Liberty	High efficiency air compressor	Calculated	35% of total cost
NH - PSNH	High efficiency air compressor	Calculated	35% of total cost
NH - Unitil	High efficiency air compressor	Calculated	35% of total cost
VT - Efficiency Vermont	High Performance T8 Fixtures Re-lamp, Re-ballast	Fixed	Cost values were collected for ballasts, lamps, and labor and used to determine the total cost for retrofit for each fixture type. This is the same cost used in normal replacement as well. No incremental cost is used for normal replacement here.
NH - PSNH	LED & LEC Exit Light	Calculated	35% of total cost
NH - Unitil	LED & LEC Exit Light	Calculated	35% of total cost
NH - Liberty	LED lighting	Calculated	35% of total cost
NH - Liberty	LED parking/roadway	Calculated	35% of total cost
NY - ConEdison	Lighting (Muliple types)	Fixed - varies by lighting measure	Full cost of new measures (equipment + labor)
NY - ConEdison	Lighting (Muliple types)	Calculated	Full cost of the replacement lighting
VT - Efficiency Vermont	Lighting (Muliple types)	Fixed	Cost values were collected for ballasts, lamps, and labor and used to determine separate baseline and proposed costs and the incremental cost between them was adopted for each fixture type.
NH - Liberty	Lighting controls	Calculated	35% of total cost
NH - PSNH	Lighting controls	Calculated	35% of total cost
NH - Unitil	Lighting controls	Calculated	35% of total cost
NY - NGRID	Lighting Systems/Lighting Controls	Calculated based on new equipment	New equipment cost
MA - National Grid	Commercial Lighting Retrofit	Calculated	Cost is based on the total installed cost of the new fixtures (labor and materials)

EARLY REPLACEMENT COST METHODS			
State - PA	**Efficient Measure Description**	**Early Replacement Cost - Fixed Amount or Calculated**	**Early Replacement Cost - Calculation Method**
MD - BGE	General Lighting (Lamp and Ballast Retrofits Commodity Fixtures Advanced Fixtures Fluorescent High Bay Fixtures Compact Fluorescent LED Exit Signs LED Strips LED Integral Replacement Lamps)	Calculated	Treat like normal replacement, just use incremental cost (EE - market)
CT - CL&P, UI, CNG, SCG, Yankeegas, Energize Connecticut	Lighting Retrofit	Determined for each project based on installed cost	Determined for each project
CO - Xcel Energy	Lighting Retrofit	Fixed amount, based on full cost of installing new fixture to replace existing fixture	Based on contractor prices obtained by Xcel
MN - Xcel Energy	Lighting Retrofit	Fixed amount, based on full cost of installing new fixture to replace existing fixture	Based on contractor prices obtained by Xcel
CT - CL&P, UI, CNG, SCG, Yankeegas, Energize Connecticut	Package Terminal Heat Pump		
CT - CL&P, UI, CNG, SCG, Yankeegas, Energize Connecticut	Refrigerator		
VT - Efficiency Vermont	Refrigerator Replacement	The initial measure cost for an Energy Star refrigerator is $533, Tier 2 is $612, Tier 3 is $670. The avoided replacement cost (after 3 years) of a baseline refrigerator is $504	Measure costs are based on review of data from the Northeast Regional ENERGY STAR Consumer Products Initiative; "2009 ENERGY STAR Appliances Practices Report", submitted by Lockheed Martin, December 2009. See 2009 VT Appliance Data_TRMCostAnalysis.xlsfor data. ESTAR incremental cost reduced to $40 based on ENERGY STAR Calculator; http://www.energystar.gov/ia/business/bulk_purchasing/bpsavings_calc/appliance_calculator.xlsx?e678-f5e6&e678-f5e6 These calculated full costs ($740 for ENERGY STAR, $850 for CEE Tier 2, $930 for CEE Tier 3 and $700 for a baseline unit) are multiplied by the 72% size factor to account for the smaller units being installed in MF.
VT - Efficiency Vermont	Refrigerator Replacement	The initial measure cost for an Energy Star refrigerator is $740 and Tier 2 is $850 and Tier 3 is $930. The avoided replacement cost (after 3 years) of a baseline refrigerator is $700	Measure costs are based on review of data from the Northeast Regional ENERGY STAR Consumer Products Initiative; "2009 ENERGY STAR Appliances Practices Report", submitted by Lockheed Martin, December 2009. See 2009 VT Appliance Data_TRMCostAnalysis.xlsfor data. ESTAR incremental cost reduced to $40 based on ENERGY STAR Calculator; http://www.energystar.gov/ia/business/bulk_purchasing/bpsavings_calc/appliance_calculator.xlsx?e678-f5e6&e678-f5e6
Washington, D.C. - DC SEU	Refrigerator Retrofit	Fixed	The initial measure cost for an ENERGY STAR refrigerator is $536 and Tier 2 is $638. The avoided replacement cost (after 3 years) of a baseline replacement refrigerator is $496. The $40 incremental cost from baseline based on ENERGY STAR calculator (EPA research, 2010). Tier 2 incremental and baseline costs are a weighted estimated from "TECHNICAL REPORT: Analysis of Amended Energy Conservation Standards for Residential Refrigerator-Freezers".
