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

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|  | Public Meeting held September 13, 2012 |
| Commissioners Present: |  |

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| Robert F. Powelson, Chairman | | |  |
| John F. Coleman, Jr., Vice Chairman  Wayne E. Gardner, Commissioner | | |  |
| James H. Cawley, Commissioner | | |  |
| Pamela A. Witmer, Commissioner | | |  |
|  |  |
| Implementation of the Alternative Energy Portfolio  Standards Act of 2004: Standards for the Participation  of Demand Side Management Resources – Technical  Reference Manual 2013 Update | Docket No. M-2012-2313373  M-00051865 |

**2013 TRM ANNUAL UPDATE Tentative Order**

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**BY THE COMMISSION:**

As explained in our Order, entered June 1, 2009 at Docket No. M-00051865, in implementing the Alternative Energy Portfolio Standards Act (AEPS Act), 73 P.S. §§ 1648.1‑1648.8 and 66 Pa.C.S. § 2814,this Commission had adopted an *Energy‑Efficiency and DSM Rules for Pennsylvania’s Alternative Energy Portfolio Standard, Technical Reference Manual* (TRM).[[1]](#footnote-1) In adopting the original version of the TRM, this Commission directed its Bureau of Conservation, Economics and Energy Planning (CEEP)[[2]](#footnote-2) to oversee the implementation, maintenance and periodic updating of the TRM.[[3]](#footnote-3) Additionally, in the *Energy Efficiency and Conservation Program* Implementation Order for Phase I of Act 129’s Energy Efficiency and Conservation (EE&C) Program,[[4]](#footnote-4) this Commission adopted the TRM as a component of the EE&C Program evaluation process. In that Phase I 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.”[[5]](#footnote-5)

Soon after the adoption of the EE&C Program Phase I 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 that culminated in the adoption of the 2009 TRM at the May 28, 2009 Public Meeting.[[6]](#footnote-6) In adopting the 2009 TRM, the Commission recognized the importance of updating the TRM on an annual basis.[[7]](#footnote-7)

With regard to Phase II of the Act 129 EE&C Program, the Commission again adopted the TRM as a component of the EE&C Program evaluation process.[[8]](#footnote-8) The *Phase II Implementation Order* also recognized the importance of the continued use of an annual updating process for the TRM for Phase II.[[9]](#footnote-9) With this Tentative Order, the Commission advances the fourth annual update of the TRM to be applied beginning with the 2013‑2014 AEPS Act and Act 129 EE&C Program Phase II compliance year.

**BACKGROUND**

Act 129 of 2008, P.L. 1592, specifically directed this Commission to establish an evaluation process that monitors and verifies data collection, quality assurance and the results of each electric distribution company’s (EDC) EE&C plan and the EE&C program as a whole. *See* 66 Pa. C.S. § 2806.1(a)(2). To assist in meeting this obligation, the Commission contracted with GDS Associates, Inc. in August 2009, to perform these duties as the Act 129 Statewide Evaluator (SWE). As part of its duties, the SWE is to review the TRM and the Total Resource Cost Test Manual (TRC) and to provide suggestions for possible revisions and additions to these manuals. A program evaluation group (PEG)[[10]](#footnote-10) was formed to, among other things, provide guidance to the SWE in clarifying energy savings measurement protocols and plans by recommending improvements to the existing TRM and other aspects of the EE&C program. In addition, the Commission convened a Technical Working Group (TWG)[[11]](#footnote-11) meeting to discuss the proposed 2013 TRM updates.[[12]](#footnote-12)

The Commission, in a Tentative Order adopted on January 28, 2010, sought comments on a proposed 2010 TRM annual update.[[13]](#footnote-13) In an Order, adopted June 3, 2010, the Commission promulgated the 2010 TRM.[[14]](#footnote-14)

The Commission, in a Tentative Order adopted on November 19, 2010, sought comments on a proposed 2011 TRM annual update.[[15]](#footnote-15) In an Order, adopted February 24, 2011, the Commission promulgated the 2011 TRM.[[16]](#footnote-16)

The Commission in a Tentative Order adopted on September 22, 2011, sought comments on a proposed 2012 TRM annual update.[[17]](#footnote-17) In an Order, adopted December 15, 2011, the Commission promulgated the 2012 TRM.[[18]](#footnote-18)

The SWE, in collaboration with the PEG and Commission Staff, with input from the TWG, reviewed the 2012 TRM and proposes several changes and additions for consideration for inclusion in the 2013 TRM. This Tentative Order discusses the significant changes proposed for the 2013 version of the TRM. With the adoption of this Tentative Order, the Commission seeks comments on the proposed 2013 TRM. The proposed 2013 TRM and its associated Appendixes can be found on the Commission’s website at <http://www.puc.state.pa.us/electric/Act129/TRM.aspx>. A notice of the adoption of this Tentative Order and the proposed 2013 TRM will be published in the *Pennsylvania Bulletin* with comments on the proposed 2013 TRM due within 30 days after publication of the notice and reply comments due within 40 days after publication of the notice.

