

**PENNSYLVANIA
PUBLIC UTILITY COMMISSION**
Harrisburg, PA. 17105-3265

Public Meeting held May 28, 2009

Commissioners Present:

James H. Cawley, Chairman
Tyrone J. Christy, Vice Chairman
Kim Pizzingrilli
Wayne E. Gardner
Robert F. Powelson

Implementation of the Alternative Energy Portfolio Standards Act of 2004: Standards for the Participation of Demand Side Management Resources – Technical Reference Manual Update Docket No. M-00051865

ORDER

BY THE COMMISSION:

In implementing the Alternative Energy Portfolio Standards Act, 73 P.S. §§ 1648.1 – 1648.8, this Commission had previously adopted an *Energy-Efficiency and DSM Rules for Pennsylvania’s Alternative Energy Portfolio Standard, Technical Reference Manual* (“TRM”).¹ In adopting the original version of the TRM, this Commission directed the Bureau of Conservation, Economics and Energy Planning (“CEEP”) to oversee the implementation, maintenance and periodic updating of the TRM.² Additionally, in the Energy Efficiency and Conservation Program Implementation Order,³ this Commission adopted the TRM as a component of the Energy Efficiency and Conservation (“EE&C”) Program evaluation process. In that

¹ Order entered on October 3, 2005, under the above-referenced caption and Docket Number.

² *Id.* at page 13.

³ Order entered on January 16, 2009, at Docket No. M-2008-2069887, at page 13 (Implementing the energy efficiency and conservation program requirements of Act 129 of 2008, 66 Pa.C.S. §§ 2806.1).

Implementation Order, this Commission also noted that “as the TRM was initially created to fulfill requirements of the AEPS Act, it will need to be updated and expanded to fulfill the requirements of the EE&C provisions of Act 129.”⁴ Soon after the adoption of the EE&C Program Implementation Order, Commission staff initiated a collaborative process to review and update the TRM with the purpose of supporting both the AEPS Act and the Act 129 EE&C program. With this Order, the Commission adopts the 2009 version of the TRM as contained in the Annex to this Order.

BACKGROUND

On February 20, 2009, this Commission issued a Secretarial Letter seeking comments on a proposed TRM update.⁵ Comments were due March 12, 2009, with reply comments due March 27, 2009. Commission staff also held a TRM Working Group meeting with interested stakeholders On March 24, 2009, to discuss the proposed TRM and filed comments. At that meeting, Commission staff extended the reply comment period to March 30, 2009.

The following parties filed comments to the proposed TRM update: Duquesne Light Co. (“Duquesne”), Elster Integrated Solutions (“Elster”), The Energy Association of Pennsylvania (“EAPA”), Lawrence E. Spielvogel, Inc. (“Spielvogel”), PECO Energy Co. (“PECO”), Positive Energy, Inc. (“Positive Energy”), PPL Electric Utilities Corp. (“PPL”), UGI Utilities, Inc. – Gas Division, UGI Penn Natural Gas, Inc. and UGI Central Penn Gas, Inc. (collectively, “UGI”), and West Penn Power Co. d/b/a Allegheny Power (“Allegheny”).

⁴ See page 13 of Implementation Order at Docket No. M-2008-2069887, entered January 16, 2009.

⁵ Commission staff developed this proposed TRM in consultation with Clean Power Markets, the Commission’s Alternative Energy Program Administrator, and Lawrence Berkeley National Laboratory.

The following parties participated in the March 24, 2009, TRM Working Group meeting: Clean Power Markets, Duquesne, the E Cubed Co., Elster, EAPA, EnerNOC, Inc. (“EnerNOC”), First Energy Corp. (“First Energy”), Honeywell Corp. (“Honeywell”), MCR Group (“MCR”), PECO, Pennsylvania Department of Environmental Protection (“DEP”), PPL, Regulatory Connection, and UGI.

The following parties filed reply comments: Duquesne, EAPA, EnerNOC, First Energy, Keystone Energy Efficiency Alliance (“KEEA”), PA Home Energy, PECO, Positive Energy, PPL, Allegheny. The Commission would like to thank all of those who participated in this process.

DISCUSSION

Below, we will discuss the more significant changes and updates being made to the TRM. Minor administrative changes will not be discussed.

A. Dual Purpose of TRM

As noted above, the EE&C Program Implementation Order entered January 16, 2009 indicated that the Commission will utilize the TRM for the EE&C Program evaluation process requirements. A process was initiated to expand and update the TRM to fulfill the requirements of the EE&C provisions of Act 129 as well as the requirements of the AEPS Act. The expanded and updated TRM will be used for implementation of Act 129 and continued use for the purpose of identifying demand side management and energy efficiency (“DSM/EE”) alternative energy credit amounts for AEPS Act compliance.

We have received several comments noting that some of the draft TRM language is confusing because it relates only to either the AEPS Act or the EE&C provisions of

Act 129. Comments recommend employing a means that will identify elements of the TRM that are specific to Act 129 or the AEPS Act. In addition, we have received suggestions that the TRM include a section with definitions to aid in clarifying the elements that are specific to the AEPS Act or Act 129.

The Commission agrees that the TRM needs to indicate its dual purpose for use with the EE&C provisions of Act 129 and the AEPS Act such that it clearly indicates which elements are solely related to the AEPS Act. As such, we have shaded those elements in the TRM that apply solely to the AEPS Act. All non-shaded areas are applicable to both the EE&C provisions of Act 129 and the AEPS Act.

The Commission also agrees that the addition of a definitions section to the TRM would be helpful to clarify words and terms used and to identify their applicability to the AEPS Act, the EE&C provisions of Act 129, or both. A small definitions section has been added to the TRM.

B. Changes to Individual Measures

In this section we will address individual standard measures identified in the TRM or proposed by commenters.

1. Energy Star Savings vs. Sales-Weighted Average

Lawrence Berkeley National Laboratory (“LBNL”) recommended adjusting the Energy Star appliance savings based on existing Federal standards as the baseline to savings adjusted for current sales-weighted average efficiencies based on the most recent Association of Home Appliance Manufacturers (“AHAM”) information. The tables provided by LBNL that use AHAM information significantly reduced the savings

estimates for refrigerators, freezers, dishwashers, room air conditioners, and residential clothes washers.

EAPA, First Energy, PECO and Duquesne recommend savings calculations based on Federal standards. Allegheny recommends that information from industry resources and manufacturers regarding each appliance be used to determine the deemed energy savings.

The Commission will use Energy Star appliance savings based on current Federal standards for this revision of the TRM. We note that the TRM contains deemed energy savings, EDCs are free to utilize approved custom measures for appliance replacements, as Allegheny suggests.

In addition, several commenters noted that there are updated ratings for Energy Star appliances that are not incorporated in the TRM. These updates pertain to water heaters, heat pumps, dishwashers and clothes washers. We have updated these ratings in Tables 7 and 10 to reflect the latest Energy Star ratings.

Finally, PECO and KEEA noted a need to allow the use of software that meets a national standard for savings' calculations. We agree with these comments and have incorporated language in the TRM under Residential New Construction to allow for any recognized software that meets national standards when implementing Home Performance with Energy Star. Similarly, we have revised the language under Home Performance with Energy Star noting that software that meets national standards for savings' calculations of whole-house approaches such as Home Performance must be used. References for three standards are provided.

2. Energy Star Lighting – Compact Fluorescent Lighting

LBNL recommended a reduction in the hours of use for compact fluorescent lighting (“CFL”) from 3.4 hrs/day to 2.0 hrs/day. LBNL also recommended a reduction in the measured lifetime for CFLs, as well as a downward adjustment over time in the net-to-gross ratios of screw-in CFLs to account for the impacts of the Energy Independence and Security Act of 2007⁶ (“EISA”).

Both EAPA and PECO recommend against adopting LBNL’s proposed changes. They disagree with LBNL’s recommendation to reduce TRM hours of use because, the recommendation is not based on data gathered in Pennsylvania. PECO points out that LBNL recommended a net-to-gross adjustment that is more aggressive than and inconsistent with the EISA schedule. PECO stated that the Commission should adopt net-to-gross methodology that is more reasonable and Pennsylvania specific.

The Commission rejects LBNL’s recommendations to reduce the TRM hours of use for CFLs to 2.0 hrs/day. However, the commission will reduce the TRM hours of use for CFLs to 3.0 hrs/day based on information from the U.S. Department of Energy, Energy Star Calculator as of March 16, 2009.

The Commission agrees with EAPA and PECO that LBNL’s recommended net-to-gross ratio adjustment for screw-in CFLs is inconsistent with the EISA schedule and declines to follow LBNL’s recommendation. However, the Commission believes that implementation of EISA requirements for standard incandescent light bulbs needs to be accounted for in energy savings EDCs claim from CFL distribution measures. The EISA requires phasing out, over several years, the manufacturing and importation of incandescent bulbs in their current configuration by imposing new performance standards

⁶ 42 U.S.C.S. § 6295

with prescribed wattage limitations. For example, under the new standards the lumens produced from a currently available 100 watt bulb must be produced by a bulb with a maximum wattage of 72 watts. The phased implementation begins January 1, 2012, when 100W incandescent bulbs can no longer be manufactured or imported for sale; the 75W bulb is restricted beginning January 2013; with the 60W and 40W bulbs follow in January 2014. While the EISA prohibits the manufacture and importation of existing incandescent bulbs, it does not prohibit the sale of the phased out bulbs in stock. The Commission recognizes that depletion of incandescent bulb existing stock will take some time and has decided to use a depletion time of five months following the effective date of a new standard established in EISA.

Therefore, the Commission directs EDCs to adjust the calculated energy savings claimed from CFL measures to reflect implementation of the EISA incandescent light bulb standards. Specifically, the amount of energy savings reflected in the table is reduced in accordance with the new maximum wattages established by the EISA with a five month delay to account for the depletion of existing incandescent bulb stocks. For example, if an EDC distributes 26W CFLs to replace 100W incandescent bulbs in 2010, the energy savings calculations would use 74 watts saved per bulb until June 1, 2012, but only 46 watts saved for the remaining time of the CFL measure life.

3. LED Traffic Signals

The draft TRM included Table 16: Traffic Signals. PECO commented that the Equivalent Full Load Hours in Table 16 were calculated using inappropriate variables and recommended removal of the table or replacement with a new table provided by PECO. PECO's proposed Table 16 compared incandescent and LED traffic signals. EAPA and PPL supported the inclusion of PECO's proposed table for traffic signals. In its reply comments, PECO included a revised and more complete Table 16. The

Commission agrees that LED traffic light signals should be included in the TRM and has included PECO's revised Table 16 in the TRM.

4. Large Scale Data Analysis

Positive Energy request that the Commission include Large Scale Data Analysis ("LSDA") as part of the revised TRM or at least allow LSDA to be used as a custom measure. Duquesne, PECO and PPL commented that LSDA is not an appropriate measure for inclusion in the TRM. In its reply comments, Positive Energy clarified that the Commission should accept LSDA as an appropriate evaluation, measurement and verification ("EM&V") technique and that the TRM acknowledge the use of LSDA as such.

The Commission agrees with comments that oppose inclusion of LSDA in the TRM and recognizes Positive Energy for submitting reply comments to clarify their request. The Commission agrees that LSDA can be considered one of many techniques that evaluators may use to measure efficiency gains. However, the Commission does not believe that the TRM is the appropriate place to address specific EM&V measures unrelated to standard measures and will decline to include LSDA in the TRM.

5. Smart Meters

Elster suggested that smart meters be used to collect data for use in the TRM. PECO commented that since the Commission has not issued its proposed smart meter rules, Elster's suggestion is pre-mature. The Commission acknowledges that special metering may be necessary to validate certain custom measures. However, the Commission agrees with PECO and believes that smart meter issues should be addressed in the Commission's Smart Meter Procurement and Installation plans proceeding at Docket No. M-2009-2092655.

6. Natural Gas Fuel Switching

UGI and PECO support measures that count energy and demand savings when electric equipment is removed and replaced with equipment that uses natural gas. PECO suggested that the Commission tentatively approve fuel switching as a potential TRM measure, pending the establishment and report of a fuel-switching sub-group.

First Energy does not support fuel switching and notes that there are many issues related to fuel switching that must be considered. PPL suggests that fuel switching should be considered a custom measure and not included in the TRM. EAPA supports convening a sub-group to examine the fuel switching issue and the possibility of including it in the TRM in subsequent years.

The Commission recognizes that fuel switching is a complicated topic that will require additional time and effort to fully address. As the TRM will provide vital guidance to EDCs in developing their EE&C plans, which are due to be filed by July 1, 2009, there is not enough time to convene a working group to address all the related issues, fuel switching will not be included in this TRM. The Commission will convene a fuel switching working group in the near future to identify, research and address issues related fuel switching. Depending on the outcome of this working group, fuel switching may be incorporated into a future version of the TRM.

7. Additional Measures Not Included

The Commission received several comments about measures not contained in the TRM. These comments fall into two general categories, potential standard measures not currently included in the TRM and custom measures. We will address each general category.

PECO and Duquesne provided comments on several potential standard measures that may qualify for deemed savings calculations for future TRM updates. These standard measures include street lighting, outdoor lighting, and home and office electronics. Duquesne mentioned the potential for residential TVs, TV set-top boxes, DVDs and desktop computers.

The Commission fully intends to add new standard measures to the TRM as commonly accepted savings calculations become available. We will consider such recommendations in our regular TRM update process. Some of the specific equipment mentioned by PECO and Duquesne may be good candidates for additions to future versions of the TRM as more information becomes available.

The second general category of comments pertaining to measures not included in the TRM refers to custom measures. EAPA commented that the TRM was missing many energy and demand savings measures such as rates and tariffs involving peak load management; e.g. time-of-use, critical peak pricing, direct load control and curtailment/interruptible load tariffs. EAPA also noted the absence of measures for whole house/building EE&C projects. Duquesne commented on the absence of residential retrofit measures, such as insulation, duct work, infiltration reduction and whole house performance. Also noted by Duquesne was the absence of commercial measures such as refrigeration and commercial building retro-commissioning.

We will adopt the general approach proposed by PECO and PPL that for the purposes of the Act 129 EE&C program, custom measures should be outside of the scope of the TRM. As noted by PPL, the TRM is intended only for standard measures that warrant standard energy efficiency calculation methods and assumptions. More complex measures, that involve unique variables and/or whose results are measured directly, should be treated as custom measures. Examples noted above, including residential whole house or building EE&C projects, retrofit projects, or pricing programs designed

for peak demand-savings, are all considered custom measures. The absence of these measures in the TRM should in no way discourage EDCs from proposing such measures in their EE&C plans. The Commission fully expects that a sizeable proportion of the residential programs and perhaps a majority of the commercial and industrial programs will be based on custom measures. The determination of energy and demand savings for EE&C program custom measures will be based on the EM&V protocols as determined by the Commission, versus the deemed savings contained in the TRM for standard measures.

Consistent with our determination to use the TRM only for standard measures, we will make several modifications to the TRM. First, we will remove the section entitled “Blue Line Innovations-Power Cost Monitor” including Table 14 noting the reductions in electricity consumption associated with the installation of in home energy monitoring devices. Such devices should be considered as custom measures and their savings determined through EM&V protocols. Second, we will delete Table 15, Lighting Verification Summary as commercial and industrial lighting applications will be considered as custom measures whose savings will be determined by EM&V protocols. Finally, we will delete Table 17 entitled Prescriptive Lighting for Commercial Customers as such applications will be considered as custom measures.

In addition, the Commission determined, based on comments and further analysis, that Table 4, “Applicable to Building Completions from January 2001 through March 2003” on page 16, and Table 6, “Energy Star Homes- REMRate User Defined Reference Homes,” on pages 19-20 of the January 2009 draft TRM are not applicable and have been eliminated from the TRM. The worksheet on page 42 is also not applicable and has been eliminated.