MA - National Grid, NSTAR, Cape Light Compact, Unitil, WMECo, Columbia Gas, New England Gas, Blackstone Gas, Berkshire Gas	Refrigerator Retrofit/Replacement	200 for adjusted cost	
MA - National Grid, NSTAR, Cape Light Compact, Unitil, WMECo, Columbia Gas, New England Gas, Blackstone Gas, Berkshire Gas	Refrigerator Retrofit/Replacement		
MA - National Grid, NSTAR, Cape Light Compact, Unitil, WMECo, Columbia Gas, New England Gas, Blackstone Gas, Berkshire Gas	Refrigerators/Freezer Replacement	Costs for Low Income unknown, they are billed by the site, not by the apartment unit or refrigerator	
NH - PSNH	Refrigerators/Freezer Replacement	Fixed	Based on tier
CO - Xcel Energy (Public Service Company of Colorado)	Refrigerator Replacement	Fixed amount ($631)	This is from the CO Governor's Energy Office and is the cost of a 2008 ENERGY STAR refrigerator with a $70 labor charge added on. This is listed as an incremental cost, but is actually the cost of the new refrigerator.
MN - Xcel Energy	Refrigerator Replacement	Fixed amount ($574), presumably to pay for the removal cost and the cost of the new ENERGY STAR unit.	Deemed value, it appears to be from their vendor, but they determined the vendor cost to be too high, so it was scaled down by multiplying the vendor cost by the ratio of the deemed air conditioner replacement measure cost to the vendor air conditioner cost to estimate vendor mark-up.
CT - CL&P, UI, CNG, SCG, Yankeegas, Energize Connecticut	Room AC		
NH - PSNH	Room AC	NO DETAILS AVAILABLE	NO DETAILS AVAILABLE
VT - Efficiency Vermont	Room AC	Fixed. The efficient (ENERGY STAR) unit costs are listed as $256, $337, $491, and $611. The new baseline (after RUL) costs are listed as $212, $293, $447, and $567	Costs were surveyed on the Lowes, Home Depot and Sears websites, cost for each product size class is based on the average cost per BTU of units of similar sizes and weighted average calculated assuming 10% of units will be more expensive CEE Tier 1 compliant.
Washington, D.C. - DC SEU	Room AC	Fixed	The cost for this measure is assumed to be $220 for the ENERGY STAR unit and $260 for a CEE Tier 1 unit, plus the cost of labor – assumed to be one hour at $20/hour . The deferred baseline replacement cost (the cost associated with the replacement of the existing unit with a standard unit that would have occurred in 3 years, had the existing unit not been replaced) is assumed to be $170. This cost should be assumed to occur three years after installation. Based on ENERGY STAR calculator assumption, VEIC field study for difference between CEE Tier 1 and ENERGY STAR cost, and a VEIC estimate of labor costs
Washington, D.C. - DC SEU	T12 Replacement	Fixed	Deemed and varies based on fixture type. It is separated into lamp, ballast replacement labor, and ballast cost for both the baseline and efficient fixtures. The source is not stated.

EARLY REPLACEMENT COST METHODS			
State - PA	**Efficient Measure Description**	**Early Replacement Cost - Fixed Amount or Calculated**	**Early Replacement Cost - Calculation Method**
CO - Xcel Energy (Public Service Company of Colorado)	Upgrade Motors with Premium or Enhanced Efficiency (1% above premium) Motors, 1 hp - 500 hp	Calculated based on motor size	New installation cost added to NEMA premium cost, varies based on motor size. Enhanced costs are extrapolated from NEMA premium costs
MN - Xcel Energy	Upgrade Motors with Premium or Enhanced Efficiency (1% above premium) Motors, 1 hp - 500 hp	Calculated based on motor size	New motor installation cost added to NEMA premium (or enhanced premium) material cost minus estimated motor rewind costs, varies based on motor size
NH - Liberty	VFD	Calculated	35% of total cost
NH - PSNH	VFD	Calculated	35% of total cost
NH - Unitil	VFD	Calculated	35% of total cost
CO - Xcel Energy	Factory-integrated VFDs on Air Compressors from 10 to 49 HP	Calculated based on motor size	Cost calculated for each motor size based on average cost from three manufacturers and $1,500 installation cost and then the baseline cost is subtracted to get the incremental cost
MN - Xcel Energy	VFDs on Air Compressors from 10 to 40 HP	Calculated based on motor size	Cost calculated for each motor size based on average cost from three manufacturers and $1,500 installation cost and then the baseline cost is subtracted to get the incremental cost
MA - National Grid, NSTAR, Cape Light Compact, Unitil, WMECo, Columbia Gas, New England Gas, Blackstone Gas, Berkshire Gas	Window AC (Retrofit)		
MA - National Grid	Window AC Replacement		
MN - Xcel Energy	Window AC Replacement	Fixed amount ($368), presumably to pay for the removal cost and the cost of the new ENERGY STAR unit.	Deemed value, no source provided. It is likely from their implementation vendor

Appendix G: Study Measures – Other Information

OTHER INFORMATION			
State - PA	**Efficient Measure Description**	**Other Information**	**Info Sources Used**