**DISCUSSION**

The proposed improvements to the TRM are based on more recent research, a review of TRMs from other states and the needs and experiences of the EDCs. The EDCs provided, through the SWE evaluation and verification process, much of the data that forms the basis of these recommended improvements. Specifically, the current proposed improvements were the result of SWE site inspections, and conservation service provider (CSP) and EDC independent evaluator comments. The proposed updates mainly focus on improving assumptions for key parameters, algorithms, deemed savings values and accounting for new codes and standards for existing residential, and commercial and industrial (C&I) EE&C measures. The Commission believes that these proposed changes will make the TRM a more effective and professional tool for validating energy savings and providing support for the Act 129 goals. The major goals of the proposed modifications are as follows:

1. To appropriately balance the integrity and accuracy of claimed energy savings estimates with costs incurred to measure and verify the claimed energy savings;
2. To clarify existing calculation methods;
3. To minimize the number of EE&C measures that must be evaluated through custom protocols; and
4. To provide additional reasonable methods for measurement and verification of incremental energy savings associated with EE&C measures without unduly burdening EDC EE&C program and evaluation staff.

A summary of the changes proposed in 2013 TRM update follows:

1. General Improvements to the TRM
   * 1. Clarification of Coincident Peak Window.
2. Clarification of the following residential EE&C measure deemed protocols:
   * 1. Modification of Heating, Ventilation, and Air Conditioning (HVAC) Equivalent Full Load Hours (EFLH) and addition of a proper sizing savings algorithm;
     2. Clarification of lighting protocols regarding the hours of usage (HOU) of compact fluorescent light bulbs (CFL), updates to the algorithms for ENERGY STAR lighting, and clarification regarding the implementation of federal legislation and regulations;
     3. Clarification of ENERGY STAR Appliances protocol, including new protocols for each appliance, updated baseline assumptions, and inclusion of new and future standards;
     4. Update of Refrigerator/Freezer Replacement and Recycling protocols based on the latest available program data;
     5. Modification of electric hot water heater daily water usage assumption;
     6. Modification of low flow showerhead and faucet aerator assumptions; and
     7. Clarification of Residential New Construction protocols.
3. Clarification of the following C&I EE&C measure deemed protocols:
   * 1. Clarification of lighting protocols regarding the HOU and coincidence factors (CF), building types, control technologies and savings factors, implementation of federal legislation and regulations, new construction calculator, and temperature ranges for interactive factor values;
     2. Clarification of HVAC protocols regarding EFLH;
     3. Clarification of Motors and Variable Frequency Drive (VFD) protocols regarding energy savings and demand savings factors, as well as operating hours;
     4. Clarification of Office Equipment Network Power Management Systems protocols regarding deemed savings values;
     5. Clarification of Light-Emitting Diode (LED) Channel Signage protocol regarding savings algorithm, and assumptions table;
     6. Clarification of refrigeration protocols regarding EFLH;
     7. Clarification of Low Flow Pre-Rinse Sprayers protocol regarding minimum code requirement for time of sale/retail program type;
     8. Clarification of Refrigeration – Evaporator Fan Controllers protocol regarding savings algorithm, definitions, and assumptions table;
     9. Clarification of Geothermal Heat Pumps protocol regarding language and definitions; and
     10. To improve the functionality and scope of the TRM Appendix C (Lighting Inventory Tool) and Appendix D (Motor and Variable Frequency Drive Inventory Tool).

Below, we will discuss in more detail the more significant proposed changes and updates. Minor administrative changes will not be discussed.

1. **General Improvements**

In Section 1.9 of the 2012 TRM, the off-peak energy savings timeframe has a time gap for weekends and holidays in Table 1-1.[[19]](#footnote-19) The 2012 TRM currently states 12 AM to 12 PM on Saturdays, Sundays and holidays, which unintentionally omits the timeframe from 12 PM to 12 AM. The Commission proposes to update the time period to 12 AM to 12 AM to incorporate all hours.