C. Baseline Estimates for Measure Burnout vs. Early Retirement

The version of the TRM issued for comment noted under the heading of “Baseline Estimates” that for most efficiency measures the change in energy usage values are based on the energy use of standard new products versus new high efficiency products. Several parties, including EAPA, PPL, PECO, Allegheny, LBNL and First Energy noted that EDC programs will likely promote the early retirement of functioning appliances or technology for which a different baseline estimate is more appropriate.

Commenters generally recommended that in the case of early retirement or retrofit measures, EDCs should use as the baseline, the estimated energy use of the existing, in place equipment. This is in contrast with using a standard, predetermined energy use baseline for all high-efficiency refrigerator installations, regardless of the actual energy use of the refrigerator being replaced. These commenters also recommended that this baseline be applied for a period not to exceed the remaining useful life of the equipment being replaced.

While commenters agreed on this approach for baseline estimates for early retirement or retrofit measures, there were different proposals for determining the useful life of the existing equipment. PPL does not agree that the exact age of the appliance (as determined by the purchase date) needs to be obtained, verified or recorded to determine the specific remaining useful life to calculate savings. PPL recommends that the TRM should assume a standard remaining life for appliances, such as eight years. Also noting the cost and difficulty of determining the remaining useful life of equipment, First Energy suggests adopting an assumed five years of remaining useful life in the TRM, absent any other supported alternative.

Allegheny provides a different approach based on a program that their affiliate in Maryland is currently implementing. In the Maryland program, data about the existing

equipment is collected by a recycling contractor who verifies the working condition of the equipment, collects the nameplate data and provides an estimate of the energy saved by replacing the old unit.

The Commission agrees with the general comments that in the case of retrofit measures where existing, in-place equipment is replaced, EDCs should use, as the baseline, the estimated energy use of the existing in-place equipment for the remaining useful life of the existing equipment. During this period, the energy savings would be the difference between the usage of the existing, in-place equipment, and the usage of the new high-efficiency equipment. Once the remaining useful life of the existing equipment would have expired, the newly installed high-efficiency equipment is likely to have additional years of useful life. For this remaining useful life of the new high-efficiency equipment, the energy savings will be the difference in energy savings from new standard equipment and the new high-efficiency equipment. For example, if an EDC replaces an existing refrigerator that has a remaining useful life of five-years, with a new high-efficiency refrigerator that has a measure life of 15-years, then the energy savings credited during the first five-years will be the difference between the usage of the existing refrigerator and the new high-efficiency refrigerator. For the remaining ten-years, the energy savings will be the difference between a new standard refrigerator and the new high-efficiency refrigerator.

However, we do not agree with the comments of PPL and First Energy, who recommended that we adopt a standard useful life of existing equipment, such as five or eight years. The remaining useful life of equipment is likely to vary considerably by the type of equipment (refrigerator, freezer, HVAC) and perhaps by EDC service territory. Initially, EDCs should adopt the general approach noted by Allegheny, where equipment-specific data is collected for the existing equipment and used to calculate the energy savings for the remaining useful life of that equipment. At such time as EDCs have compiled sufficient experience and have sufficient data available to be able to calculate

average life expectancies for specific types of equipment in their service territory (i.e. refrigerators, freezers), then they can request that the commission approve a standard useful life of x years for future use in lieu of determining useful life and energy savings on a case-by-case basis. This approach supports the development of a useful life standard based on actual research findings consistent with the overall approach of the TRM.

We point out at this time that the measure lives of the programs as noted in Appendix A of the TRM are not to exceed fifteen years for calculations of the TRC test. Actual useful lives of measures may be used when calculating energy savings for meeting annual energy reduction targets under the AEPS Act implementation procedures. An asterisk will be placed next to each measure with a useful life greater than fifteen years indicating that fifteen years is the maximum number of years that can be used for the TRC test calculations, but the actual useful life may be used for AEPS Act purposes.

D. Documented Savings for Standard Measures

Allegheny requests assurance that EDCs will not be limited to exclusive reliance on the TRM. Allegheny noted that where EDCs implement alternative, well-documented methods to measure savings, the Commission should consider the measurement methods and add language to that effect in the TRM.

The Commission envisions two general cases where EDCs may implement measures that are not in the TRM or use the TRM values to calculate energy savings. The first case is when custom measures are used, in which case alternative measurement methods are required to arrive at verifiable energy savings that are unique to the specific application. The second case is where an EDC may install a standard measure that is contained in the TRM but does not wish to use the deemed energy savings values contained in the TRM. In these cases, the EDC may use alternative, well-documented, measurements that are more robust to arrive at the energy savings. The alternative

measurement methods used will be subject to review and approval by the Commission to ensure their accuracy. We will include language to this effect in the TRM.

E. Weather Adjustments

The Commission received comments from numerous parties regarding the weather adjustments contained in the TRM. For example, EAPA and PECO noted that some tables contain calculations that are inappropriately applied to measures that are not climate sensitive. Several other commenters, such as LBNL, noted that the method used to adjust HVAC and thermal-envelope savings for climates that differ from Pennsylvania are overly simplistic. PECO commented that the Equivalent Full-Load Hours (“EFLHs”) do not correlate with the Energy Star values.

We will adopt the position advocated by PECO and use the EFLHs provided by the U.S. Department of Energy’s Energy Star Calculator for the following seven cities in Pennsylvania: Allentown, Erie, Harrisburg, Philadelphia, Pittsburgh, Scranton and Williamsport. These Energy Star values will be applied to Table 3, Residential Electric HVAC; Table 10, Room Air Conditioners; and Tables 25 and 27, Commercial and Industrial HVAC, Heat Pumps and Electric Chillers. We will also remove climate zone references in Table 16, Traffic Signals, and Table 23, Motors, as these applications are not affected by climate zone variations.

F. Net-to-Gross Ratio Adjustments to Savings

A common consideration for determining the cost benefit of energy efficiency programs is whether to make adjustments to gross energy savings through the use of a net-to-gross (“NTG”) ratio. The NTG ratio adjusts the cost-effectiveness results so that they only reflect those energy efficiency gains that are attributed to and are a direct result

of the energy efficiency program in question.⁷ The NTG ratio gives evaluators an estimate of savings achieved as a direct result of program expenditures by removing savings that would have occurred even absent a conservation program.

Three common factors addressed through the NTG ratio are free-riders, take-back effect, and spillover effect sometimes referred to as free-drivers. The concept of free-riders consists of customers that may take advantage of rebates or cost savings measures available through conservation programs even though they would have installed the energy efficient measure on their own. Take-back effect occurs when customers displace any reduction in energy bills by increasing their total energy use for comfort or convenience. Spillover is the opposite of the free-rider effect, it occurs when customers adopt efficiency measures because they are influenced by program-related information and marketing efforts, without actually participating in the program. Net-to-gross ratio adjustments for free-riders and take-back effects result in the reduction of claimed energy savings, whereas, spillover effects result in additions to claimed energy savings.

Most of the comments relating to NTG ratios suggested that during the first year, plans assume a NTG ratio of one, or zero, as all NTG related adjustments cancel each other out. None of the commenters cited any studies or research that would support these assumptions. However, it was noted that New Jersey handled the NTG ratio issue by assuming a NTG ratio of one. The commenters also suggested that the Commission form a working group to examine this issue and look at ways to identify appropriate NTG ratios to be applied in future years.

Net-to-gross ratio adjustments are likely to be influenced by program or measure-specific applications. The degree to which free-rider, take-back and spillover

⁷ National Action Plan for Energy Efficiency (2008). *Understanding Cost-Effectiveness of Energy Efficiency Programs: Best Practices, Technical Methods, and Emerging Issues for Policy-Makers*. Energy and Environmental Economics, Inc. and Regulatory Assistance Project.
www.epa.gov/eeactionplan

effects are present in a program is best determined by research conducted at the program-participant level. This research comes at a cost that increases total program costs. In addition, if adjustments are made through NTG ratios that result in reductions to claimed savings due to free-rider and take-back effects that are not cancelled out by spillover effects, then EDCs must implement additional energy efficiency measures to meet the mandated reduction targets. While the deployment of additional reduction measures may produce incremental reductions in the cost of wholesale power, to the benefit of all customers whether they participate or not, it may be difficult to measure and correlate the wholesale power market changes to the additional energy efficiency measures.

The Commission does not necessarily agree that assuming a NTG ratio of one is correct. However, due to the short time period to finalize the TRM prior to the EE&C plan filing deadline, we will initially assume a NTG ratio of one. As the NTG ratio will also be a factor in the total resource cost test adopted by this Commission, we will establish a process for developing future NTG ratios in that proceeding.

G. Future TRM Updates

We received numerous comments on the importance of updating the TRM on an annual basis. The updates need to be finalized soon enough for use with the next year EE&C plans consistent the Commission's EE&C program Implementation Order. All the comments supported a draft TRM update by June 1 each year with the final revision by December 31 for use effective June 1 of the following year.

The Commission received no alternative suggestions. We agree with the importance of a set timetable for TRM updates and direct that the Bureau of Conservation, Economics, and Energy Planning enlist whatever resources are necessary

to produce a final revised TRM by December 31 of each year; to be used by EDCs as the basis for deemed energy savings in subsequent EE&C plan compliance years.

CONCLUSION

This Order represents the initial step in establishing a comprehensive TRM with a purpose of supporting both the AEPS Act and the EE&C provision of Act 129. We extend our thanks to all who provided comments and participated in the stakeholder meeting. **THEREFORE,**

IT IS ORDERED:

1. That the 2009 Technical Reference Manual contained in the Annex to this Order is adopted and replaces the prior version of the Technical Reference Manual as of the entry date of this Order.

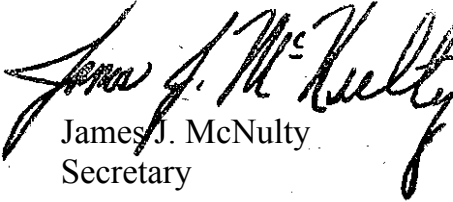
2. That a copy of this Order and Annex shall be served upon the Office of Consumer Advocate, the Office of Small Business Advocate, the Office of Trial Staff, all jurisdictional electric distribution companies, all licensed electric generation suppliers, and the Pennsylvania Department of Environmental Protection.

3. That the Secretary shall deposit a notice of this Order and Annex with the Legislative Reference Bureau for publication in the *Pennsylvania Bulletin*.

4. That this Order and Annex be published on the Commission's website.

5. That a fuel-switching working group is established to identify, research and address issues related to including fuel-switching measures in a future Technical Reference Manual. This working group shall provide a report to the Commission, with recommendations, by June 1, 2010.

BY THE COMMISSION



James J. McNulty
Secretary

(SEAL)

ORDER ADOPTED: May 28, 2009

ORDER ENTERED: June 1, 2009

Annex

**Technical Reference Manual (TRM)
for
Pennsylvania Act 129
Energy Efficiency and Conservation Program
and
Act 213
Alternative Energy Portfolio Standards**

Pennsylvania Public Utility Commission

May 2009

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<i>Prescriptive Lighting</i>	<i>Error! Bookmark not defined.</i>
<i>Lighting Controls.....</i>	<i>Error! Bookmark not defined.</i>
<i>20% Lighting Power Density (LPD) Reduction.....</i>	<i>Error! Bookmark not defined.</i>
<i>Fluorescent Lighting Fixture</i>	<i>Error! Bookmark not defined.</i>
<i>Motors.....</i>	<i>Error! Bookmark not defined.</i>
<i>HVAC Systems</i>	<i>Error! Bookmark not defined.</i>
<i>Electric Chillers.....</i>	<i>Error! Bookmark not defined.</i>
<i>Variable Frequency Drives.....</i>	<i>Error! Bookmark not defined.</i>
<i>Air Compressors with Variable Frequency Drives.....</i>	<i>Error! Bookmark not defined.</i>
Demand Response Programs	Error! Bookmark not defined.
Commercial and Industrial Applications	Error! Bookmark not defined.
Residential Applications	Error! Bookmark not defined.
Algorithms	Error! Bookmark not defined.
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Appendix A - Measure Lives.....	55

Pennsylvania Technical Reference Manual

Introduction⁸

The Technical Reference Manual (TRM) was developed to measure the resource savings from standard energy efficiency measures. The savings' algorithms use measured and customer data as input values in industry-accepted algorithms. The data and input values for the algorithms come from AEPS application forms, standard values including Energy Star standards, or data gathered by Electric Distribution Companies (EDCs). The standard input values are based on the best available measured or industry data.

The standard values for most commercial and industrial (C&I) measures are supported by end-use metering for key parameters for a sample of facilities and circuits, based on the metered data from past applications in other states. These C&I standard values are based on five years of data for most measures and two years of data for lighting.

Some electric input values were derived from a review of literature from various industry organizations, equipment manufacturers, and suppliers. These input values are updated to reflect changes in code, federal standards and recent program evaluations.

Purpose

The TRM was developed for the purpose of estimating annual energy savings for a selection of energy efficient technologies and measures. The TRM provides guidance to the Administrator responsible for awarding Alternative Energy Credits (AECs). The revised TRM serves a dual purpose of being used to determine compliance with the Alternative Energy Portfolio Standards (AEPS) Act, 73 P.S. §§ 1648.1-1648.8, and the energy efficiency and conservation requirements of Act 129 of 2008, 66 Pa.C.S. § 2806.1. The TRM will continue to be updated on an annual basis to reflect the addition of technologies and measures as needed to remain relevant and useful.

Resource savings to be measured include electric energy (kWh) and capacity (kW) savings. The algorithms in this document focus on the determination of the per unit savings for the energy efficiency and demand response measures.

Definitions

The TRM is designed for use with both the AEPS Act and Act 129; however, it contains words and terms that apply only to the AEPS or only to Act 129. The following definitions are provided to identify words and terms that are specific for implementation of the AEPS:

⁸ Note: Information in the TRM specifically relating to the AEPS Act are shaded in gray.

- Administrator/Program Administrator – The Credit Administrator of the AEPS program that receives and processes, and approves AEPS Credit applications.
- AEPS application forms – application forms submitted to qualify and register alternative energy facilities for alternative energy credits.
- Application worksheets – part of the AEPS application forms.
- Alternative Energy Credits (AECs) – A tradable instrument used to establish, verify, and measure compliance with the AEPS. One credit is earned for each 1000kWh of electricity generated (or saved from energy efficiency or conservation measures) at a qualified alternative energy facility.

For the Act 129 program, EDCs may, as an alternative to using the energy savings' values for standard measures contained in the TRM, submit documentation of alternative measurement methods to support different energy savings' values. The alternative measurement methods are subject to review and approval by the Commission to ensure their accuracy.

General Framework

In general, energy and demand savings will be measured using measured and customer data as input values in algorithms in the TRM, and information from the AEPS application forms, worksheets and field tools.

Three systems will work together to ensure accurate data on a given measure:

1. The application form that the customer or customer's agent submits with basic information.
2. Application worksheets and field tools with more detailed, site-specific data, input values and calculations.
3. Algorithms that rely on standard or site-specific input values based on measured data. Parts or all of the algorithms may ultimately be implemented within the tracking system, application forms and worksheets and field tools.

Algorithms

The algorithms that have been developed to calculate the energy and or demand savings are driven by a change in efficiency level for the installed measure compared to a baseline level of efficiency. This change in efficiency is reflected in both demand and energy savings for electric measures and energy savings for gas. The following are the basic algorithms.

Electric Demand Savings = $\Delta kW = kW_{\text{baseline}} - kW_{\text{energy efficient measure}}$

Electric Energy Savings = $\Delta kW \times EFLH$

Electric Peak Coincident Demand Savings = $\Delta kW \times \text{Coincidence Factor}$

Where:

EFLH = Equivalent Full Load Hours of operation for the installed measure.

Other resource savings will be calculated as appropriate.

Specific algorithms for each of the measures may incorporate additional factors to reflect specific conditions associated with a measure. This may include factors to account for coincidence of multiple installations or interaction between different measures.