IL - Ameren	Air Source Heat Pump		Impact and Process Evaluation of Ameren Illinois Company's Residential HVAC Program (PY5); Illinois Statewide Techincal Reference Manual for Energy Efficiency
OH - Dayton Power & Light	Air-Source Heat-Pump	New measure in 2012; no early replacement information in Ohio TRM	State of Ohio Energy Efficiency Technical Reference Manual; DP&L Portfolio Plan 2013-2015; 2010, 2011, 2012, 2013 Portfolio Status Report
CT - CL&P, UI, CNG, SCG, Yankeegas, Energize Connecticut	Boiler	Early Retirement savings are shown as the sum of the lost opportunity savings (normal replacement) and the retrofit savings (RUL of existing unit against existing unit efficiency). When a boiler is also used for domestic hot water, those savings are also included and are estimated using the hot water load from the water heater program	Connecticut Program Savings Documentation 2013, Energize Connecticut website, Star Supply website
MA - National Grid, NSTAR, Cape Light Compact, Unitil, WMECo, Columbia Gas, New England Gas, Blackstone Gas, Berkshire Gas	Boiler	This program was designed to remove very old boilers from homes. To qualify for the extra incentive, the existing boiler needs to be at least 30 years old. This is not a new program but a new way of counting savings. They are now claiming some additional savings (and lower lifetime) in the HEHE program to account for the % of equipment that was early retirement based on a recent evaluation study.	Massachusetts TRM, Rhode Island 2014 TRM
MA - National Grid, NSTAR, Cape Light Compact, Unitil, WMECo, Columbia Gas, New England Gas, Blackstone Gas, Berkshire Gas	Boiler	"Correcting common errors in cost benefit analysis" paper was used in this analysis	Massachusetts TRM, GasNetworks.com
NH - Liberty	Boiler		MA TRM 2013-2015; Rebate form, and "Early Retirement" excel forms
NY - ConEdison	Boiler		NYS Appendix M Call w/ ConEdison Engineering Staff on 6/23/16
IL - Ameren	Boiler		Impact and Process Evaluation of Ameren Illinois Company's Residential HVAC Program (PY5); Illinois Statewide Techincal Reference Manual for Energy Efficiency
NH - PSNH	Boiler Circulating Pump		2014 PSNH All Pgms
CT - CL&P, UI, CNG, SCG, Yankeegas, Energize Connecticut	Central AC	Early Retirement savings are shown as the sum of the lost opportunity savings (normal replacement) and the retrofit savings (RUL of existing unit against existing unit efficiency)	Connecticut Program Savings Documentation 2013, Energize Connecticut website
NH - PSNH	Central AC		2014 PSNH All Pgms
MA - National Grid, NSTAR, Cape Light Compact, Unitil, WMECo, Columbia Gas, New England Gas, Blackstone Gas, Berkshire Gas	Central AC or HP Early Replacement	Installation of new equipment is verified. Age of existing equipment is not verified and is assumed to be 10-12 years.	Massachusetts TRM, Mass. Statewide Three-year plan
IL - Ameren	Central AC		Impact and Process Evaluation of Ameren Illinois Company's Residential HVAC Program (PY5); Illinois Statewide Techincal Reference Manual for Energy Efficiency
OH - Dayton Power & Light	Central AC -- Early replacement, New construction, and Replace on failure -- Multiple efficiency tiers		State of Ohio Energy Efficiency Technical Reference Manual; DP&L Portfolio Plan 2013-2015; 2010, 2011, 2012, 2013 Portfolio Status Report
AZ - Tucson Electric Power	Central AC or HP Early Retirement with Quality Install	The efficient equipment is assumed to be either a 14 SEER packaged A/C or heat pump with duct sealing and quality install or a 14.5 SEER split-system A/C or heat pump with duct sealing and quality install. The efficient units must be ENERGY STAR qualified. The ER incentive requires that contractors provide 72 hour notice to TEP before installing the new unit so that TEP can perform spot checks and can check to see if the existing unit conforms to program requirements. The prescriptive (non-performance) measures are subject to random data sampling. Duct sealing portion of the measure requires contractors to attend training on identifying and repairing leaks. Incentives as % of incremental costs: 59% for normal replace prescriptive, 70% for normal replace performance, 61% for ER prescriptive, 69% for ER performance	Tucson Electric Power Technical Reference Manual 2013. Tucson Electric Power Existing Homes Program ACC Filing, TEP Efficient Home Program Notice of Changes to Program Incentives, TEP.com
CO - Xcel Energy (Public Service Company of Colorado)	Early Retirement AC		Xcel Energy Deemed Savings Workbook - CO HEAC Rebate, Xcel Energy High Efficiency Cooling Rebate Application and Webpage
NY - ConEdison	Chiller		NYS Appendix M Call w/ ConEdison Engineering Staff on 6/23/15
CT - CL&P, UI, CNG, SCG, Yankeegas, Energize Connecticut	Clothes Washer	Water heating and drying fuels are accounted for by separate algorithms for the different fuels. If the fuel sources are unknown, a blended savings algorithm is used using estimated Connecticut fuel mix.	Connecticut Program Savings Documentation 2013, Energize Connecticut website