1. **Residential EE&C Measure Protocols and Processes**

The following sections describe clarifications and modifications to the residential measure protocols:

* 1. **Electric HVAC Protocols**
     + 1. **Equivalent Full Load Hours**

The EFLH for cooling and heating in the 2012 TRM[[20]](#footnote-20) were taken from the ENERGY STAR calculators for central air conditioners and air-source heat pumps. The source listed in the ENERGY STAR calculators for these values is “EPA 2002,” which is a reference to a program called ENERGY STAR Investor, which is no longer published and for which no further information is available. To determine whether the use of the ENERGY STAR EFLH values is still accurate, other state TRMs (Massachusetts, Mid-Atlantic, New Jersey, New York, Ohio, Rhode Island and Wisconsin) were examined. None of these states used the full ENERGY STAR EFLH values. These TRMs had cooling EFLH values that were approximately 30-50% lower than the ENERGY STAR values and heating EFLH values that were approximately 35-55% lower than ENERGY STAR values. A large part of this difference is due to the fact that the ENERGY STAR EFLH does not take into account the over-sizing of HVAC equipment that often occurs in residential homes. An over-sized HVAC unit will run fewer hours than a perfectly-sized unit installed in the same home. Therefore, we believe that an update to the EFLH in the TRM is needed to account for the oversizing of residential HVAC equipment.

The methodology used to update the EFLH was a modeling approach because REM/Rate modeling was used for residential HVAC measures in the SWE’s Electric Energy Efficiency Potential for Pennsylvania Final Report (Market Potential Study)[[21]](#footnote-21) and many of the other state TRMs used a modeling approach to develop EFLH estimates. The REM/Rate models used in the Market Potential Study, were based on average home characteristics for each EDC territory from the SWE’s Pennsylvania Statewide Residential End-Use and Saturation Study (Residential Baseline Study),[[22]](#footnote-22) and were used to develop the statewide EFLH estimates. In addition, the EFLH were estimated using cooling and heating kWh consumption and design loads calculated by REM/Rate modeling for each EDC housing characteristic model in each weather location. These results were then scaled for cooling by an over-sizing factor of 1.5 (50% oversized), based on a 1999 study of field data prepared for the American Council for an Energy-Efficient Economy (ACEEE)[[23]](#footnote-23) and confirmed by a 2008 study by the Energy Center of Wisconsin.[[24]](#footnote-24) For heating, an over-sizing factor of 1.4 (40% oversized) was used, based on the Air Conditioning Contractors of America Manual S[[25]](#footnote-25) for proper sizing of HVAC equipment.

Based on the above methodology, the Commission proposes adjusting the cooling and heating EFLH values. These new EFLH values shall affect the following sections of the 2012 TRM: Section 2.1 – Electric HVAC,[[26]](#footnote-26) Section 2.5 – Furnace Whistle,[[27]](#footnote-27) Section 2.11 – Programmable Thermostat,[[28]](#footnote-28) Section 2.17 – Ductless Mini-Split Heat Pumps,[[29]](#footnote-29) Section 2.20 – Fuel Switching: Electric Heat to Gas Heat,[[30]](#footnote-30) and Section 2.21 – Ceiling, Wall, and Attic Insulation.[[31]](#footnote-31)

Furthermore, the Commission proposes allowing an alternative, optional methodology for calculating estimating EFLH. The Commission proposes that the EDCs be allowed to develop their own EFLH estimates based on billing data analysis from residential customers in their territories as an alternative to the default EFLH based on modeling, if they believe that the billing data analysis will provide more accurate EFLH estimates than the REM/Rate modeling and assumed over-sizing factors.

* + - 1. **Sizing Algorithm**

In the 2011 TRM, an algorithm existed for savings associated with the installation of a properly-sized air conditioner.[[32]](#footnote-32) This algorithm was removed in the 2012 TRM update. Since the new cooling EFLH values will account for over-sizing and there is currently no algorithm for the proper sizing of air conditioners, EDCs that have programs which require contractors to prove proper sizing of equipment to receive a rebate will not receive the savings credit associated with proper sizing. A properly-sized air conditioner will run more efficiently because it will cycle fewer times, draw less energy, and will provide both cooling and dehumidification at the proper rates.