Data and Input Values

The input values and algorithms are based on the best available and applicable data. The input values for the algorithms come from the **AEPS application forms**, EDC data gathering, or from standard values based on measured or industry data.

Many input values, including site-specific data, come directly from the **AEPS application forms**, EDC data gathering, worksheets and field tools. Site-specific data on the **AEPS application forms** and EDC data gathering are used for measures with important variations in one or more input values (e.g., delta watts, efficiency level, capacity, etc.).

Standard input values are based on the best available measured or industry data, including metered data, measured data from other state evaluations (applied prospectively), field data, and standards from industry associations. The standard values for most commercial and industrial measures are supported by end-use metering for key parameters for a sample of facilities and circuits. These standard values are based on five years of metered data for most measures⁹. Data that were metered over that time period are from measures that were installed over an eight-year period. Many input values are based on program evaluations of New Jersey's Clean Energy Programs or similar programs in the northeast region.

For the standard input assumptions for which metered or measured data were not available, the input values (e.g., delta watts, delta efficiency, equipment capacity, operating hours, coincidence factors) were based on the best available industry data or standards. These input values were based on a review of literature from various industry organizations, equipment manufacturers and suppliers.

Baseline Estimates

For all new construction and any replacement of non-working equipment appliance, the ΔkW and ΔkWh values are based on the vintage efficiency of the items being replaced versus new high-efficiency products. The approach used for the replacement measures encourages residential and business consumers to replace working inefficient equipment and appliances with new high-efficiency products rather than taking no action to upgrade

⁹ Values for lighting, air conditioners, chillers and motors are based on measured usage from a large sample of participants from 1995 through 1999. Values for heat pumps reflect metered usage from 1996 through 1998 and variable speed drives reflect metered usage from 1995 through 1998.

or only replacing them with new standard-efficiency products. The baseline estimates used in the TRM are documented in baseline studies or other market information. Baselines will be updated to reflect changing codes, practices and market transformation effects.

Resource Savings in Current and Future Program Years

A E C s and energy efficiency and demand response reduction savings will apply in equal annual amounts corresponding to either PJM planning years or calendar years beginning with the year deemed appropriate by the Administrator, and lasting for the approved life of the measure for AEPS Credits. Energy efficiency and demand response savings associated with Act 129 can claim savings for up to fifteen years.

Prospective Application of the TRM

The TRM will be applied prospectively. The input values are from the AEPS application forms and EDC data gathering and standard input values (based on measured data including metered data and evaluation results). The TRM will be updated annually based on new information and available data and then applied prospectively for future program years. Updates will not alter the number of AEPS Credits, once awarded, by the Administrator, nor will it alter any energy savings or demand reductions already in service and within measure life..

Electric Resource Savings

Algorithms have been developed to determine the electric energy and coincident peak demand savings.

Annual electric energy savings are calculated and then allocated separately by season (summer and winter) and time of day (on-peak and off-peak). Summer coincident peak demand savings are calculated using a demand savings algorithm for each measure that includes a coincidence factor. Application of this coincidence factor converts the demand savings of the measure, which may not occur at time of system peak, to demand savings that is expected to occur during the Summer On-Peak period.

Table 1: Periods for Energy Savings and Coincident Peak Demand Savings

	Energy Savings	Coincident Peak Demand Savings
Summer	May through September	June through September
Winter	October through April	NA
On Peak (Monday - Friday)	8:00 a.m. to 8:00 p.m.	12:00 p.m. to 8:00 p.m.
Off Peak (Weekends and Holidays)	8:00 p.m. to 8:00 a.m.	NA

The time periods for energy savings and coincident peak demand savings were chosen to best fit the Act 129 requirement, which reflects the seasonal avoided cost patterns for electric energy and capacity that were used for the energy efficiency program cost effectiveness purposes. For energy, the summer period May through September was selected based on the pattern of avoided costs for energy at the PJM level. In order to keep the complexity of the process for calculating energy savings' benefits to a reasonable level by using two time periods, the knee periods for spring and fall were split approximately evenly between the summer and winter periods.

For capacity, the summer period June through September was selected to match the period of time required to measure the 100 highest hours of demand. This period also correlates with the highest avoided costs' time period for capacity. The experience in PJM has been that nearly all of the 100 highest hours of an EDC's peak demand occur during these four months. Coincidence factors are used to determine the impact of energy efficiency measures on peak demand.

Post-Implementation Review

The Administrator will review AEPS application forms and tracking systems for all measures and conduct field inspections on a sample of installations. For some programs and jobs (e.g., custom, large process, large and complex comprehensive design), post-installation review and on-site verification of a sample of AEPS application forms and installations will be used to ensure the reliability of site-specific savings' estimates.

Adjustments to Energy and Resource Savings

Coincidence with Electric System Peak

Coincidence factors are used to reflect the portion of the connected load savings or generation that is coincident with the electric system peak.

Measure Retention and Persistence of Savings

The combined effect of measure retention and persistence is the ability of installed measures to maintain the initial level of energy savings or generation over the measure life. Measure retention and persistence effects were accounted for in the metered data that were based on C&I installations over an eight-year period. As a result, some algorithms incorporate retention and persistence effects in the other input values. For other measures, if the measure is subject to a reduction in savings or generation over time, the reduction in retention or persistence is accounted for using factors in the calculation of resource savings (e.g., in-service rates for residential lighting measures).

Interaction of Energy Savings

Interaction of energy savings is accounted for as appropriate. For all other measures, interaction of energy savings is zero.

For Residential New Construction, the interaction of energy savings is accounted for in the home energy rating tool that compares the efficient building to the baseline or reference building and calculates savings.

For Commercial and Industrial Efficient Construction, the energy savings for lighting is increased by an amount specified in the algorithm to account for HVAC interaction.

For commercial and industrial custom measures, interaction where relevant is accounted for in the site-specific analysis.

Calculation of the Value of Resource Savings

The calculation of the value of the resources saved is not part of the TRM. The TRM is limited to the determination of the per unit resource savings in physical terms.

In order to calculate the value of the energy savings for reporting and other purposes, the energy savings are determined at the customer level and then increased by the amount of the transmission and distribution losses to reflect the energy savings at the system level. The energy savings at the system level are then multiplied by the appropriate avoided costs to calculate the value of the benefits.

System Savings = (Savings at Customer) X (T&D Loss Factor)

Value of Resource Savings = (System Savings) X (System Avoided Costs) + (Value of Other Resource Savings)

The value of the benefits for a particular measure will also include other resource savings where appropriate. Maintenance savings will be estimated in annual dollars levelized over the life of the measure.

Transmission and Distribution System Losses

The TRM calculates the energy savings at the customer level. These savings need to be increased by the amount of transmission and distribution system losses in order to determine the energy savings at the system level. The electric loss factor multiplied by the savings calculated from the algorithms will result in savings at the supply level.

The electric loss factor applied to savings at the customer meter is 1.11 for both energy and demand. The electric system loss factor was developed to be applicable to statewide programs. Therefore, average system losses at the margin based on PJM data were utilized. This reflects a mix of different losses that occur related to delivery at different voltage levels. The 1.11 factor used for both energy and capacity is a weighted average loss factor. These electric loss factors reflect losses at the margin.

Measure Lives

Measure lives are provided in Appendix A for informational purposes and for use in other applications such as reporting lifetime savings or in benefit cost studies that span more than one year. For the purpose of calculating the total Resources Cost Test for Act 129, measures cannot claim savings for more than 15 years.

Custom Measures¹⁰

Custom measures are considered too complex or unique to be included in the list of standard measures provided in the TRM. Also included are measures that may involve metered data, but require additional assumptions to arrive at a ‘typical’ level of savings as opposed to an exact measurement. The qualification for and availability of AEPS Credits and energy efficiency and demand response savings are determined on a case-by-case basis.

An AEPS application must be submitted, containing adequate documentation fully describing the energy efficiency measures installed or proposed and an explanation of how the installed facilities qualify for A E Cs. The AEPS application must include a proposed evaluation plan by which the Administrator may evaluate the effectiveness of the energy efficiency measures provided by the installed facilities. All assumptions should be identified, explained and supported by documentation, where possible. The applicant may propose incorporating tracking and evaluation measures using existing data streams currently in use provided that they permit the Administrator to evaluate the program using the reported data.

To the extent possible, the energy efficiency measures identified in the AEPS application should be verified by the meter readings submitted to the Administrator.

Impact of Weather

To account for weather differences within Pennsylvania Equivalent FullLoad Hours (ELFH) were taken from the US Department of Energy’s Energy Star Calculator that provides ELFH values for seven Pennsylvania cities: Allentown, Erie, Harrisburg, Philadelphia, Pittsburgh, Scranton, and Williamsport. These cities provide a representative sample of the various climate and utility regions in Pennsylvania.

Algorithms for Energy Efficient Measures

The following pages present measure-specific algorithms.

¹⁰ Note: Programs where measures are replaced before the end of their useful life are considered Custom Measures. In these programs, savings are measured from the efficient unit versus the replaced unit for the existing life of the unit, then from the efficiency unit versus a new standard unit for the remaining life of the efficient measure.

Residential Electric HVAC

Algorithms

The measurement plan for residential high-efficiency cooling and heating equipment is based on algorithms that determine a central air conditioner's or heat pump's cooling/heating energy use and peak demand. Input data is based both on fixed assumptions and data supplied from the high efficiency equipment **AEPS application form** or EDC data gathering. The algorithms also include the calculation of additional energy and demand savings due to the required proper sizing of high-efficiency units.

The savings will be allocated to summer/winter and on-peak/off-peak time periods based on load shapes from measured data and industry sources. The allocation factors are documented below in the input value table.

The algorithms applicable for this program measure the energy savings directly related to the more efficient hardware installation. Estimates of energy savings due to the proper sizing of the equipment are also included.

The following is an explanation of the algorithms used and the nature and source of all required input data.

Algorithms

Central Air Conditioner (A/C) and Air Source Heat Pump (ASHP)

Cooling Energy Consumption and Peak Demand Savings – Central A/C and ASHP (High Efficiency Equipment Only)

$$\text{Energy Impact (kWh)} = \text{CAPY}/1000 \times (1/\text{SEER}_b - 1/\text{SEER}_q) \times \text{EFLH}$$

$$\text{Peak Demand Impact (kW)} = \text{CAPY}/1000 \times (1/\text{EER}_b - 1/\text{EER}_q) \times \text{CF}$$

Heating Energy Savings – ASHP

$$\text{Energy Impact (kWh)} = \text{CAPY}/1000 \times (1/\text{HSPF}_b - 1/\text{HSPF}_q) \times \text{EFLH}$$

Cooling Energy Consumption and Demand Savings – Central A/C and ASHP (Proper Sizing)

$$\text{Energy Impact (kWh)} = (\text{CAPY}/(\text{SEER}_q \times 1000)) \times \text{EFLH} \times \text{PSF}$$

$$\text{Peak Demand Impact (kW)} = ((\text{CAPY}/(\text{EER}_q \times 1000)) \times \text{CF}) \times \text{PSF}$$

Cooling Energy Consumption and Demand Savings – Central A/C and ASHP (QIV)

$$\text{Energy Impact (kWh)} = (((\text{CAPY}/(1000 \times \text{SEER}_q)) \times \text{EFLH}) \times (1 - \text{PSF}) \times \text{QIF})$$

$$\text{Peak Demand Impact (kW)} = ((\text{CAPY}/(1000 \times \text{EER}_q)) \times \text{CF}) \times (1 - \text{PSF}) \times \text{QIF}$$

Cooling Energy Consumption and Demand Savings – Central A/C and ASHP (Maintenance)

$$\text{Energy Impact (kWh)} = ((\text{CAPY}/(1000 \times \text{SEER}_m)) \times \text{EFLH}) \times \text{MF}$$

$$\text{Peak Demand Impact (kW)} = ((\text{CAPY}/(1000 \times \text{EER}_m)) \times \text{CF}) \times \text{MF}$$

Cooling Energy Consumption and Demand Savings– Central A/C and ASHP (Duct Sealing)

$$\text{Energy Impact (kWh)} = (\text{CAPY}/(1000 \times \text{SEER}_q)) \times \text{EFLH} \times \text{DuctSF}$$

$$\text{Peak Demand Impact (kW)} = ((\text{CAPY}/(1000 \times \text{EER}_q)) \times \text{CF}) \times \text{DuctSF}$$

Ground Source Heat Pumps (GSHP)

$$\text{Cooling Energy (kWh) Savings} = \text{CAPY}/1000 \times (1/\text{SEER}_b - (1/(\text{EER}_g \times \text{GSER}))) \times \text{EFLH}$$

$$\text{Heating Energy (kWh) Savings} = \text{CAPY}/1000 \times (1/\text{HSPF}_b - (1/(\text{COP}_g \times \text{GSOP}))) \times \text{EFLH}$$

$$\text{Peak Demand Impact (kW)} = \text{CAPY}/1000 \times (1/\text{EER}_b - (1/(\text{EER}_g \times \text{GSPK}))) \times \text{CF}$$

GSHP Desuperheater

$$\text{Energy (kWh) Savings} = \text{EDSH}$$

$$\text{Peak Demand Impact (kW)} = \text{PDSH}$$

Furnace High Efficiency Fan

$$\text{Heating Energy (kWh) Savings} = ((\text{Capy}_t \times \text{EFLH}_{\text{HT}})/100,000 \text{ BTU/therm}) \times \text{HFS}$$

$$\text{Cooling Energy (kWh) Savings} = \text{CFS}$$

Definition of Terms

CAPY = The cooling capacity (output in Btuh) of the central air conditioner or heat pump being installed. This data is obtained from the AEPS Application Form based on the model number or from EDC data gathering.

SEER_b = The Seasonal Energy Efficiency Ratio of the Baseline Unit.

SEER_q = The Seasonal Energy Efficiency Ratio of the qualifying unit being installed. This data is obtained from the AEPS Application Form or EDC's data gathering based on the model number.

SEER_m = The Seasonal Energy Efficiency Ratio of the Unit receiving maintenance

EER_b = The Energy Efficiency Ratio of the Baseline Unit.

EER_q = The Energy Efficiency Ratio of the unit being installed. This data is obtained from the AEPS Application Form or EDC data gathering based on the model number.

EER_g = The EER of the ground source heat pump being installed. Note that EERs of GSHPs are measured differently than EERs of air source heat pumps (focusing on entering water temperatures rather than ambient air temperatures). The equivalent SEER of a GSHP can be estimated by multiplying EER_g by 1.02.

GSER = The factor to determine the SEER of a GSHP based on its EER_g.

EFLH = The Equivalent Full Load Hours of operation for the average unit.

ESF = The Energy Sizing Factor or the assumed saving due to proper sizing and proper installation.

PSF = The Proper Sizing Factor or the assumed savings due to proper sizing of cooling equipment.

QIF = The Quality Installation factor or assumed savings due to a verified quality installation of cooling equipment.

MF = The Maintenance Factor or assumed savings due to completing recommended maintenance on installed cooling equipment.

DuctSF = The Duct Sealing Factor or the assumed savings due to proper sealing of all cooling ducts.

CF = The coincidence factor which equates the installed unit's connected load to its demand at time of system peak.

DSF = The Demand Sizing Factor or the assumed peak-demand capacity saved due to proper sizing and proper installation.

HSPF_b = The Heating Seasonal Performance Factor of the Baseline Unit.

HSPF_q = The Heating Seasonal Performance Factor of the unit being installed. This data is obtained from the **AEPS Application Form** or EDC's data gathering.

COP_g = Coefficient of Performance. This is a measure of the efficiency of a heat pump.

GSOP = The factor to determine the HSPF of a GSHP based on its COP_g.

GSPK = The factor to convert EER_g to the equivalent EER of an air conditioner to enable comparisons to the baseline unit.

EDSH = Assumed savings per desuperheater.¹¹

PDSH = Assumed peak-demand savings per desuperheater.