VT - Efficiency Vermont	Clothes Washer Retrofit	Efficient unit WF and MEF values depend on which efficiency level is selcted. ENERGY STAR is the lowest, followed by CEE Tier 2, CEE Tier 3, ENERGY STAR most efficient, and Top Ten.	Efficiency Vermont TRM Early Replacement and Dual Baseline Measures, Efficiency Vermont TRM
VT - Efficiency Vermont	In-Unit Clothes Washer Retrofit	Efficient unit WF and MEF values depend on which efficiency level is selcted. ENERGY STAR is the lowest, followed by CEE Tier 2, CEE Tier 3, ENERGY STAR most efficient, and Top Ten.	Efficiency Vermont TRM Early Replacement and Dual Baseline Measures, Efficiency Vermont TRM
VT - Efficiency Vermont	Common Area Clothes Washer Retrofit	Efficient unit WF and MEF values depend on which efficiency level is selcted. ENERGY STAR is the lowest, followed by CEE Tier 2, CEE Tier 3, ENERGY STAR most efficient, and Top Ten.	Efficiency Vermont TRM Early Replacement and Dual Baseline Measures, Efficiency Vermont TRM
NY - NGRID	Compressed Air Systems	"Appendix M is all about screening. Were not allowed to do a measure if it doesn't pass screening, the general format is benefits/costs >1. The benefits are from savings, converted to dollars using avoided costs. Costs are the costs of the measure or project with other things you add in such as admin costs and adjustment factors. Simple formula (kw * $/kwh *adjustment factor)/(costs). Has to be greater than 1 to be considered."	Call with Joe Dolengo at NY NGRID (3/27/14) Appendix M
CT - CL&P, UI, CNG, SCG, Yankeegas, Energize Connecticut	Custom		Connecticut Program Savings Documentation 2013
MA - National Grid	Custom		Dave Jacobson interview
MD - BGE	Varies based on project	RUL and free ridership related questions include: Is the current equipment functioning? Do you know the approximate age of the equipment? How much longer would it operate if not replaced by the program? Would you have replaced the equipment if the program was not available (if so, when)? Would you have waited until equipment failure? If would do early replacement: How long from now would yor replace? How many years is the new equipment expected to last?	Call Notes (6/12/14) w/ Navigant - Brent Barkett (Program Evaluator)
NH - Liberty	Custom		MA TRM 2012 & Liberty Utilities "All 2014 Applications"

OTHER INFORMATION			
State - PA	**Efficient Measure Description**	**Other Information**	**Info Sources Used**
NH - PSNH	Custom		MA TRM 2013-2015 PLAN FINAL & "All 2014 Applications" (Liberty file)
NH - Unitil	Custom		MA TRM 2013-2015 PLAN FINAL & "All 2014 Applications" (Liberty file)
NY - NGRID	Custom measures	"Appendix M is all about screening. Were not allowed to do a measure if it doesn't pass screening, the general format is benefits/costs >1. The benefits are from savings, converted to dollars using avoided costs. Costs are the costs of the measure or project with other things you add in such as admin costs and adjustment factors. Simple formula (kw * $/kwh *adjustment factor)/(costs). Has to be greater than 1 to be considered."	Call with Joe Dolengo at NY NGRID (3/27/14) Appendix M
MT - NorthWestern Energy	Custom measures	" Are always trying to find better ways to get savings, but must use the current TRC tool, which wont change for next 10 years, so don't really have any flexibility to consider other options "	Call with David Bausch at Northwestern Energy (3/5/14)
CT - CL&P, UI, CNG, SCG, Yankeegas, Energize Connecticut	Dehumidifier	Early Retirement savings are shown as the sum of the lost opportunity savings (normal replacement) and the retrofit savings (RUL of existing unit against existing unit efficiency).	Connecticut Program Savings Documentation 2013
MA - Cape Light Compact	Dehumidifiers (Early Retirement)	The measure description in the TRM includes both the normal replacement measure and the early retirement measure. The ER measure only applies to the RUL, there is no assumed savings after that.	Massachusetts TRM, NGRID Electric Annual Report (Appendix pg 80)
CT - CL&P, UI, CNG, SCG, Yankeegas, Energize Connecticut	Dishwasher	Water heating fuels are accounted for by separate algorithms/savings values for the different fuels. If the fuel sources are unknown, a blended savings algorithm is used using estimated Connecticut fuel mix. Connecticut uses Retirement for the RUL of the existing unit savings and Lost Opportunity for the EUL of the new unit savings and for normal replacements. The entire early retirement savings are classified as Retrofit	Connecticut Program Savings Documentation 2013
NH - Liberty	Electronically Commutated (EC) Motors		MA TRM 2013-2015 PLAN FINAL & "All 2014 Applications" (Liberty file)
NH - PSNH	Electronically Commutated (EC) Motors		2012 AAA Master & 2013 Master Spreadsheet - Lighting (Measure life)
NH - Unitil	Electronically Commutated (EC) Motors		2012 AAA Master & 2013 Master Spreadsheet - Lighting (Measure life)