The Commission therefore proposes reinserting the proper sizing savings algorithm for cooling HVAC equipment to allow EDCs to claim savings for a properly-sized HVAC and continue offering programs that require proper sizing as a condition to receive rebates.

* 1. **Lighting Protocols**
     + 1. **CFL Hours of Operation per Day**

The 2009,[[33]](#footnote-33) 2010[[34]](#footnote-34) and 2011[[35]](#footnote-35) TRMs adopted a stipulated value of 3.0 HOU per day for CFLs based on an ENERGY STAR calculator for residential lighting. In the 2011 TRM Final Order, the Commission directed the TWG to “discuss and develop CFL HOU study proposals to be submitted to the Commission by June 1, 2011.”[[36]](#footnote-36) These proposals were to include a variety of factors including, but not limited to, market penetration, light metering, light logging, estimated costs and funding methodologies.

As part of the 2012 TRM update, the SWE and Commission Staff conducted an in-depth review of two lighting studies that were determined to be most applicable to Pennsylvania based on factors such as the age of the program, the geographic location, demographics and sampling techniques. Because geographical location affects hours of operation for CFLs, more weight was given to this factor when determining a study’s applicability to Pennsylvania.[[37]](#footnote-37) The study selected as most applicable to Pennsylvania was performed by Navigant Consulting entitled “EmPOWER Maryland 2010 Interim Evaluation Report – Chapter 5: Lighting and Appliances” which was presented to Baltimore Gas and Electric, Potomac Electric Power Company, Delmarva Power and Light, Southern Maryland Electric Cooperative, and Allegheny Power.[[38]](#footnote-38) Based on the data analyzed and adjusting for hours of daylight across the year, Navigant developed a “mean-annualized HOU estimate of 2.98.”[[39]](#footnote-39)

The 2012 TRM[[40]](#footnote-40) maintained 3.0 as the value for CFL HOU, based on the results of the Maryland study. The Commission supported the values found in the Maryland Study because the geographic attributes, weather and other factors are similar to Pennsylvania, and confirm the applicability of the existing 3.0 CFL HOU value for use in the 2012 TRM.[[41]](#footnote-41) However, the Commission directed the TWG “to monitor and review studies related to CFL HOU values in markets similar to Pennsylvania’s and provide recommendations for future TRM updates.”[[42]](#footnote-42)

Following this direction, the SWE, PEG and Commission Staff reviewed seven CFL metering studies completed over the past ten years. The SWE also reviewed a U.S. Department of Energy (DOE) 2010 U.S. Lighting Market Characterization report, which indicated that operating hours vary from study to study due to differences in sample size, residence types, occupant habits, sample geographies, and other factors. The report supported the use of a 2010 California study, which found 1.9 HOU as most representative of the national average because it is the most recent comprehensive study.[[43]](#footnote-43) A 2005 Wisconsin review of various metering studies determined that important limitations of studies were the duration of metering and number of loggers deployed, because shorter duration studies relied on extrapolation techniques and a smaller sample is considered less reliable.[[44]](#footnote-44) Based on the DOE and Wisconsin reports, it was determined that, in addition to geographical location, sample size and duration of metering were major criteria when reviewing CFL HOU studies.

The SWE, PEG and Commission Staff reviewed metering studies from New England,[[45]](#footnote-45) California,[[46]](#footnote-46) Maine,[[47]](#footnote-47) Maryland,[[48]](#footnote-48) and North and South Carolina.[[49]](#footnote-49) The length of the study, number of homes, meters installed and geographical location of the study were all analyzed as part of the review. The California studies were included in the analysis because the sample sizes of these studies were much larger than all of the other studies. The 2010 California Study installed 7,299 light loggers. The next largest study reviewed was the 2005 California Study, which deployed 752 light loggers. The largest east coast study reviewed was the 2009 New England Study which collected data from 657 light loggers. The 2007 Maine and 2011 Maryland Studies were the only studies to report a higher HOU value than 2.8; however these two studies together deployed loggers in 84 homes compared to 1,780 homes collectively for the five other studies analyzed.

In addition, the SWE, PEG and Commission Staff reviewed seven TRMs from other states and regions: Connecticut,[[50]](#footnote-50) Illinois,[[51]](#footnote-51) Maine,[[52]](#footnote-52) the Mid-Atlantic,[[53]](#footnote-53) New Jersey,[[54]](#footnote-54) New York[[55]](#footnote-55) and Ohio.[[56]](#footnote-56) Five of the seven states use a deemed HOU value for CFLs that is within 0.1 hours of 2.8.