Cap_q = Output capacity of the qualifying heating unit in BTUs/hour.

EFLH_{HT} = The Equivalent Full Load Hours of operation for the average heating unit.

HFS = Heating fan savings,

CFS = Cooling fan savings.

The 1000 used in the denominator is used to convert watts to kilowatts.

A summary of the input values and their data sources follows:

Table 2: Residential Electric HVAC

Component	Type	Value	Sources
CAPY	Variable		AEPS Application; EDC Data Gathering
SEER _b	Fixed	Baseline = 13	1
SEER _q	Variable		AEPS Application; EDC Data Gathering

¹¹ Desuperheaters are generally utilized to reduce the temperature of superheated steam to a desired set point for the protection of downstream piping and equipment or for the supply of saturated steam for heat transfer purposes.

Component	Type	Value	Sources
SEER _m	Fixed	10	15
EER _b	Fixed	Baseline = 11.3	2
EER _q	Fixed	= (11.3/13) X SEER _q	2
EER _g	Variable		AEPS Application; EDC's Data Gathering
EER _m	Fixed	8.69	19
GSER	Fixed	1.02	3
EFLH	Fixed	Allentown Cooling = 784 Hours Allentown Heating = 2,492 Hours Erie Cooling = 482 Hours Erie Heating = 2,901 Hours Harrisburg Cooling = 929 Hours Harrisburg Heating = 2,371 Hours Philadelphia Cooling = 1,032 Hours Philadelphia Heating = 2,328 Hours Pittsburgh Cooling = 737 Hours Pittsburgh Heating = 2,380 Hours Scranton Cooling = 621 Hours Scranton Heating = 2,532 Hours Williamsport Cooling = 659 Hours Williamsport Heating = 2,502	4
ESF	Fixed	2.9%	5
PSF	Fixed	5%	14
QIF	Fixed	9.2%	4
MF	Fixed	10%	20
DuctSF	Fixed	18%	14
CF	Fixed	70%	6
DSF	Fixed	2.9%	7
HSPF _b	Fixed	Baseline = 7.7	8

Component	Type	Value	Sources
HSPF _q	Variable		AEPS Application; EDC's Data Gathering
COP _g	Variable		AEPS Application; EDC's Data Gathering
GSOP	Fixed	3.413	9
GSPK	Fixed	0.8416	10
EDSH	Fixed	1842 kWh	11
PDSH	Fixed	0.34 kW	12
Cooling - CAC Time Period Allocation Factors	Fixed	Summer/On-Peak 64.9% Summer/Off-Peak 35.1% Winter/On-Peak 0% Winter/Off-Peak 0%	13
Cooling – ASHP Time Period Allocation Factors	Fixed	Summer/On-Peak 59.8% Summer/Off-Peak 40.2% Winter/On-Peak 0% Winter/Off-Peak 0%	13
Cooling – GSHP Time Period Allocation Factors	Fixed	Summer/On-Peak 51.7% Summer/Off-Peak 48.3% Winter/On-Peak 0% Winter/Off-Peak 0%	13
Heating – ASHP & GSHP Time Period Allocation Factors	Fixed	Summer/On-Peak 0.0% Summer/Off-Peak 0.0% Winter/On-Peak 47.9% Winter/Off-Peak 52.1%	13
GSHP Desuperheater Time Period Allocation Factors	Fixed	Summer/On-Peak 4.5% Summer/Off-Peak 4.2% Winter/On-Peak 43.7% Winter/Off-Peak 47.6%	13
Cap _{yq}	Variable		AEPS Application; EDC's Data Gathering

Component	Type	Value	Sources
EFLH _{HFS}	Fixed	Allentown Heating = 2,492 Hours Erie Heating = 2,901 Hours Harrisburg Heating = 2,371 Hours Philadelphia Heating = 2,328 Hours Pittsburgh Heating = 2,380 Hours Scranton Heating = 2,532 Hours Williamsport Heating = 2,502	4
HFS	Fixed	0.5 kWh	17
CFS	Fixed	105 kWh	18

Sources:

1. Federal Register, Vol. 66, No. 14, Monday, January 22, 2001/Rules and Regulations, p. 7170-7200.
2. Average EER for SEER 13 units.
3. VEIC estimate. Extrapolation of manufacturer data.
4. US Department of Energy, Energy Star Calculator. Accessed 3/16/2009.
5. Xenergy, "New Jersey Residential HVAC Baseline Study", (Xenergy, Washington, D.C., November 16, 2001).
6. Based on an analysis of six different utilities by Proctor Engineering.
7. Xenergy, "New Jersey Residential HVAC Baseline Study", (Xenergy, Washington, D.C., November 16, 2001).
8. Federal Register, Vol. 66, No. 14, Monday, January 22, 2001/Rules and Regulations, p. 7170-7200.
9. Engineering calculation, HSPF/COP=3.413.
10. VEIC Estimate. Extrapolation of manufacturer data.
11. VEIC estimate, based on PEPCo assumptions.
12. VEIC estimate, based on PEPCo assumptions.
13. Time period allocation factors used in cost-effectiveness analysis.
14. Northeast Energy Efficiency Partnerships, Inc., "Benefits of HVAC Contractor Training", (February 2006): Appendix C Benefits of HVAC Contractor Training: Field Research Results 03-STAC-01.
15. Minimum Federal Standard for new Central Air Conditioners between 1990 and 2006.
16. NJ utility analysis of heating customers, annual gas heating usage.
17. Scott Pigg (Energy Center of Wisconsin), "Electricity Use by New Furnaces: A Wisconsin Field Study", Technical Report 230-1, October 2003.
18. Ibid., p. 34. ARI charts suggest there are about 20% more full load cooling hours in NJ than southern WI. Thus, average cooling savings in NJ are estimated at 95 to 115.
19. The same EER to SEER ratio used for SEER 13 units applied to SEER 10 units.
 $EER_m = (11.3/13) * 10$.
20. VEIC estimate. Conservatively assumes less savings than for QIV because of the retrofit context.

Residential New Construction

Algorithms

Insulation Up-Grades, Efficient Windows, Air Sealing, Efficient HVAC Equipment and Duct Sealing

Energy savings due to improvements in Residential New Construction will be a direct output of accredited Home Energy Ratings (HERS) software that meets the applicable Mortgage Industry National Home Energy Rating System Standards. REM/Rate is cited here as an example of an accredited software which has a module that compares the energy characteristics of the energy efficient home to the baseline/reference home and calculates savings.

The system peak electric demand savings will be calculated from the software output with the following savings' algorithms, which are based on compliance and certification of the energy efficient home to the EPA's ENERGY STAR for New Homes' program standard:

Peak demand of the baseline home = $(PL_b \times OF_b) / (SEER_b \times BLEER \times 1,000)$.

Peak demand of the qualifying home = $(PL_q \times OF_q) / (EER_q \times 1,000)$.

Coincident system peak electric demand savings = (Peak demand of the baseline home – Peak demand of the qualifying home) X CF.

Definition of Terms

PL_b = Peak load of the baseline home in Btuh.

OF_b = The over sizing factor for the HVAC unit in the baseline home.

$SEER_b$ = The Seasonal Energy Efficiency Ratio of the baseline unit.

$BLEER$ = Factor to convert baseline $SEER_b$ to EER_b .

PL_q = The actual predicted peak load for the program qualifying home constructed, in Btuh.

OF_q = The oversizing factor for the HVAC unit in the program qualifying home.

EER_q = The EER associated with the HVAC system in the qualifying home.

CF = The coincidence factor which equates the installed HVAC system's demand to its demand at time of system peak.

A summary of the input values and their data sources follows:

Table 3: Applicable to Building Completions from April 2003 to Present

Component	Type	Value	Sources
PL_b	Variable		1
OF _b	Fixed	1.6	2
SEER _b	Fixed	13	3
BLEER	Fixed	0.92	4
PL _q	Variable		Software Output
OF _q	Fixed	1.15	5
EER _q	Variable		AEPS Application; EDC's Data Gathering
CF	Fixed	0.70	6

Sources:

1. Calculation of peak load of baseline home from the home energy rating tool, based on the reference home energy characteristics.
2. PSE&G 1997 Residential New Construction baseline study.
3. Federal Register, Vol. 66, No. 14, Monday, January 22, 2001/Rules and Regulations, p. 7170-7200
4. Engineering calculation.
5. Program guideline for qualifying home.
6. Based on an analysis of six different utilities by Proctor Engineering.

Lighting and Appliances

Quantification of additional saving due to the addition of high-efficiency lighting and clothes washers will be based on the algorithms presented for these appliances in the Energy Star Lighting Algorithms and the Energy Star Appliances Algorithms, respectively. These algorithms are found in Energy Star Products.

Ventilation Equipment

Additional energy savings of 175 kWh and peak-demand saving of 60 Watts will be added to the output of the home energy rating software to account for the installation of high-efficiency ventilation equipment. These values are based on a baseline fan of 80 Watts and an efficient fan of 20 Watts running for eight-hours per day.

The following tables describe the characteristics of the three reference homes.

Table 4: ENERGY STAR Homes

REMRate User Defined Reference Homes -- Applicable to building completions from pril 2003 to present -- Reflects MEC 95

Data Point	Single and Multiple Family Except as Noted.
Active Solar	None
Ceiling Insulation	U=0.031 (1)
Radiant Barrier	None
Rim/Band Joist	U=0.141 Type A-1, U=0.215 Type A-2 (1)
Exterior Walls - Wood	U=0.141 Type A-1, U=0.215 Type A-2 (1)
Exterior Walls - Steel	U=0.141 Type A-1, U=0.215 Type A-2 (1)
Foundation Walls	U=0.99
Doors	U=0.141 Type A-1, U=0.215 Type A-2 (1)
Windows	U=0.141 Type A-1, U=0.215 Type A-2 (1), No SHGC req.
Glass Doors	U=0.141 Type A-1, U=0.215 Type A-2 (1), No SHGC req.
Skylights	U=0.031 (1), No SHGC req.
Floor over Garage	U=0.050 (1)
Floor over Unheated Basement	U=0.050 (1)
Floor over Crawlspace	U=0.050 (1)
Floor over Outdoor Air	U=0.031 (1)
Unheated Slab on Grade	R-0 edge/R-4.3 under
Heated Slab on Grade	R-0 edge/R-6.4 under
Air Infiltration Rate	0.51 ACH winter/0.51 ACH summer
Duct Leakage	No Observable Duct Leakage
Mechanical Ventilation	None
Lights and Appliances	Use Default
Setback Thermostat	Yes for heating, no for cooling
Heating Efficiency	
Furnace	80% AFUE (3)
Boiler	80% AFUE
Combo Water Heater	76% AFUE (recovery efficiency)
Air Source Heat Pump	7.7 HSPF
Geothermal Heat Pump	Open not modeled, 3.0 COP closed
PTAC / PTHP	Not differentiated from air source HP
Cooling Efficiency	
Central Air Conditioning	13.0 SEER
Air Source Heat Pump	13.0 SEER
Geothermal Heat Pump	3.4 COP (11.6 EER)
PTAC / PTHP	Not differentiated from central AC
Window Air Conditioners	Not differentiated from central AC
Domestic WH Efficiency	
Electric	0.97 EF (4)
Natural Gas	0.67 EF (4)
Water Heater Tank Insulation	None
Duct Insulation	N/A

Notes:

Table 5: ENERGY STAR Homes
REMRate User Defined Reference Homes -- Applicable to building completions from
January 2008 to present

Data Point	Single and Multiple Family Except as Noted.
Domestic WH Efficiency	
Electric	EF = 0.97 - (0.00132 * gallons) (1)
Natural Gas	EF = 0.67 - (0.0019 * gallons) (1)

Notes:

ENERGY STAR Products

ENERGY STAR Appliances, ENERGY STAR Lighting, ENERGY STAR Windows, and ENERGY STAR Audit

ENERGY STAR Appliances

Algorithms

The general form of the equation for the ENERGY STAR Appliance measure savings' algorithms is:

Number of Units X Savings per Unit

To determine resource savings, the per unit estimates in the algorithms will be multiplied by the number of appliance units. The number of units will be determined using market assessments and market tracking. Some of these market tracking mechanisms are under development. Per unit savings' estimates are derived primarily from a 2000 Market Update Report by RLW for National Grid's appliance program and from previous NEEP screening tool assumptions (clothes washers).

Note that the pre-July 2001 refrigerator measure has been deleted given the timing of program implementation. As no field results are expected until July 2001, there was no need to quantify savings relative to the pre-July 2001 efficiency standards improvement for refrigerators.

ENERGY STAR Refrigerators

Electricity Impact (kWh) = $ESav_{REF}$

Demand Impact (kW) = $DSav_{REF} \times CF_{REF}$

ENERGY STAR Clothes Washers

Electricity Impact (kWh) = $ESav_{CW}$

Demand Impact (kW) = $DSav_{CW} \times CF_{CW}$

ENERGY STAR Dishwashers

Electricity Impact (kWh) = $ESav_{DW}$

Demand Impact (kW) = $DSav_{REF} \times CF_{DW}$

ENERGY STAR Dehumidifiers

Electricity Impact (kWh) = $ESav_{DH}$

Demand Impact (kW) = $DSav_{DH} \times CF_{DH}$

ENERGY STAR Room Air Conditioners

Electricity Impact (kWh) = ES_{AVRAC}

Demand Impact (kW) = $DS_{AVRAC} \times CF_{RAC}$

ENERGY STAR Freezer

Demand Impact (kW) = $kW_{BASE} - kW_{EE}$

Energy Impact (kWh) = $\Delta kW \times HOURS$

Definition of Terms

ES_{AVREF} = Electricity savings per purchased ENERGY STAR refrigerator.

DS_{AVREF} = Summer demand savings per purchased ENERGY STAR refrigerator.

ES_{AVCW} = Electricity savings per purchased ENERGY STAR clothes washer.

DS_{AVCW} = Summer demand savings per purchased ENERGY STAR clothes washer.

ES_{AVDW} = Electricity savings per purchased ENERGY STAR dishwasher.

DS_{AVDW} = Summer demand savings per purchased ENERGY STAR dishwasher.

ES_{AVDH} = Electricity savings per purchased ENERGY STAR dehumidifier

DS_{AVDH} = Summer demand savings per purchased ENERGY STAR dehumidifier

ES_{AVRAC} = Electricity savings per purchased ENERGY STAR room AC.

DS_{AVRAC} = Summer demand savings per purchased ENERGY STAR room AC.

$CF_{REF}, CF_{CW}, CF_{DW}, CF_{DH}, CF_{RAC}$ = Summer demand coincidence factor. The coincidence of average appliance demand to summer system peak equals 1 for demand impacts for all appliances reflecting embedded coincidence in the DSav factor except for room air conditioners where the CF is 58%.

ΔkW = gross customer connected load kW savings for the measure

kW_{BASE} = Baseline connected kW

kW_{EE} = Energy efficient connected kW

HOURS = average hours of use per year

Table 6: ENERGY STAR Appliances

Component	Type	Value	Sources
$ESav_{REF}$	Fixed	see Table below	12
$DSav_{REF}$	Fixed	0.0125 kW	1
REF Time Period Allocation Factors	Fixed	Summer/On-Peak 20.9% Summer/Off-Peak 21.7% Winter/On-Peak 28.0% Winter/Off-Peak 29.4%	2
$ESav_{CW}$	Fixed	see Table below	12
$DSav_{CW}$	Fixed	0.0147 kW	3
CW Electricity Time Period Allocation Factors	Fixed	Summer/On-Peak 24.5% Summer/Off-Peak 12.8% Winter/On-Peak 41.7% Winter/Off-Peak 21.0%	2
$ESav_{DW}$	Fixed	see Table below	12
$DSav_{DW}$	Fixed	0.0225	4
DW Electricity Time Period Allocation Factors	Fixed	19.8%, 21.8%, 27.8%, 30.6%	2
$ESav_{DH}$	Fixed	see Table below	12
$DSav_{DH}$	Fixed	.0098 kW	10
$ESav_{RAC}$	Fixed	see Table below	12
$DSav_{RAC}$	Fixed	0.1018 kW	6
$CF_{REF}, CF_{CW}, CF_{DW}, CF_{DH}, CF_{RAC}$	Fixed	1.0, 1.0, 1.0, 1.0, 0.58	7
RAC Time Period Allocation Factors	Fixed	65.1%, 34.9%, 0.0%, 0.0%	2
kW_{BASE}	Fixed	0.0926	11
kW_{EE}	Fixed	0.0813	11
HOURS	Fixed	5000	11
ΔkW	Fixed	0.0113	11

Sources:

1. Energy Star Refrigerator Savings Calculator (Calculator updated: 2/15/05; Constants updated 05/07). Demand savings derived using refrigerator load shape.
2. Time period allocation factors used in cost-effectiveness analysis. From residential appliance load shapes.
3. Energy and water savings based on Consortium for Energy Efficiency estimates. Assumes 75% of participants have gas water heating and 60% have gas drying (the balance being electric). Demand savings derived using NEEP screening clothes washer load shape.