NY - ConEdison	Electronically Commutated (EC) Motors	Measure offered through Small Business Direct Install Program.	Interview with Small Business Direct Install Program Manager & NY TRM
NH - PSNH	Fixtures		2014 PSNH All Pgms
NH - Unitil	Fixtures		2014 PSNH All Pgms
NH - Liberty	Fluorescent fixtures		MA TRM 2012 & Liberty Utilities "All 2014 Applications"
NH - PSNH	Fluorescent		2013 Master Spreadsheet - Lighting
NH - Unitil	Fluorescent		2013 Master Spreadsheet - Lighting
CT - CL&P, UI, CNG, SCG, Yankeegas, Energize Connecticut	Freezer Replacement	Early Retirement savings are shown as the sum of the lost opportunity savings (normal replacement) and the retrofit savings (RUL of existing unit against existing unit efficiency). Exceptions to standard calculations for replacement of existing units may occur in the following special situations: a. If the annual kWh usage of the existing unit is already less than or equal to the baseline level (Ee Eb), no retirement savings may be claimed. b. If the annual kWh usage of existing unit is less than the baseline level but greater than the annual kWh usage of the new installed unit (Ei < Ee < Eb), the lost opportunity component of savings may still be claimed, but the existing unit Annual kWh usage must be used for the baseline rather than Energy Star 2004. c. If new unit Annual kWh is greater than or equal to the existing unit kWh (Ee<Ei), regardless of size, no savings may be claimed.	Connecticut Program Savings Documentation 2013, Energize Connecticut website
VT - Efficiency Vermont	Freezer Replacement	This measure became prescriptive in 2009, so individual unit energy use is no longer tracked. The age requirement for this measure was changed in 2012 from pre-1993 to pre-2001. 8477 equivalent full load hours are assumed. Efficient unit efficiency: High efficiency is defined as any model meeting or exceeding 2007 Energy Star standard – currently set to 10% over the 2001 federal minimum standard.	Efficiency Vermont TRM Early Replacement and Dual Baseline Measures, Efficiency Vermont TRM
VT - Efficiency Vermont	Freezer Replacement	This measure became prescriptive in 2009, so individual unit energy use is no longer tracked. The age requirement for this measure was changed in 2012 from pre-1993 to pre-2001. 8477 equivalent full load hours are assumed. Efficient unit efficiency: High efficiency is defined as any model meeting or exceeding 2007 Energy Star standard – currently set to 10% over the 2001 federal minimum standard.	Efficiency Vermont TRM Early Replacement and Dual Baseline Measures, Efficiency Vermont TRM
MA - National Grid, NSTAR, Cape Light Compact, Unitil, WMECo, Columbia Gas, New England Gas, Blackstone Gas, Berkshire Gas	Freezer Retrofit/Replacement	High-efficiency case is a new high efficiency freezer, but is not defined.	Massachusetts TRM, MassSave website
MN - Xcel Energy	Freezer Replacement	Also, for all of the low income measures, it should be noted that the rebate amounts are equal to the incremental costs, which are equal to the cost of removing and disposing of the existing units and purchasing the new unit	Xcel Energy Deemed Savings Workbook - Home Energy Savings Program, Xcel Energy Income-Qualified Home Energy Services website
CT - CL&P, UI, CNG, SCG, Yankeegas, Energize Connecticut	Furnace	Early Retirement savings are shown as the sum of the lost opportunity savings (normal replacement) and the retrofit savings (RUL of existing unit against existing unit efficiency)	Connecticut Program Savings Documentation 2013, Energize Connecticut website, Star Supply website
NY - ConEdison	Furnace		NYS Appendix M Call w/ ConEdison Engineering Staff on 6/23/14
NH - PSNH	Furnace Fan		2014 PSNH All Pgms
NH - PSNH	Furnace w/ ECM Motor		2014 PSNH All Pgms
IL - Ameren	Furnace		Impact and Process Evaluation of Ameren Illinois Company's Residential HVAC Program (PY5); Illinois Statewide Techincal Reference Manual for Energy Efficiency
OR - Energy Trust of Oregon	Furnace	* Are now studying whether to ad a second (dual) baseline to capture additional smaller savings for 21 years	Call with Paul Sklar at ET (3/4/14) "Annointing but not a blessing of gas furnace arly replacement" (Email outlining the program)
IL - Ameren	Ground Source Heat Pump	Ameren does not distinguish between early and normal replacement for this measure.	Impact and Process Evaluation of Ameren Illinois Company's Residential HVAC Program (PY5); Illinois Statewide Techincal Reference Manual for Energy Efficiency
OH - Dayton Power & Light	Ground Source Heat Pump	New measure in 2010; no early replacement information in Ohio TRM	State of Ohio Energy Efficiency Technical Reference Manual; DP&L Portfolio Plan 2013-2015; 2010, 2011, 2012, 2013 Portfolio Status Report
NH - PSNH	Hardwired CFL		2013 Master Spreadsheet - Lighting
NH - Unitil	Hardwired CFL		2013 Master Spreadsheet - Lighting

OTHER INFORMATION			
State - PA	**Efficient Measure Description**	**Other Information**	**Info Sources Used**
MA - National Grid, NSTAR, Cape Light Compact, Unitil, WMECo, Columbia Gas, New England Gas, Blackstone Gas, Berkshire Gas	Heating System Replacement		Massachusetts TRM, GasNetworks.com
NH - PSNH	HID Lighting		2013 Master Spreadsheet - Lighting
NH - Unitil	HID Lighting		2013 Master Spreadsheet - Lighting
NH - Liberty	High efficiency air compressor		MA TRM 2012 & Liberty Utilities "All 2014 Applications"
NH - PSNH	High efficiency air compressor		2012 AAA Master & 2013 Master Spreadsheet - Lighting (Measure life)
NH - Unitil	High efficiency air compressor		2012 AAA Master & 2013 Master Spreadsheet - Lighting (Measure life)
VT - Efficiency Vermont	High Performance T8 Fixtures Re-lamp, Re-ballast		Efficiency Vermont TRM
NH - PSNH	LED & LEC Exit Light		2013 Master Spreadsheet - Lighting
NH - Unitil	LED & LEC Exit Light		2013 Master Spreadsheet - Lighting
NH - Liberty	LED lighting		MA TRM 2012 & Liberty Utilities "All 2014 Applications"
NH - Liberty	LED parking/roadway		MA TRM 2012 & Liberty Utilities "All 2014 Applications"
NY - ConEdison	Lighting (Muliple types)	Measures offered through Small Business Direct Install Program. Most savings from T12 to T8; also do high and low bay lighting, HIDs, normal incandescents to CFLs or LEDs. Hard to collecting existing equipment information cost effectively when serving 400-500 small businesses per week. Many customers are Hard to Reach and don't track prior equipment installations.	Interview with Small Business Direct Install Program Manager
NY - ConEdison	Lighting (Muliple types)	Recent adjustments to LED EULs available at: https://www.conedci.com/Lighting.aspx	NYS Appendix O Call w/ ConEdison Engineering Staff on 6/23/14
VT - Efficiency Vermont	Lighting (Muliple types)		Efficiency Vermont TRM
NH - Liberty	Lighting controls		MA TRM 2012 & Liberty Utilities "All 2014 Applications"
NH - PSNH	Lighting controls		2013 Master Spreadsheet - Lighting
NH - Unitil	Lighting controls		2013 Master Spreadsheet - Lighting
NY - NGRID	Lighting Systems/Lighting Controls	"Appendix M is all about screening. Were not allowed to do a measure if it doesn't pass screening, the general format is benefits/costs >1. The benefits are from savings, converted to dollars using avoided costs. Costs are the costs of the measure or project with other things you add in such as admin costs and adjustment factors. Simple formula (kw * $/kwh *adjustment factor)/(costs). Has to be greater than 1 to be considered."	Call with Joe Dolengo at NY NGRID (3/27/14) Appendix M
MA - National Grid	Commercial Lighting Retrofit	incentive is 50% of total cost including labor	Massachusetts TRM
MD - BGE	General Lighting (Lamp and Ballast Retrofits Commodity Fixtures Advanced Fixtures Fluorescent High Bay Fixtures Compact Fluorescent LED Exit Signs LED Strips LED Integral Replacement Lamps)		BGE Energy Solutions for Business Application BGE Call Notes (3/7/14) w/ Sheldon Switzer (BGE), Drew Durkee (ICF) and Karl Eser (BGE) Navigant Call Notes (6/12/14) w/ Brent Barkett
CT - CL&P, UI, CNG, SCG, Yankeegas, Energize Connecticut	Lighting Retrofit	To account for the Energy Independence and Security Act of 2007 the baseline for existing (installed) General Service bulbs shall be based on high efficiency incandescent bulbs (such as halogen). Therefore, if the existing incandescent bulb is not a halogen, 75% of actual installed wattage is used for the baseline calculation. General Service bulbs are defined as medium base bulbs that are intended for general service applications as specified in the Energy Independence and Security Act of 2007.	Connecticut Program Savings Documentation 2013, http://repository.tamu.edu/bitstream/handle/1969.1/128838/ESL-IC-11-10-57.pdf?sequence=1, 2014 Project Caps and Incentive Structure for CL&P
CO - Xcel Energy	Lighting Retrofit		Xcel Energy Deemed Savings Workbook - Lighting Efficiency
MN - Xcel Energy	Lighting Retrofit		Xcel Energy Deemed Savings Workbook - Business Lighting
CT - CL&P, UI, CNG, SCG, Yankeegas, Energize Connecticut	Package Terminal Heat Pump	Early Retirement savings are shown as the sum of the lost opportunity savings (normal replacement) and the retrofit savings (RUL of existing unit against existing unit efficiency)	Connecticut Program Savings Documentation 2013, Energize Connecticut website
CT - CL&P, UI, CNG, SCG, Yankeegas, Energize Connecticut	Refrigerator	Early Retirement savings are shown as the sum of the lost opportunity savings (normal replacement) and the retrofit savings (RUL of existing unit against existing unit efficiency). Exceptions to standard calculations for replacement of existing units may occur in the following special situations: a. If the annual kWh usage of the existing unit is already less than or equal to the baseline level (Ee Eb), no retirement savings may be claimed. b. If the annual kWh usage of existing unit is less than the baseline level but greater than the annual kWh usage of the new installed unit (Ei < Ee < Eb), the lost opportunity component of savings may still be claimed, but the existing unit Annual kWh usage must be used for the baseline rather than Energy Star 2004. c. If new unit Annual kWh is greater than or equal to the existing unit kWh (Ee<Ei), regardless of size, no savings may be claimed.	Connecticut Program Savings Documentation 2013, Energize Connecticut website