4. Energy and water savings from RLW Market Update. Assumes 37% electric hot water market share and 63% gas hot water market share. Demand savings derived using dishwasher load shape.
5. Energy and demand savings from engineering estimate based on 600 hours of use. Based on delta watts for ENERGY STAR and non-ENERGY STAR units in five different size (cooling capacity) categories. Category weights from LBNL *Technical Support Document for ENERGY STAR Conservation Standards for Room Air Conditioners*.
6. Average demand savings based on engineering estimate.
7. Coincidence factors already embedded in summer peak demand reduction estimates with the exception of RAC. RAC CF is based on data from PEPCO.
8. Prorated based on six months in the summer period and six months in the winter period.
9. Energy Star Dehumidifier Savings Calculator (Calculator updated: 2/15/05; Constants updated 05/07). A weighted average based on the distribution of available ENERGY STAR products was used to determine savings.
10. Conservatively assumes same kW/kWh ratio as Refrigerators.
11. Efficiency Vermont. Technical Reference User Manual: Measure Savings Algorithms and Cost Assumptions (July 2008).
12. All values are taken from the Energy Star Savings Calculators at www.energystar.gov.

Table 7: Energy Savings from Energy Star Calculators

Refrigerator	
Manual Defrost	72 kWh
Partial Automatic Defrost	72 kWh
Top mount freezer without door ice	80 kWh
Side mount freezer without door ice	95 kWh
Bottom mount freezer without door ice	87 kWh
Top mount freezer with door ice	94 kWh
Side mount freezer with door ice	100 kWh
Freezers	
Upright with manual defrost	55 kWh
Upright with automatic defrost	80 kWh
Chest Freezer	52 kWh
Compact Upright with manual defrost	62 kWh
Compact Upright with automatic defrost	83 kWh
Compact Chest Freezer	55 kWh
Dehumidifier	
1-25 pints/day	54 kWh
25-35 pints/day	117 kWh
35-45 pints/day	213 kWh
45-54 pints/day	297 kWh
54-75 pints/day	342 kWh

75-185 pints/day	374 kWh
Room Air Conditioner (Load hours in parentheses)	
Allentown	74 kWh (784 hours)
Erie	46 kWh (482 hours)
Harrisburg	88 kWh (929 hours)
Philadelphia	98 kWh (1032 hours)
Pittsburgh	70 kWh (737 hours)
Scranton	59 kWh (621 hours)
Williamsport	62 kWh (659 hours)
Dishwasher	
With Gas Hot Water Heater	77 kWh
With Electric Hot Water Heater	137 kWh
Clothes Washer	
With Gas Hot Water Heater	26 kWh
With Electric Hot Water Heater	258 kWh

Residential ENERGY STAR Lighting

Algorithms

Savings from installation of screw-in ENERGY STAR CFLs, ENERGY STAR fluorescent torchieres, ENERGY STAR indoor fixtures and ENERGY STAR outdoor fixtures are based on a straightforward algorithm that calculates the difference between existing and new wattage and the average daily hours of usage for the lighting unit being replaced. An “in-service” rate is used to reflect the fact that not all lighting products purchased are actually installed.

The general form of the equation for the ENERGY STAR or other high-efficiency lighting energy savings algorithm is:

Number of Units X Savings per Unit

Per unit savings estimates are derived primarily from a 2004 Nexus Market Research report evaluating similar retail lighting programs in New England (MA, RI and VT)

ENERGY STAR CFL Bulbs

$$\text{Electricity Impact (kWh)} = ((\text{CFL}_{\text{watts}} \times (\text{CFL}_{\text{hours}} \times 365))/1000) \times \text{ISR}_{\text{CFL}}$$

$$\text{Peak Demand Impact (kW)} = (\text{CFL}_{\text{watts}}) \times \text{Light CF}$$

ENERGY STAR Torchieres

$$\text{Electricity Impact (kWh)} = ((\text{Torch}_{\text{watts}} \times (\text{Torch}_{\text{hours}} \times 365))/1000) \times \text{ISR}_{\text{Torch}}$$

$$\text{Peak Demand Impact (kW)} = (\text{Torch}_{\text{watts}}) \times \text{Light CF}$$

ENERGY STAR Indoor Fixture

$$\text{Electricity Impact (kWh)} = ((\text{IF}_{\text{watts}} \times (\text{IF}_{\text{hours}} \times 365))/1000) \times \text{ISR}_{\text{IF}}$$

$$\text{Peak Demand Impact (kW)} = (\text{IF}_{\text{watts}}) \times \text{Light CF}$$

ENERGY STAR Outdoor Fixture

$$\text{Electricity Impact (kWh)} = ((\text{OF}_{\text{watts}} \times (\text{OF}_{\text{hours}} \times 365))/1000) \times \text{ISR}_{\text{OF}}$$

$$\text{Peak Demand Impact (kW)} = (\text{OF}_{\text{watts}}) \times \text{Light CF}$$

Ceiling Fan with ENERGY STAR Light Fixture

$$\text{Energy Savings (kWh)} = 180 \text{ kWh}$$

$$\text{Demand Savings (kW)} = 0.01968$$

Definition of Terms

$\text{CFL}_{\text{watts}}$ = Average delta watts per purchased ENERGY STAR CFL

$\text{CFL}_{\text{hours}}$ = Average hours of use per day per CFL

ISR_{CFL} = In-service rate per CFL

$\text{Torch}_{\text{watts}}$ = Average delta watts per purchased ENERGY STAR torchiere

$\text{Torch}_{\text{hours}}$ = Average hours of use per day per torchiere

$\text{ISR}_{\text{Torch}}$ = In-service rate per Torchier

IF_{watts} = Average delta watts per purchased ENERGY STAR Indoor Fixture

IF_{hours} = Average hours of use per day per Indoor Fixture

ISR_{IF} = In-service rate per Indoor Fixture

OF_{watts} = Average delta watts per purchased ENERGY STAR Outdoor Fixture

OF_{hours} = Average hours of use per day per Outdoor Fixture

ISR_{OF} = In-service rate per Outdoor Fixture

Light CF = Summer demand coincidence factor.

ΔkWh = Gross customer annual kWh savings for the measure

ΔkW = Gross customer connected load kW savings for the measure

Table 8: ENERGY STAR Lighting

Component	Type	Value	Sources
CFL _{watts}	Fixed	Variable	Data Gathering
CFL _{hours}	Fixed	3.0	6
ISR _{CFL}	Fixed	84%	3
Torch _{watts}	Fixed	115.8	1
Torch _{hours}	Fixed	3.0	2
ISR _{Torch}	Fixed	83%	3
IF _{watts}	Fixed	48.7	1
IF _{hours}	Fixed	2.6	2
ISR _{IF}	Fixed	95%	3
OF _{watts}	Fixed	94.7	1
OF _{hours}	Fixed	4.5	2
ISR _{OF}	Fixed	87%	3
Light CF	Fixed	5%	4
ΔkWh	Fixed	180 kWh	5
ΔkW	Fixed	0.01968	5

Sources:

1. Nexus Market Research, “Impact Evaluation of the Massachusetts, Rhode Island and Vermont 2003 Residential Lighting Programs”, Final Report, October 1, 2004, p. 43 (Table 4-9)
2. Ibid., p. 104 (Table 9-7). This table adjusts for differences between logged sample and the much larger telephone survey sample and should, therefore, have less bias.
3. Ibid., p. 42 (Table 4-7). These values reflect both actual installations and the % of units planned to be installed within a year from the logged sample. The logged % is used because the adjusted values (i.e to account for differences between logging and telephone survey samples) were not available for both installs and planned installs. However, this seems appropriate because the % actual installed in the logged sample from this table is essentially identical to the % after adjusting for differences between the logged group and the telephone sample (p. 100, Table 9-3).
4. RLW Analytics, “Development of Common Demand Impacts for Energy Efficiency Measures/Programs for the ISO Forward Capacity Market (FCM)”, prepared for the New England State Program Working Group (SPWG), March 25, 2007, p. IV.
5. Efficiency Vermont. Technical Reference User Manual: Measure Savings Algorithms and Cost Assumptions (July 2008).
6. US Department of Energy, Energy Star Calculator. Accessed 3-16-2009.

ENERGY STAR Windows

Algorithms

The general form of the equation for the ENERGY STAR or other high-efficiency windows energy savings' algorithms is:

Square Feet of Window Area X Savings per Square Foot

To determine resource savings, the per square foot estimates in the algorithms will be multiplied by the number of square feet of window area. The number of square feet of window area will be determined using market assessments and market tracking. Some of these market tracking mechanisms are under development. The per unit energy and demand savings estimates are based on prior building simulations of windows.

ENERGY STAR Windows

Savings' estimates for ENERGY STAR Windows are based on modeling a typical 2,500 square foot home using REM Rate, the home energy rating tool.¹² Savings are per square foot of qualifying window area. Savings will vary based on heating and cooling system type and fuel. These fuel and HVAC system market shares will need to be estimated from prior market research efforts or from future program evaluation results.

Heat Pump

Electricity Impact (kWh) = ESav_{HP}

Demand Impact (kW) = DSav_{HP} X CF

Electric Heat/CAC

Electricity Impact (kWh) = ESav_{RES/CAC}

Demand Impact (kW) = DSav_{CAC} X CF

Electric Heat/No CAC

Electricity Impact (kWh) = ESav_{RES/NOCAC}

Demand Impact (kW) = DSav_{NOCAC} X CF

¹² Energy Information Administration. *Residential Energy Consumption Survey*. 2005.
http://www.eia.doe.gov/emeu/recs/recs2005/hc2005_tables/detailed_tables2005.html

Definition of Terms

$ESav_{HP}$ = Electricity savings (heating and cooling) with heat pump installed.

$ESav_{RES/CAC}$ = Electricity savings with electric resistance heating and central AC installed.

$ESav_{RES/NOCAC}$ = Electricity savings with electric resistance heating and no central AC installed.

$DSav_{HP}$ = Summer demand savings with heat pump installed.

$DSav_{CAC}$ = Summer demand savings with central AC installed.

$DSav_{NOCAC}$ = Summer demand savings with no central AC installed.

CF = System peak demand coincidence factor. Coincidence of building cooling demand to summer system peak.

Table 9: ENERGY STAR Windows

Component	Type	Value	Sources
$ESav_{HP}$	Fixed	2.2395 kWh	1
HP Time Period Allocation Factors	Fixed	Summer/On-Peak 10% Summer/Off-Peak 7% Winter/On-Peak 40% Winter/Off-Peak 44%	2
$ESav_{RES/CAC}$	Fixed	4.0 kWh	1
Res/CAC Time Period Allocation Factors	Fixed	Summer/On-Peak 10% Summer/Off-Peak 7% Winter/On-Peak 40% Winter/Off-Peak 44%	2
$ESav_{RES/NOCAC}$	Fixed	3.97 kWh	1
Res/No CAC Time Period Allocation Factors	Fixed	Summer/On-Peak 3% Summer/Off-Peak 3% Winter/On-Peak 45% Winter/Off-Peak 49%	2
$DSav_{HP}$	Fixed	0.000602 kW	1
$DSav_{CAC}$	Fixed	0.000602 kW	1
$DSav_{NOCAC}$	Fixed	0.00 kW	1
CF	Fixed	0.75	3

Sources:

1. From REMRATE Modeling of a typical 2,500 sq. ft. NJ home. Savings expressed on a per square foot of window area basis. New Brunswick climate data.

2. Time period allocation factors used in cost-effectiveness analysis.
3. Based on reduction in peak cooling load.
4. Prorated based on 12% of the annual degree days falling in the summer period and 88% of the annual degree days falling in the winter period.

ENERGY STAR Audit

Algorithms

No algorithm was developed to measure energy savings for this program. The purpose of the program is to provide information and tools that residential customers can use to make decisions about what actions to take to improve energy efficiency in their homes. Many measure installations that are likely to produce significant energy savings are covered in other programs. These savings are captured in the measured savings for those programs. The savings produced by this program that are not captured in other programs would be difficult to isolate and relatively expensive to measure.

Refrigerator/Freezer Retirement

Algorithms

The general form of the equation for the Refrigerator/Freezer Retirement savings algorithm is:

Number of Units X Savings per Unit

To determine resource savings, the per unit estimates in the algorithms will be multiplied by the number of appliance units.

Unit savings are the product of average fridge/freezer consumption (gross annual savings).

Algorithm

Electricity Impact (kWh) = $ESav_{RetFridge}$

Demand Impact (kW) = $DSav_{RetFridge} \times CF_{RetFridge}$

Definition of Terms

$ESav_{RetFridge}$ = Gross annual energy savings per unit retired appliance

$DSav_{RetFridge}$ = Summer demand savings per retired refrigerator/freezer

$CF_{RetFridge}$ = Summer demand coincidence factor.

Table 10: REFRIGERATOR/FREEZER RECYCLING

Component	Type	Value	Sources
ESav _{RetFridge}	Fixed	1,728 kWh	1
DSav _{RetFridge}	Fixed	.2376 kW	2
CF _{RetFridge}	Fixed	1	3

Sources:

1. The average power consumption of units retired under similar recent programs:
 - a. Fort Collins Utilities, February 2005. Refrigerator and Freezer Recycling Program 2004 Evaluation Report.
 - b. Midwest Energy Efficiency Alliance, 2005. 2005 Missouri Energy Star Refrigerator Rebate and Recycling Program Final Report
 - c. Pacific Gas and Electric, 2007. PGE ARP 2006-2008 Climate Change Impacts Model (spreadsheet)
 - d. Quantec, Aug 2005. Evaluation of the Utah Refrigerator and Freezer Recycling Program (Draft Final Report).
 - e. CPUC DEER website,
<http://eega.cpuc.ca.gov/deer/measure.asp?s=1&c=2&sc=7&m=389059>
 - f. Snohomish PUD, February 2007. 2006 Refrigerator/Freezer Recycling Program Evaluation.
 - g. Ontario Energy Board, 2006. Total Resource Cost Guide.
2. Applied the kW to kWh ratio derived from Refrigerator savings in the ENERGY STAR Appliances Program.
3. Coincidence factor already embedded in summer peak demand reduction estimates

Home Performance with ENERGY STAR

In order to implement Home Performance with Energy Star, there are various standards a program implementer must adhere to in order to deliver the program. The program implementer must use software that meets a national standard for savings calculations from whole-house approaches such as home performance. The software program implementer must adhere to at least one of the following standards:

- A software tool whose performance has passed testing according to the National Renewable Energy Laboratory's HERS BESTEST software energy simulation testing protocol.¹³
- Software approved by the US Department of Energy's Weatherization Assistance Program.¹⁴
- RESNET approved rating software.¹⁵

There are numerous software packages that comply with these standards. Some examples of the software packages are REM/Rate, EnergyGauge, TREAT, and HomeCheck. The HomeCheck software is described below as an example of a software that can be used to determine if a home qualifies for Home Performance with Energy Star.