VT - Efficiency Vermont	Refrigerator Replacement	This measure became prescriptive in 2009, so individual unit energy use is no longer tracked. The age requirement for this measure was changed in 2012 from pre-1993 to pre-2001. 8477 equivalent full load hours are assumed. Efficient unit efficiency: High efficiency is defined as any model meeting or exceeding 2007 Energy Star standard – currently set to 20% over the 2001 federal minimum standard or optionally 25% or 30% to meet CEE Tier 2 or Tier 3. EVT's energy savings estimates are based on the weighted average test measurements for qualifying models based on the models rebated during the previous calendar year.	Efficiency Vermont TRM Early Replacement and Dual Baseline Measures, Efficiency Vermont TRM

OTHER INFORMATION			
State - PA	**Efficient Measure Description**	**Other Information**	**Info Sources Used**
VT - Efficiency Vermont	Refrigerator Replacement	This measure became prescriptive in 2009, so individual unit energy use is no longer tracked. The age requirement for this measure was changed in 2012 from pre-1993 to pre-2001. 8477 equivalent full load hours are assumed. Efficient unit efficiency: High efficiency is defined as any model meeting or exceeding 2007 Energy Star standard – currently set to 20% over the 2001 federal minimum standard or optionally 25% or 30% to meet CEE Tier 2 or Tier 3. EVT's energy savings estimates are based on the weighted average test measurements for qualifying models based on the models rebated during the previous calendar year.	Efficiency Vermont TRM Early Replacement and Dual Baseline Measures, Efficiency Vermont TRM
Washington, D.C. - DC SEU	Refrigerator Retrofit	According to Nikola, this measure is no longer in use. It was recorded here for completeness.	DC SEU TRM addendum to the Mid-Atlantic TRM, 2013 Mid-Atlantic TRM
MA - National Grid, NSTAR, Cape Light Compact, Unitil, WMECo, Columbia Gas, New England Gas, Blackstone Gas, Berkshire Gas	Refrigerator Retrofit/Replacement	High-efficiency case is ENERGY STAR refrigerator (at least 7.75 cubic feet). Savings are all based on 8,760 operating hours.	Massachusetts TRM, MassSave website
MA - National Grid, NSTAR, Cape Light Compact, Unitil, WMECo, Columbia Gas, New England Gas, Blackstone Gas, Berkshire Gas	Refrigerator Retrofit/Replacement	High-efficiency case is ENERGY STAR refrigerator (at least 7.75 cubic feet). Savings are all based on 8,760 operating hours.	Massachusetts TRM, MassSave website
MA - National Grid, NSTAR, Cape Light Compact, Unitil, WMECo, Columbia Gas, New England Gas, Blackstone Gas, Berkshire Gas	Refrigerators/Freezer Replacement	ENERGY STAR unit efficiency determined from nameplate on new unit and refrigerator database. Occupant adjustment factor used to adjust the energy savings according to the number of occupants in the dwelling unit, based on a table in TRM. It ranges from 1 to 1.16 for 0 to 5 occupants. It is also assumed that there is 0.00013 kW reduction for every kWh saved. This comes from: Cadmus Demand Impact Model (2012). Prepared for Massachusetts Program Administrators. Loadshape: Res Multi Family Electric Refrigeration (REFRIGERATOR) Normal. It is unclear why this is listed as a separate measure, since there is a previous refrigerator early retirement, low income measure	Massachusetts TRM, MassSave website
NH - PSNH	Refrigerators/Freezer Replacement		2014 PSNH All Pgms
CO - Xcel Energy (Public Service Company of Colorado)	Refrigerator Replacement		Xcel Energy Deemed Savings Workbook - Single Family Weatherization
MN - Xcel Energy	Refrigerator Replacement	Also, for all of the low income measures, it should be noted that the rebate amounts are equal to the incremental costs, which are equal to the cost of removing and disposing of the existing units and purchasing the new unit	Xcel Energy Deemed Savings Workbook - Home Energy Savings Program, Xcel Energy Income-Qualified Home Energy Services website
CT - CL&P, UI, CNG, SCG, Yankeegas, Energize Connecticut	Room AC	Early Retirement savings are shown as the sum of the lost opportunity savings (normal replacement) and the retrofit savings (RUL of existing unit against existing unit efficiency)	Connecticut Program Savings Documentation 2013
NH - PSNH	Room AC		2014 PSNH All Pgms
VT - Efficiency Vermont	Room AC	Efficient case EER values for each of the four capacity categories come from averages of ENERGY STAR published EER values for A/C equipment from 2009 and range from 9.52 to 10.85, based on capacity. It must meet or exceed ENERGY STAR requirements. http://www.energystar.gov/index.cfm?fuseaction=roomac.display_products_html It is assumed that the average unit replaced will be 12 years old. FLH are assumed to be 1000 hours per year using loadshape #15 from the Vermont Screening Tool. The four capacity categories are represented by values of 6, 12, 18, and 24,000 BTU/h in the algorithms. 1% degredation assumption comes from: Personal communications with Harvey Sachs (ACEEE) and Michael Pilat (NYSERDA/Lockheed Martin), both dated 10/09/09. Also, the "NYSERDA Keep Cool Report 2000-2003" (Aspen Systems Corporation, 2003) page A-2 describes testing of old AC units which found EER degradation of 16% in units averaging 15 years of age.	Efficiency Vermont TRM Early Replacement and Dual Baseline Measures, Efficiency Vermont TRM
Washington, D.C. - DC SEU	Room AC	According to Nikola, this measure is no longer in use. It was recorded here for completeness.	DC SEU TRM addendum to the Mid-Atlantic TRM
Washington, D.C. - DC SEU	T12 Replacement	This measure accounts for both cooling savings and heating penalties associated with a reduction in lighting power. There isn't really a normal replacement companion measure, since this measure is just for T12 fixture replacement. This measure also includes incandescent and fluorescent exit sign retrofits. High-output T12 lamps are considered, along with high-performance 28-watt T8 lamps. In one program document, the rebate is $20 per fixture. In another, the rebate is free lamps, installation, removal, and clean up.	DC SEU TRM addendum to the Mid-Atlantic TRM, Fluorescent Lighting Upgrade datasheet, CLEER T12 program datasheet
CO - Xcel Energy (Public Service Company of Colorado)	Upgrade Motors with Premium or Enhanced Efficiency (1% above premium) Motors, 1 hp - 500 hp	Xcel uses Plan A and Plan B to designate whether a measure is new replacement or early retirement. Plan A is new and Plan B is early retirement for measures that have early retirement at all.	Xcel Energy Deemed Savings Workbook - Motor and Drive Efficiency, Xcel Energy Business Motor and Drive Efficiency Rebate Application
MN - Xcel Energy	Upgrade Motors with Premium or Enhanced Efficiency (1% above premium) Motors, 1 hp - 500 hp	Xcel uses Plan A and Plan B to designate whether a measure is new replacement or early retirement. Plan A is new and Plan B is early retirement for measures that have early retirement at all. This measure has both a plan B and a plan B enhanced to designate the efficiency of the proposed motors	Xcel Energy Deemed Savings Workbook - Motors and Drives, Xcel Energy Business Motor Efficiency Rebate Application
NH - Liberty	VFD		MA TRM 2012 & Liberty Utilities "All 2014 Applications"
NH - PSNH	VFD		2012 AAA Master & 2013 Master Spreadsheet - Lighting (Measure life)
NH - Unitil	VFD		2012 AAA Master & 2013 Master Spreadsheet - Lighting (Measure life)
CO - Xcel Energy	Factory-integrated VFDs on Air Compressors from 10 to 49 HP	Xcel uses Plan A and Plan B to designate whether a measure is new replacement or early retirement. Plan A is new and Plan B is early retirement for measures that have early retirement at all.	Xcel Energy Deemed Savings Workbook - Compressed Air Efficiency, Xcel Energy Business Compressed Air VFD and No-Loss Drain Rebate Application
MN - Xcel Energy	VFDs on Air Compressors from 10 to 40 HP	Xcel uses Plan A and Plan B to designate whether a measure is new replacement or early retirement. Plan A is new and Plan B is early retirement for measures that have early retirement at all.	Xcel Energy Deemed Savings Workbook - Fluid System Optimization, Xcel Energy Business Fluid System Optimization Rebate Application
MA - National Grid, NSTAR, Cape Light Compact, Unitil, WMECo, Columbia Gas, New England Gas, Blackstone Gas, Berkshire Gas	Window AC (Retrofit)	Only offered as a measure when an AC timer would not reduce usage during the peak period. Efficient unit in ER measure has an efficiency that was not provided.	Massachusetts TRM, MassSave website
MA - National Grid	Window AC Replacement	EFLH value comes from: RLW Analytics (2008). Coincidence Factor Study: Residential Room Air Conditioners. Prepared for Northeast Energy Efficiency Partnerships' New England Evaluation and State Program Working Group; Page 32, Table 22 - found by averaging the EFLH values for MA cities (Boston and Worcester): (228+172)/2 = 200. All equipment installations are verified.	Massachusetts TRM,

OTHER INFORMATION			
State - PA	**Efficient Measure Description**	**Other Information**	**Info Sources Used**
MN - Xcel Energy	Window AC Replacement	Also, for all of the low income measures, it should be noted that the rebate amounts are equal to the incremental costs, which are equal to the cost of removing and disposing of the existing units and purchasing the new unit	Xcel Energy Deemed Savings Workbook - Home Energy Savings Program, Xcel Energy Income-Qualified Home Energy Services website