HomeCheck Software Example

Conservation Services Group (CSG) implements Home Performance with Energy Star in several states. CSG has developed proprietary software known as HomeCheck which is designed to enable an energy auditor to collect information about a customer's site and based on what is found through the energy audit, recommend energy savings measures and demonstrate the costs and savings associated with those recommendations. The HomeCheck software is also used to estimate the energy savings that are reported for this program.

CSG has provided a description of the methods and inputs utilized in the HomeCheck software to estimate energy savings. CSG has also provided a copy of an evaluation report prepared by Nexant which assessed the energy savings from participants in the Home Performance with Energy Star Program managed by the New York State Energy Research and Development Authority (NYSERDA)¹⁶. The report concluded that the savings estimated by HomeCheck and reported to NYSEERDA were in general agreement with the savings estimates that resulted from the evaluation.

¹³ A new standard for BESTEST is currently being developed. The existing 1995 standard can be found at <http://www.nrel.gov/docs/legosti/fy96/7332a.pdf>.

¹⁴ A listing of the approved software available at <http://www.waptac.org/si.asp?id=736>.

¹⁵ A listing of the approved software available at <http://resnet.us>.

¹⁶ M&V Evaluation, Home Performance with Energy Star Program, Final Report, Prepared for the New York State Energy Research and Development Authority, Nexant, June 2005.

These algorithms incorporate the HomeCheck software by reference which will be utilized for estimating energy savings for Home Performance with Energy Star. The following is a summary of the HomeCheck software which was provided by CSG: CSG's HomeCheck software was designed to streamline the delivery of energy efficiency programs. The software provides the energy efficiency specialist with an easy-to-use guide for data collection, site and HVAC testing algorithms, eligible efficiency measures, and estimated energy savings. The software is designed to enable an auditor to collect information about customers' sites and then, based on what he/she finds through the audit, recommend energy-saving measures, demonstrate the costs and savings associated with those recommendations. It also enables an auditor/technician to track the delivery of services and installation of measures at a site.

This software is a part of an end-to-end solution for delivering high-volume retrofit programs, covering administrative functions such as customer relationship management, inspection scheduling, sub-contractor arranging, invoicing and reporting. The range of existing components of the site that can be assessed for potential upgrades is extensive and incorporates potential modifications to almost all energy using aspects of the home. The incorporation of building shell, equipment, distribution systems, lighting, appliances, diagnostic testing and indoor air quality represents a very broad and comprehensive ability to view the needs of a home.

The software is designed to combine two approaches to assessing energy savings opportunities at the site. One is a measure specific energy loss calculation, identifying the change in use of BTU's achieved by modifying a component of the site. Second, is the correlation between energy savings from various building improvements, and existing energy use patterns at a site. The use of both calculated savings and the analysis of existing energy use patterns, when possible, provides the most accurate prescription of the impact of changes at the site for an existing customer considering improvements on a retrofit basis.

This software is not designed to provide a load calculation for new equipment or a HERS rating to compare a site to a standard reference site. It is designed to guide facilities in planning improvements at the site with the goal of improved economics, comfort and safety. The software calculates various economic evaluations such as first year savings, simple payback, measure life cost-effectiveness, and Savings-to-Investment ratio (SIR).

Site-Level Parameters and Calculations

There are a number of calculations and methodologies that apply across measures and form the basis for calculating savings potentials at a site.

Heating Degree Days and Cooling Degree Hours

Heat transfer calculations depend fundamentally on the temperature difference between inside and outside temperature. This temperature difference is often summarized on a seasonal basis using fixed heating degree-days (HDD) and cooling degree-hours (CDH). The standard reference temperature for calculating HDD (the outside temperature at which the heating system is required), for example, has historically been 65°F. Modern

houses have larger internal gains and more efficient thermal building envelopes than houses did when the 65°F standard was developed, leading to lower effective reference temperatures. This fact has been recognized in ASHRAE Fundamentals, which provides a variable-based degree-day method for calculating energy usage. CSG's Building Model calculates both HDD and CDH based on the specific characteristics and location of the site being treated.

Building Loads, Other Parameters, and the Building Model

CSG is of the opinion that, in practice, detailed building load simulation tools are quite limited in their potential to improve upon simpler approaches due to their reliance on many factors that are not measurable or known, as well as limitations to the actual models themselves. Key to these limitations is the Human Factor (e.g., sleeping with the windows open; extensive use of high-volume extractor fans, etc.) that is virtually impossible to model. As such, the basic concept behind the model was to develop a series of location specific lookup tables that would take the place of performing hourly calculations while allowing the model to perform for any location. The data in these tables would then be used along with a minimum set of technical data to calculate heating and cooling building loads.

In summary, the model uses:

- Lookup tables for various parameters that contain the following values for each of the 239 TMY2 weather stations:
 - Various heating and cooling infiltration factors.
 - Heating degree days and heating hours for a temperature range of 40 to 72°F.
 - Cooling degree hours and cooling hours for a temperature range of 68 to 84°F.
 - Heating and cooling season solar gain factors.
- Simple engineering algorithms based on accepted thermodynamic principles, adjusted to reflect known errors, the latest research and measured results
- Heating season iterative calculations to account for the feedback loop between conditioned hours, degree days, average “system on” indoor and outdoor temperatures and the building
- The thermal behavior of homes is complex and commonly accepted algorithms will on occasion predict unreasonably high savings, HomeCheck uses a proprietary methodology to identify and adjust these cases. This methodology imposes limits on savings projected by industry standard calculations, to account for interactivities and other factors that are difficult to model. These limits are based on CSG's measured experience in a wide variety of actual installations.

Usage Analysis

The estimation of robust building loads through the modeling of a building is not always reliable. Thus, in addition to modeling the building, HomeCheck calculates a normalized annual consumption for heating and cooling, calculated from actual fuel consumption and weather data using a Seasonal Swing methodology. This methodology uses historic local

weather data and site-specific usage to calculate heating and cooling loads. The methodology uses 30-year weather data to determine spring and fall shoulder periods when no heating or cooling is likely to be in use. The entered billing history is broken out into daily fuel consumption, and these daily consumption data along with the shoulder periods is used to calculate base load usage and summer and winter seasonal swing fuel consumption.

Multiple HVAC Systems

HVAC system and distribution seasonal efficiencies are used in all thermal-shell measure algorithms. HVAC system and distribution seasonal efficiencies and thermostat load reduction adjustments are used when calculating the effect of interactivity between mechanical and architectural measures. If a site has multiple HVAC systems, weighted average seasonal efficiencies and thermostat load reduction adjustments are calculated based on the relative contributions (in terms of percent of total load) of each system.

Multiple Heating Fuels

It is not unusual to find homes with multiple HVAC systems using different fuel types. In these cases, it is necessary to aggregate the NACs for all fuel sources for use in shell savings algorithms. This is achieved by assigning a percentage contribution to total NAC for each system, converting this into BTU's, and aggregating the result. Estimated first year savings for thermal shell measures are then disaggregated into the component fuel types based on the pre-retrofit relative contributions of fuel types.

Interactivity

To account for interactivity between architectural and mechanical measures, CSG's HomeCheck employs the following methodology, in order:

- Noninteracted first year savings are calculated for each individual measure.
- Non-interacted SIR (RawSIR) is calculated for each measure.
- Measures are ranked in descending order of RawSIR,
- Starting with the most cost-effective measure (as defined by RawSIR), first year savings are adjusted for each measure as follows:
 - Mechanical measures (such as thermostats, HVAC system upgrades or distribution system upgrades) are adjusted to account for the load reduction from measures with a higher RawSIR.
 - Architectural measures are adjusted to account for overall HVAC system efficiency changes and thermostat load reduction changes. Architectural measures with a higher RawSIR than that of HVAC system measures are calculated using the existing efficiencies. Those with RawSIR's lower than that of heating equipment use the new heating efficiencies.
- Interacted SIR is then calculated for each measure, along with cumulative SIR for the entire job.
- All measures are then re-ranked in descending order of SIR.
- The process is repeated, replacing RawSIR with SIR until the order of measures does not change.

Lighting

Quantification of additional saving due to the addition of high efficiency lighting will be based on the algorithms presented for these appliances in the Energy Star Lighting Algorithms found in Energy Star Products.

Commercial and Industrial Energy Efficient Construction

C&I Electric

Baselines and Code Changes

All baselines are designed to reflect current market practices which are generally the higher of code or available equipment, that are updated periodically to reflect upgrades in code or information from evaluation results.

Lighting Equipment

For new construction and entire facility rehabilitation projects, savings are calculated using market-driven assumptions that presume a decision to upgrade the lighting system from an industry standard system. For existing commercial lighting, the most efficient T-12 lamp and magnetic ballast fixture serves as the baseline. For T-5 and T-8 fixtures replacing HID, 250 watt or greater T-12 fluorescent or 250 watt or greater incandescent fixtures savings are calculated referencing pre-existing connected lighting load.

Lighting equipment includes fluorescent fixtures, ballasts, compact fluorescent fixtures, exit signs, LED fixtures and metal halide lamps. The measurement of energy savings is based on algorithms with measurement of key variables (i.e., Coincidence Factor and Operating Hours) through end-use metering data accumulated from a large sample of participating facilities from 1995 through 1999.

Algorithms

Energy Savings (kWh) = $\Delta kW \times EFLH \times (1+IF)$

Demand Savings (kW) = $\Delta kW \times CF \times (1+IF)$

Definition of Variables

ΔkW = Change in connected load from baseline to efficient lighting level. The baseline value is expressed in watts/square foot calculated as: $(\text{Watts/Sq.Ft.} - \text{Watts/Sq.Ft. (qualified equipment by same area)}) \times \text{Area Sq.Ft./1000}$ (see table above).

CF = Coincidence Factor – the value represents the percentage of the total lighting connected load which is on during electric system's Peak Window. The Peak Window covers the time period from 12 noon to 8 p.m. These values are based on measured usage in the JCP&L service territory.

IF = Interactive Factor – applies to C&I interior lighting only. This represents the secondary demand and energy savings in reduced HVAC consumption resulting from decreased indoor lighting wattage.

EFLH = Equivalent Full Load Hours – represents the annual operating hours.

Table 11: Traffic Signals¹⁷

	Wattage	% Burn	Burn Hours	kWhs	Demand Savings	Energy Savings
Round Traffic Signals						
Red 8"	69	55%	4,818	332	-	-
Red 8" LED	7	55%	4,818	34	0.062	299
Yellow 8"	69	2%	175	12	-	-
Yellow 8" LED	10	2%	175	2	0.059	10
Green 8"	69	43%	3,767	260	-	-
Green 8" LED	9	43%	3,767	34	0.060	226
Red 12"	150	55%	4,818	723	-	-
Red 12" LED	6	55%	4,818	29	0.144	694
Yellow 12"	150	2%	175	26	-	-
Yellow 12" LED	13	2%	175	2	70.137	24
Green 12"	150	43%	3,767	565	-	-
Green 12" LED	12	43%	3,767	45	0.138	520
Turn Arrows						
Yellow 8"	116	8%	701	81	-	-
Yellow 8" LED	7	8%	701	5	0.109	76
Yellow 12"	116	8%	701	81	-	-
Yellow 12" LED	9	8%	701	6	0.107	75
Green 8"	116	8%	701	81	-	-
Green 8" LED	7	8%	701	5	0.109	76
Green 12"	116	8%	701	81	-	-
Green 12" LED	7	8%	3767	5	0.109	76
Pedestrian Signs						
Hand/Man 12"	116	100%	8,760	1,016	-	-

¹⁷ Source: PECO Comments on the PA TRM, received March30, 2009.

Hand/Man LED	8	100%	8,760	70	0.108	946
Note: kWh and Energy Savings are Annual; Demand Savings listed are per lamp.						

Reference specifications for above traffic signal wattages are from the following manufacturers:

- 8” Incandescent traffic signal bulb: General Electric Traffic Signal Model 17325-69A21/TS
 - 12” Incandescent traffic signal bulb: General Electric Signal Model 35327-150PAR46/TS
 - Incandescent Arrows & Hand/Man Pedestrian Signs: General Electric Traffic Signal Model 19010-116A21/TS
 - 8” and 12” LED traffic signals: Leotek Models TSL-ES08 and TSL-ES12
 - 8” LED Yellow Arrow: General Electric Model DR4-YTA2-01A
 - 8” LED Green Arrow: General Electric Model DR4-GCA2-01A
 - 12” LED Yellow Arrow: Dialight Model 431-3334-001X
 - 12: LED Green Arrow: Dialight Model 432-2324-001X
 - LED Hand/Man Pedestrian Sign: dialight 430-6450-001X
- Coincidence factor for demand savings = 55% for red, 43% for green and 2% for yellow.

Prescriptive Lighting

Prescriptive Lighting is a fixture replacement program for existing commercial customers that are targeted at facilities performing efficiency upgrades to their lighting systems.

The baseline is existing T-12 fixtures with energy efficient lamps and magnetic ballast.

The baseline for compact fluorescent is that the fixture replaced was four times the wattage of the replacement compact fluorescent.

Algorithms

Energy Savings (kWh) = ΔkW X EFLH

Demand Savings (kW) = ΔkW X CF

ΔkW=Number of fixtures installed X (baseline wattage for fixture type(from above baseline))-number of replaced fixtures X (wattage from table)

Table 12: Prescriptive Lighting Savings Table

The table will be updated periodically to include new fixtures and technologies available after table publication. Baselines will be established based on the guidelines noted above.

Fixture Type	Type	New Watts (w/fixture)	Baseline (w/fixture)	Savings (w/fixture)
COMPACT FLUORESCENT (2) 11W CF/HW	CFL2	26	104	78

Fixture Type	Type	New Watts (w/fixture)	Baseline (w/fixture)	Savings (w/fixture)
COMPACT FLUORESCENT (2) 13W CF/HW	CFL2	30	120	90
COMPACT FLUORESCENT (2) 18W CF/HW	CFL2	36	144	108
COMPACT FLUORESCENT (2) 18W QD/ELEC	CFL2	38	152	114
COMPACT FLUORESCENT (3) 18W	CFL2	54	225	171
COMPACT FLUORESCENT (2) 26W CF/HW	CFL2	53	212	159
COMPACT FLUORESCENT (2) 26W QD/ELEC	CFL2	54	216	162
COMPACT FLUORESCENT (2) 5W CF/HW	CFL2	14	56	42
COMPACT FLUORESCENT (2) 7W CF/HW	CFL2	18	72	54
COMPACT FLUORESCENT (2) 9W CF/HW	CFL2	22	88	66
COMPACT FLUORESCENT 11W CF/HW	CFL1	13	52	39
COMPACT FLUORESCENT 13W CF/HW	CFL1	15	60	45
COMPACT FLUORESCENT 18W CF/HW	CFL1	19	76	57
COMPACT FLUORESCENT 18W QD/ELEC	CFL1	22	88	66
COMPACT FLUORESCENT 20W CF/HW	CFL1	22	88	66
COMPACT FLUORESCENT 22W QD/ELEC	CFL1	26	104	78
COMPACT FLUORESCENT 26W CF/HW	CFL1	28	112	84
COMPACT FLUORESCENT 26W QD/ELEC	CFL1	27	108	81
COMPACT FLUORESCENT 28W CF/HW	CFL1	30	120	90
COMPACT FLUORESCENT 32W CF/HW	CFL1	34	136	102
COMPACT FLUORESCENT 36W CF/HW	CFL1	41	164	123
COMPACT FLUORESCENT 40W CF/HW	CFL1	45	180	135
COMPACT FLUORESCENT (2) 40W CF/HW	CFL2	71	180	109
COMPACT FLUORESCENT 5W CF/HW	CFL1	7	28	21
COMPACT FLUORESCENT 7W CF/HW	CFL1	10	40	30
COMPACT FLUORESCENT 9W CF/HW	CFL1	11	44	33
Low Bay T-5 2L FP54/T5/Elec/Ho	LOBA	117	250	133
Low Bay T-5 3L FP54/T5/Elec/Ho	LOBA	179	290	111
Low Bay T-5 4L FP54/T5/Elec/Ho	LOBA	234	409	175
Low Bay T-5 6L FP54/T5/Elec/Ho	LOBA	351	992	641
Low Bay T-8 2L4	LOBA	55	73	18
Low Bay T-8 2L8	LOBA	118	158	40
Low Bay T-8 3L4	LOBA	79	105	26
Low Bay T-8 4L4	LOBA	110	146	36
Low Bay T-8 4L8	LOBA	233	316	83
Low Bay T-8 6L4	LOBA	224	454	230
High Bay T-5 3L FP54/T5/Elec/Ho	HIBA	179	290	111
High Bay T-5 4L FP54/T5/Elec/Ho	HIBA	234	409	175
High Bay T-5 6L FP54/T5/Elec/Ho	HIBA	351	992	641
High Bay T-8 8L4 FP54/T5/Elec/Ho	HIBA	468	1080	612
High Bay T-8 3L4	HIBA	79	105	26
High Bay T-8 4L4	HIBA	110	146	36
High Bay T-8 4L8	HIBA	233	316	83
High Bay T-8 6L4	HIBA	224	454	230
High Efficiency Fluorescent 1L2 (1) FO17T8/Elec	HEF	18	32	14
High Efficiency Fluorescent 1L2 (2) FO17T8/Elec	HEF	34	56	22
High Efficiency Fluorescent 1L2 (3) FO17T8/Elec	HEF	50	78	28

Fixture Type	Type	New Watts (w/fixture)	Baseline (w/fixture)	Savings (w/fixture)
High Efficiency Fluorescent 1L2 (4) FO17T8/Elec	HEF	62	112	50
High Efficiency Fluorescent 1L3 (1) FO25T8/Elec	HEF	30	46	16
High Efficiency Fluorescent 1L3 (2) FO25T8/Elec	HEF	48	80	32
High Efficiency Fluorescent 1L3 (3) FO25T8/Elec	HEF	68	126	58
High Efficiency Fluorescent 1L3 (4) FO25T8/Elec	HEF	90	160	70
High Efficiency Fluorescent T-5 3L FP54/T5/Elec/Ho	HEF	179	290	111
High Efficiency Fluorescent T-5 4L FP54/T5/Elec/Ho	HEF	234	409	175
High Efficiency Fluorescent T-5 6L FP54/T5/Elec/Ho	HEF	351	992	641
High Efficiency Fluorescent T-8 1L4	HEF	28	42	14
High Efficiency Fluorescent T-8 1L8	HEF	67	78	11
High Efficiency Fluorescent T-8 2L2	HEF	62	94	32
High Efficiency Fluorescent T-8 2L4	HEF	55	73	18
High Efficiency Fluorescent T-8 2L8	HEF	118	158	40
High Efficiency Fluorescent T-8 3L4	HEF	79	105	26
High Efficiency Fluorescent T-8 4L4	HEF	110	146	36
High Efficiency Fluorescent T-8 4L8	HEF	233	316	83
LED Exit Sign	EXIT	20	18	2
PULSE START METAL HALIDE 1000 W	PSMH	1075	1080	5
PULSE START METAL HALIDE 150 W	PSMH	185	200	15
PULSE START METAL HALIDE 175 W	PSMH	208	285	77
PULSE START METAL HALIDE 200 W	PSMH	235	285	50
PULSE START METAL HALIDE 250 W	PSMH	288	454	166
PULSE START METAL HALIDE 300 W	PSMH	342	454	112
PULSE START METAL HALIDE 320 W	PSMH	368	454	86
PULSE START METAL HALIDE 350 W	PSMH	400	454	54
PULSE START METAL HALIDE 400 W	PSMH	450	454	4
PULSE START METAL HALIDE 750 W	PSMH	815	1075	260
Low Bay LED 85 W for 250 Metal Halide	LBLD	85	248	163
Low Bay LED 85 W for 2LHO T-8	LBLF	85	118	33

Lighting Controls

Lighting controls include occupancy sensors, daylight dimmer systems, occupancy controlled hi-low controls for fluorescent and HID controls. The measurement of energy savings is based on algorithms with key variables (i.e., coincidence factor, equivalent full load hours) provided through existing end-use metering of a sample of facilities or from other utility programs with experience with these measures (i.e., % of annual lighting energy saved by lighting control). For lighting controls, the baseline is a manual switch.

Algorithms

$$\text{Energy Savings (kWh)} = kW_c \times \text{SVG} \times \text{EFLH} \times (1+\text{IF})$$

$$\text{Demand Savings (kW)} = kW_c \times \text{SVG} \times \text{CF}$$

Definition of Variables

SVG = % of annual lighting energy saved by lighting control; refer to table by control type.

kW_c = kW lighting load connected to control.

IF = Interactive Factor – This applies to C&I interior lighting only. This represents the secondary demand and energy savings in reduced HVAC consumption resulting from decreased indoor lighting wattage.

CF = Coincidence Factor – the percentage of the total load which is on during electric system’s peak window.

EFLH = Equivalent full load hours.

Table 13: Lighting Controls

Component	Type	Value	Source
kW_c	Variable	Load connected to control	AEPS Application; EDC Data Gathering
SVG	Fixed	Occupancy Sensor, Controlled Hi-Low Fluorescent Control and controlled HID = 30% Daylight Dimmer System=50%	, 2, and 3
CF	Fixed	By building type and size see lighting verification summary table	Assumes same as JCP&L metered data
EFLH	Variable	Based on Building Type and Location	AEPS Application; EDC Data Gathering
IF	Variable		AEPS Application; EDC Data Gathering
Time Period Allocation Factors	Fixed	Summer/On-Peak 26% Summer/Off-Peak 16% Winter/On-Peak 36% Winter/Off-Peak 22%	

Sources:

1. Northeast Utilities, *Determination of Energy Savings Document*, 1992

2. Levine, M., Geller, H., Koomey, J., Nadel S., Price, L., "Electricity Energy Use Efficiency: Experience with Technologies, Markets and Policies" ACEEE, 1992
3. Lighting control savings fractions consistent with current programs offered by National Grid, Northeast Utilities, Long Island Power Authority, NYSERDA, and Energy Efficient Vermont.

20% Lighting Power Density (LPD) Reduction

Lighting power density reduction is new construction efficient lighting with a reduced wattage.

Algorithms

$$\text{Energy Savings (kWh)} = \text{kW}_{\text{save}} \times \text{HOURS} \times \text{WHF}_e$$

$$\text{Demand Savings (kW)} = \text{kW}_{\text{save}} \times \text{WHF}_d$$

$$\text{kW}_{\text{save}} = (\text{WSF}_{\text{base}} - \text{WSF}_{\text{effic}}) / 1000$$

Definition of Variables

kW_{save} = lighting connected load kW saved

HOURS = annual lighting hours of use per year

WHF_e = Waste heat factor for energy to account for cooling savings from efficient lighting.

WHF_d = Waste heat factor for demand to account for cooling savings from efficient lighting.

WSF_{base} = the baseline lighting watts per square foot or linear foot.

$\text{WSF}_{\text{effic}}$ = the actual installed lighting watts per square foot or linear foot.

Table 14: Lighting Power Density

Component	Type	Value	Source
kW_{save}	Variable		AEPS Application; EDC Data Gathering
WHF_e	Fixed	Cooled space = 1.12 Refrigerated space: Freezer spaces = 1.15; Medium-temperature refrigerated spaces = 1.29; High-temperature refrigerated spaces = 1.18 Uncooled space = 1	1
WHF_d	Fixed	Cooled space = 1.34 Refrigerated space: Freezer spaces = 1.5; Medium-temperature refrigerated spaces = 1.29; High-temperature refrigerated spaces = 1.18 Uncooled space = 1	1
HOURS	Variable		AEPS Application; EDC Data Gathering
WSF_{base}	Variable		ASHRAE 90.1-2004
WSF_{effic}	Variable		ASHRAE 90.1-2004

Source:

1. Efficiency Vermont. Technical Reference User Manual: Measure Savings Algorithms and Cost Assumptions (July 2008).

Fluorescent Lighting Fixture

A fluorescent lighting fixture is a high performance or ‘super’ T8 lamp ballast system.

Algorithms

$$\text{Energy Savings (kWh)} = ((\text{Watts}_{BASE} - \text{Watts}_{EE}) / 1000) \times \text{HOURS} \times \text{WHF}_e$$

$$\text{Demand Savings (kW)} = ((\text{Watts}_{BASE} - \text{Watts}_{EE}) / 1000) \times \text{WHF}_d$$

Definition of Variables

Watts_{BASE} = Baseline connected kW.

Watts_{EE} = Energy efficient connected kW.

WHF_d = Waste heat factor for demand to account for cooling savings from efficient lighting.

HOURS = annual lighting hours of use per year.

WHF_e = Waste heat factor for energy to account for cooling savings from efficient lighting

Table 15: Fluorescent Lighting Fixture

Component	Type	Value	Source
WHF _e	Fixed	Prescriptive measures, default = 1.17	1
WHF _d	Fixed	Prescriptive measures, default = 1.06	1
HOURS	Variable		AEPS Application; EDC Data Gathering
Watt _{SEE}	Fixed	See Watt _{EE} and Watt _{BASE} Table (below)	1
Watt _{BASE}	Fixed	See Watt _{EE} and Watt _{BASE} Table (below)	1

Source:

1. Efficiency Vermont. Technical Reference User Manual: Measure Savings Algorithms and Cost Assumptions (July 2008).

Table 16: Watt_{SEE} and Watt_{BASE}

Equipment Description	Watt _{EE}	Watt _{BASE}
Relamp/Reballast to Super T8		
1 Lamp	25	40
2 Lamp	49	68
3 Lamp	72	110
4 Lamp	94	139
Super T8 Troffer/Wrap; Super T8 Industrial/Strip; Super T8 Indirect		
1 Lamp	25	32
2 Lamp	49	59
3 Lamp	72	88
4 Lamp	94	114

Motors

Algorithms

From AEPS application form or EDC data gathering calculate ΔkW where:

$$\Delta kW = 0.746 \times [(\text{hp}_{\text{base}} \times \text{RLF}_{\text{base}}) / \eta_{\text{base}} - (\text{hp}_{\text{ee}} \times \text{RLF}_{\text{ee}}) / \eta_{\text{ee}}]$$

$$\text{Energy Savings (kWh)} = (\Delta kW) \times \text{EFLH}$$

$$\text{Demand Savings (kW)} = (\Delta kW) \times \text{CF}$$

Definition of Variables

hp_{base} = Rated horsepower of the baseline motor

hp_{ee} = Rate horsepower of the energy-efficient motor

RLF_{base} = Rated load factor of the baseline motor

RLF_{ee} = Rated load factor of the energy-efficient motor

η_{base} = Efficiency of the baseline motor

η_{ee} = Efficiency of the energy-efficient motor

Table 17: Motors

Component	Type	Value	Source
Motor kW	Variable	Based on horsepower and efficiency	AEPS Application; EDC Data Gathering
EFLH	Variable	Based on Building Type and Location	AEPS Application; EDC Data Gathering
hp_{base}	Fixed	Comparable EPACT Motor Table Below	EPACT Directory
hp_{ee}	Variable	Nameplate	AEPS Application; EDC Data Gathering
RLF_{base}	Fixed	0.70-0.80	Industry Data
RLF_{ee}	Variable	Nameplate	AEPS Application; EDC Data Gathering
Efficiency – η_{base}	Fixed	Comparable EPACT Motor Table Below	From EPACT directory.

Component	Type	Value	Source
Efficiency - η_{ee}	Variable	Nameplate	AEPS Application; EDC Data Gathering
CF	Fixed	35%	JCP&L metered data
Time Period Allocation Factors	Fixed	Summer/On-Peak 25% Summer/Off-Peak 16% Winter/On-Peak 36% Winter/Off-Peak 23%	

Table 18: Baseline Motor Efficiencies - nbase (EPAct)

	Open Drip Proof (ODP) # of Poles			Totally Enclosed Fan-Cooled (TEFC)		
	6	4	2	6	4	2
	Speed (RPM)			Speed (RPM)		
Size HP	1200	1800	3600	1200	1800	3600
1	80.0%	82.5%	75.5%	80.0%	82.5%	75.5%
1.5	84.0%	84.0%	82.5%	85.5%	84.0%	82.5%
2	85.5%	84.0%	84.0%	86.5%	84.0%	84.0%
3	86.5%	86.5%	84.0%	87.5%	87.5%	85.5%
5	87.5%	87.5%	85.5%	87.5%	87.5%	87.5%
7.5	88.5%	88.5%	87.5%	89.5%	89.5%	88.5%
10	90.2%	89.5%	88.5%	89.5%	89.5%	89.5%
15	90.2%	91.0%	89.5%	90.2%	91.0%	90.2%
20	91.0%	91.0%	90.2%	90.2%	91.0%	90.2%
25	91.7%	91.7%	91.0%	91.7%	92.4%	91.0%
30	92.4%	92.4%	91.0%	91.7%	92.4%	91.0%
40	93.0%	93.0%	91.7%	93.0%	93.0%	91.7%
50	93.0%	93.0%	92.4%	93.0%	93.0%	92.4%
60	93.6%	93.6%	93.0%	93.6%	93.6%	93.0%
75	93.6%	94.1%	93.0%	93.6%	94.1%	93.0%
100	94.1%	94.1%	93.0%	94.1%	94.5%	93.6%
125	94.1%	94.5%	93.6%	94.1%	94.5%	94.5%
150	94.5%	95.0%	93.6%	95.0%	95.0%	94.5%
200	94.5%	95.0%	94.5%	95.0%	95.0%	95.0%

HVAC Systems

The measurement of energy and demand savings for C/I Efficient HVAC for Room AC, Central AC and air cooled DX is based on algorithms. (Includes split systems, air to air heat pumps, packaged terminal systems, water source heat pumps, ground water or ground source heat pumps)

Algorithms

Air Conditioning Algorithms:

$$\text{Energy Savings (kWh)} = (\text{Btu/H1000}) \times (1/\text{EER}_b - 1/\text{EER}_q) \times \text{EFLH}$$

$$\text{Demand Savings (kW)} = (\text{Btu/H1000}) \times (1/\text{EER}_b - 1/\text{EER}_q) \times \text{CF}$$

Heat Pump Algorithms

$$\text{Energy Savings-Cooling (kWh)} = (\text{Btu/H}_c\text{1000}) \times (1/\text{EER}_b - 1/\text{EER}_q) \times \text{EFLH}_c$$

$$\text{Energy Savings-Heating (kWh)} = \text{Btu/H}_h\text{1000} \times (1/\text{EER}_b - 1/\text{EER}_q) \times \text{EFLH}_h$$

Where c is for cooling and h is for heating.

Definition of Variables

BtuH = Cooling capacity in Btu/Hour.

EER_b = Efficiency rating of the baseline unit. For units < 65,000, SEER and HSPF should be used for cooling and heating savings, respectively.

EER_q = Efficiency rating of the High Efficiency unit. For units < 65,000, SEER and HSPF should be used for cooling and heating savings, respectively.

CF = Coincidence Factor – The percentage of the total load which is on during electric system’s Peak Window, based on existing measured usage and determined as the average number of operating hours during the peak window period.

EFLH = Equivalent Full Load Hours – A measure of energy use by season during the on-peak and off peak periods. Value is determined by existing measured data of kWh during the period divided by kW at design conditions.

Table 19: HVAC and Heat Pumps

Component	Type	Value	Source
BtuH	Variable	ARI or AHAM or Manufacturer Data	AEPS Application; EDC’s Data Gathering
EER_b	Variable	See Table below	AEPS Application; EDC’s Data Gathering
EER_q	Variable	ARI or AHAM Values	AEPS Application; EDC’s Data Gathering

Component	Type	Value	Source
CF	Fixed	67%	Engineering estimate
EFLH	Fixed	Allentown Cooling = 784 Hours Allentown Heating = 2,492 Hours Erie Cooling = 482 Hours Erie Heating = 2,901 Hours Harrisburg Cooling = 929 Hours Harrisburg Heating = 2,371 Hours Philadelphia Cooling = 1,032 Hours Philadelphia Heating = 2,328 Hours Pittsburgh Cooling = 737 Hours Pittsburgh Heating = 2,380 Hours Scranton Cooling = 621 Hours Scranton Heating = 2,532 Hours Williamsport Cooling = 659 Hours Williamsport Heating = 2,502	1
Cooling Time Period Allocation Factors	Fixed	Summer/On-Peak 45% Summer/Off-Peak 39% Winter/On-Peak 7% Winter/Off-Peak 9%	
Heating Time Period Allocation Factors	Fixed	Summer/On-Peak 0% Summer/Off-Peak 0% Winter/On-Peak 41% Winter/Off-Peak 58%	

Sources:

1. US Department of Energy. Energy Star Calculator

Table 20: HVAC Baseline Table

Equipment Type	Baseline = ASHRAE Std. 90.1 - 2007
Unitary HVAC/Split Systems	
· ≤5.4 tons:	13 SEER
· >5.4 to 11.25 tons	10.1 EER
· >11.25 to 20 tons	9.5 EER
· > 20 to 63.33 tons	9.3 EER
· > 63.33 tons	9 EER
Air-Air Heat Pump Systems (cooling)	
· ≤5.4 tons:	9.9 EER
· >5.4 to 11.25 tons	9.1 EER
· >11.25 to 20 tons	8.8 EER
· ≥ 21 to 30 tons	

Equipment Type	Baseline = ASHRAE Std. 90.1 - 2007
Water Source Heat Pumps (cooling) < 1.42 tons ≥ 1.42 tons	11.2 EER 12.0 EER
GWSHPs Open and Closed Loop All Capacities	16.2 EER
Package Terminal Systems (Replacements) PTAC (cooling) PTHP (cooling) PTHP (heating)	10.9 - (0.213 x Cap / 1000) EER 10.8 - (0.213 x Cap / 1000) EER 2.9 - (0.213 x Cap / 1000) EER

Electric Chillers

The measurement of energy and demand savings for C/I Chillers is based on algorithms with key variables (i.e., kW/ton, Coincidence Factor, Equivalent Full Load Hours) measured through existing end-use metering of a sample of facilities.

Algorithms

Energy Savings (kWh) = Tons X (kW/ton_b – kW/ton_q) X EFLH

Demand Savings (kW) = Tons X (kW/ton_b – kW/ton_q) X CF

Definition of Variables

Tons = The capacity of the chiller (in tons) at site design conditions accepted by the program.

kW/ton_b = Baseline, found in the Chiller verification summary table.

kW/ton_q = This is the manufacturer data and equipment ratings in accordance with ARI Standard 550/590 latest edition.

CF = Coincidence Factor – Represents the percentage of the total load which is on during electric system's Peak Window derived from JCP&L metered data.

EFLH = Equivalent Full Load Hours – A measure of chiller use by season determined by measured kWh during the period divided by kW at design conditions from JCP&L measurement data.

Table 21: Electric Chillers

Component	Type	Value	Source
Tons	Variable	From AEPS Application; EDC Data Gathering	
kW/ton _b	Fixed	<p>Water Cooled Chillers (= <150 tons)</p> <p><i>Baseline:..... 0.703 kW/Ton</i></p> <p>Water Cooled Chillers (151 to <300 tons)</p> <p><i>Baseline:..... 0.634 kW/Ton</i></p> <p>Water Cooled Chillers (>301 tons)</p> <p><i>Baseline:..... 0.577 kW/Ton</i></p> <p>Air Cooled Chillers (<150 tons)</p> <p><i>Baseline:..... 1.256 kW/Ton</i></p>	ASHRAE 90.1 2004
kW/ton _q	Variable	ARI Standards 550/590-Latest edition	AEPS Application; EDC Data Gathering
CF	Fixed	67%	Engineering estimate
EFLH	Fixed	<p>Allentown Cooling = 784 Hours</p> <p>Erie Cooling = 482 Hours</p> <p>Harrisburg Cooling = 929 Hours</p> <p>Philadelphia Cooling = 1,032 Hours</p> <p>Pittsburgh Cooling = 737 Hours</p> <p>Scranton Cooling = 621 Hours</p> <p>Williamsport Cooling = 659 Hours</p>	1
Time Period Allocation Factors	Fixed	<p>Summer/On-Peak 45%</p> <p>Summer/Off-Peak 39%</p> <p>Winter/On-Peak 7%</p> <p>Winter/Off-Peak 9%</p>	

Sources:

1. US Department of Energy. Energy Star Calculator

For certain fixed components, studies and surveys developed based on a review of manufacturer's data, other utilities, regulatory commissions or consultant's reports will be used to update the values for future filings.

Variable Frequency Drives

The measurement of energy and demand savings for C/I Variable Frequency Drive for VFD AEPS applications is for HVAC fans and water pumps only. VFD AEPS applications for other than this use should follow the custom path.

Algorithms

$$\text{Energy Savings (kWh)} = 0.746 \times \text{HP} \times \text{RLF} / \eta_{\text{motor}} \times \text{ESF} \times \text{FLH}_{\text{base}}$$

$$\text{Demand Savings (kW)} = 0.746 \times \text{HP} \times \text{RLF} / \eta_{\text{motor}} \times \text{DSF}$$

Definitions of Variables

HP = nameplate motor horsepower.

RLF = Rated Load Factor. Ratio of the peak running load to the nameplate rating of the motor.

η_{motor} = Motor efficiency at the peak load. Motor efficiency varies with load. At low loads of relative to the rated hp (usually below 50%) efficiency often drops dramatically.

ESF = Energy Savings Factor. The energy savings factor is equal to $1 - \text{FLH}_{\text{asd}} / \text{FLH}_{\text{base}}$. This factor can also be computed according to fan and pump laws assuming an average flow reduction and a cubic relationship between flow rate reduction and power draw savings.

FLH_{asd} = Full Load Hours of the fan/pump with the VSD.

FLH_{base} = Full Load Hours of the fan/pump with baseline drive.

DSF = Demand Savings Factor, calculated by determining the ratio of the power requirement for baseline and VFD control at peak conditions.

$$\text{DSF} = 1 - (\text{kW}_{\text{asd}} / \text{kW}_{\text{base}})_{\text{peak}}$$

kW_{asd} = peak demand of the motor under the variable control conditions.

kW_{base} = peak demand of the motor under the base operating conditions.

Table 22: Variable Frequency Drives

Component	Type	Value	Source
Motor HP	Variable	Nameplate	AEPS Application; EDC Data Gathering
kWh/motor HP	Fixed	1,653 for VAV air handler systems. 1,360 for chilled water pumps.	JCP&L metered data for VFD's ¹⁸ and chillers ¹⁹ .
RLF	Variable	Dependent on HP and peak running load	
η_{motor}	Variable	Nameplate or manufacturer specs	AEPS Application; EDC Data Gathering
ESF	Variable	Dependent on full load of base and VFD	
FLH_{asd}	Variable	Nameplate	AEPS Application; EDC Data Gathering
FLH_{base}	Fixed		Manufacturer Data
DSF	Variable	Dependent on base and variable peak demand	
kW_{asd}	Variable	Nameplate	AEPS Application; EDC Data Gathering
kW_{base}	Fixed		Manufacturer Data
Time Period Allocation Factors	Fixed	Summer/On-Peak 22% Summer/Off-Peak 10% Winter/On-Peak 47% Winter/Off-Peak 21%	

Air Compressors with Variable Frequency Drives

The measurement of energy and demand savings for variable frequency drive (VFD) air compressors.

Algorithms

$$\text{Energy Savings (kWh)} = 774 \times \text{HP}$$

$$\text{Demand Savings (kW)} = 0.129 \times \text{HP}$$

$$\text{Coincident Peak Demand Savings (kW)} = 0.106 \times \text{HP}$$

¹⁸ Results reflect metered use from 1995 – 1998.

¹⁹ Results reflect metered use from 1995 – 1999.

Definitions of Variables

HP = nameplate motor horsepower

Table 23: Air Compressors with VFDs

Component	Type	Value	Source
Motor HP	Variable	Nameplate	AEPS Application; EDC Data Gathering
kWh/motor HP	Fixed	774	1
kW/motor HP	Fixed	0.129	1
Coincident Peak kW/motor HP	Fixed	0.106	1
Time Period Allocation Factors	Fixed	Summer/On-Peak 28% Summer/Off-Peak 39% Winter/On-Peak 14% Winter/Off-Peak 19%	

Sources:

1. Aspen Systems Corporation, Prescriptive Variable Speed Drive Incentive Development Support for Industrial Air Compressors, Executive Summary, June 20, 2005.

Demand Response Programs

Commercial and Industrial Application, Residential Applications

Commercial and Industrial Applications

Each commercial and industrial application will be treated independently as a custom program. An application must be submitted, containing adequate documentation fully describing the energy efficiency measures installed or proposed and an explanation of how the installed facilities qualify for A E Cs. Each program application will be required to include²⁰:

1. Program Name
2. Program Utility Company
3. Program Location (s)
4. Type of facilities in which the measures, systems, processes, or strategies will be implemented
5. Customer class and end-use served
6. Estimated demand reduction value (kW) per measure including supporting documentation (i.e. engineering estimates or documentation of verified savings from comparable projects)
7. Estimated energy reduction value (kWh) throughout the year
8. The date by which commercial operation is expected

The required application information is the minimum requirement for submitting a program. If a submitter relies on PJM protocols for participation in the PJM market, the PJM methodology will be accepted as a reporting method.

²⁰ Application criteria for submittals is taken from ISO New England's *Measurement and Verification of Demand Reduction Value from Demand Resources*. October 1, 2007.

Residential Applications

Algorithms

The general form of the equation for the residential demand response measure savings algorithms is:

Number of Units X Savings per Unit

To determine resource savings, the per unit estimates in the algorithms will be multiplied by the number of demand response units. The number of units will be determined by the program. Per unit savings estimates will be estimated by each specific measure.

Direct Load Control (Air Conditioning Cycling and Pool Pump Load Control)

Electricity Impact (kWh) = ESav X Units X Hours

Demand Impact (kW) = ESav X Units

Definition of Terms

ESav = Energy Saved in One Hour in kW

Units = Number of Units in the Program

Hours = Number of hours throughout the year the measure operates

Component	Type	Value	Sources
ESav	Fixed	Air conditioning Cycling = 0.72 kW Pool Pump Load Control = 0.75 kW	1
Units	Variable		AEPS Application; EDC Data Gathering
Hours	Variable		AEPS Application; EDC Data Gathering

Sources:

1. Public Service Electric and Gas Company. *Petition for Approval of Demand Response Programs*. August 5, 2008.

Appendix A
Measure Lives

**Measure Lives Used in Cost-Effectiveness Screening
February 2008²¹**

PROGRAM/Measure	Measure Life
*For the purpose of calculating the total Resource Cost Test for Act 129, measure cannot claim savings for more than fifteen years.	
<i>Residential Programs</i>	
<i>Energy Star Appliances</i>	
Energy Star Refrigerator post-2001	13
Energy Star Refrigerator 2001	13
Energy Star Dishwasher	11
Energy Star Clothes Washer	11
Energy Star Dehumidifier	12
Energy Star Room Air Conditioners	10
<i>Energy Star Lighting</i>	
Compact Fluorescent Light Bulb	6.4
Recessed Can Fluorescent Fixture	20*
Torchieres (Residential)	10
Fixtures Other	20*
<i>Energy Star Windows</i>	
WINDOW -heat pump	20*
WINDOW -gas heat with central air conditioning	20*
WINDOW – electric heat without central air conditioning	20*
WINDOW – electric heat with central air conditioning	20*
<i>Refrigerator/Freezer Retirement</i>	
Refrigerator/Freezer retirement	8
<i>Residential New Construction</i>	
Single Family - gas heat with central air conditioner	20*
Single Family - oil heat with central air conditioner	20*
Single Family - all electric	20*
Multiple Single Family (Townhouse) – gas heat with central air conditioner	20*
Multiple Single Family (Townhouse) – oil heat with central air conditioner	20*
Multiple Single Family (Townhouse) - all electric	20*
Multi-Family – gas heat with central air conditioner	20*
Multi-Family - oil heat with central air conditioner	20*
Multi-Family - all electric	20*

²¹ Energy Star Appliances, Energy Star Lighting, and several Residential Electric HVAC measures lives updated February 2008. U.S. Environmental Protection Agency and U.S. Department of Energy, [Energy Star](http://www.energystar.gov/). <<http://www.energystar.gov/>>.

PROGRAM/Measure	Measure Life
*For the purpose of calculating the total Resource Cost Test for Act 129, measure cannot claim savings for more than fifteen years.	
Energy Star Clothes Washer	11
Recessed Can Fluorescent Fixture	20*
Fixtures Other	20*
Efficient Ventilation Fans with Timer	10
<i>Residential Electric HVAC</i>	
Central Air Conditioner SEER 13	14
Central Air Conditioner SEER 14	14
Air Source Heat Pump SEER 13	12
Air Source Heat Pump SEER 14	12
Central Air Conditioner proper sizing/install	14
Central Air Conditioner Quality Installation Verification	14
Central Air Conditioner Maintenance	7
Central Air Conditioner duct sealing	14
Air Source Heat Pump proper sizing/install	12
Energy Star Thermostat (Central Air Conditioner)	15
Energy Star Thermostat (Heat Pump)	15
Ground Source Heat Pump	30*
Central Air Conditioner SEER 15	14
Air Source Heat Pump SEER 15	12
Home Performance with ENERGY STAR	
Blue Line Innovations – PowerCost Monitor™	5
<u>Non-Residential Programs</u>	
<i>C&I Construction</i>	
Commercial Lighting — New	15
Commercial Lighting — Remodel/Replacement	15
Commercial Custom — New	18*
Commercial Chiller Optimization	18*
Commercial Unitary HVAC — New - Tier 1	15
Commercial Unitary HVAC — Replacement - Tier 1	15
Commercial Unitary HVAC — New - Tier 2	15
Commercial Unitary HVAC — Replacement Tier 2	15
Commercial Chillers — New	20*
Commercial Chillers — Replacement	20*
Commercial Small Motors (1-10 horsepower) — New or Replacement	20*
Commercial Medium Motors (11-75 horsepower) — New or Replacement	20*
Commercial Large Motors (76-200 horsepower) — New or Replacement	20*
Commercial Variable Speed Drive — New	15
Commercial Variable Speed Drive — Retrofit	15
Commercial Comprehensive New Construction Design	18*
Commercial Custom — Replacement	18*
Industrial Lighting — New	15

PROGRAM/Measure	
*For the purpose of calculating the total Resource Cost Test for Act 129, measure cannot claim savings for more than fifteen years.	Measure Life
Industrial Lighting — Remodel/Replacement	15
Industrial Unitary HVAC — New - Tier 1	15
Industrial Unitary HVAC — Replacement - Tier 1	15
Industrial Unitary HVAC — New - Tier 2	15
Industrial Unitary HVAC — Replacement Tier 2	15
Industrial Chillers — New	20*
Industrial Chillers — Replacement	20*
Industrial Small Motors (1-10 horsepower) — New or Replacement	20*
Industrial Medium Motors (11-75 horsepower) — New or Replacement	20*
Industrial Large Motors (76-200 horsepower) — New or Replacement	20*
Industrial Variable Speed Drive — New	15
Industrial Variable Speed Drive — Retrofit	15
Industrial Custom — Non-Process	18*
Industrial Custom — Process	10
<i>Building O&M</i>	
O&M savings	3