Based on this research and analysis, the Commission proposes revising the CFL HOU value to 2.8 for the 2013 TRM. The collective evidence supports an HOU value lower than 3.0. Specifically, five of the seven studies analyzed reported an HOU of 2.8 hours or less and five of the seven TRMs deemed an HOU value within 0.1 of 2.8. Furthermore, we find the 2.8 HOU from the 2009 New England Study significant, given that New England is geographically proximate to Pennsylvania and the study deployed more loggers and metered for a longer duration of time than all other regional studies combined.

In addition to the ENERGY STAR Lighting protocol, the revised HOU value affects the following sections of the 2012 TRM: Section 2.7 - Home Energy Conservation Kits,[[57]](#footnote-57) Section 2.32 - ENERGY STAR LEDs,[[58]](#footnote-58) Section 2.33 - Residential Occupancy Sensors[[59]](#footnote-59) and Section 2.35 - Low Income Lighting[[60]](#footnote-60) protocols.

* + - 1. **ENERGY STAR Torchieres, Indoor Fixtures, Outdoor Fixtures and Ceiling Fan Algorithms**

The 2012 TRM deemed the delta watts for all ENERGY STAR Lighting measures, except CFLs.[[61]](#footnote-61) The delta watts is defined as the difference between an efficient CFL bulb wattage and baseline bulb wattage. The Commission proposes that the algorithm for ENERGY STAR Torchieres, Indoor Fixtures and Outdoor Fixtures be revised to a form that matches ENERGY STAR CFL Bulbs, where the HOU for one year is multiplied by the in-service rate and the delta watts. The new methodology would allow EDCs that track wattage information to deviate from the single deemed delta watts value in the 2012 TRM for each respective measure. The 2012 TRM provided the same savings regardless of the baseline and efficient lamp wattage installed. In the case where installed lamp information is known, savings are calculated based on the mapping methodology for CFLs in the 2012 TRM.[[62]](#footnote-62) In the absence of EDC data gathering, default energy and demand savings are maintained for each measure.

In addition, the 2012 TRM deemed energy and demand savings for ENERGY STAR Ceiling Fans.[[63]](#footnote-63) The protocol did not offer any algorithms or assumptions and was based on data that was over ten years old.[[64]](#footnote-64) The Commission proposes updating the protocol to include an algorithm that matches the other ENERGY STAR Lighting measures (multiplying the hours of usage in one year by the in-service rate and the delta watts) with default values if lamp wattage is not known. The HOU value for this measure is 3.5, based on the ENERGY STAR Calculator for the Mid-Atlantic region.[[65]](#footnote-65) The Commission proposes adopting this value and not the HOU value for CFLs or Indoor Fixtures because ceiling fans are typically installed in higher-use locations, such as living rooms, dining rooms and kitchens.

* + - 1. **Federal Legislation and Regulations**

The Energy Independence and Security Act of 2007 (EISA 2007)[[66]](#footnote-66) introduced new minimum efficacy standards for general service bulbs, effectively phasing out current incandescent bulbs between 2012 and 2014. New standards become effective January 1st of each of the associated years, starting with the 100-watt bulb in 2012, 75-watt bulb in 2013, and 60-watt and 40-watt bulbs in 2014. This effectively reduces the energy consumption of a standard incandescent bulb and the energy savings of any measure using the incandescent bulb as the baseline.

The Commission proposes that the baseline for Indoor Fixtures, Outdoor Fixtures, and ENERGY STAR Ceiling Fans[[67]](#footnote-67) be updated per the EISA 2007 standards. The default savings adjustment for Indoor Fixtures and Outdoor Fixtures will occur at the midpoint of the EISA 2007 phase-in schedule, namely the 2013 TRM. The rationale is that the source of the default delta watts value does not define the mix of 100-watt, 75-watt, 60-watt and 40-watt bulbs that were used to calculate the value. Therefore, applying the average EISA 2007 baseline adjustment factor at the midpoint of the EISA 2007 three-year phase-in is recommended and supported by the method used in the 2011 Mid-Atlantic TRM.[[68]](#footnote-68)

The Commission also proposes adjusting the ENERGY STAR Ceiling Fans baseline to reflect the EISA 2007 standards. The baseline assumption for this measure is a 60-watt incandescent bulb. Therefore, the Commission proposes that beginning on June 1, 2014, the default energy and demand savings for ENERGY STAR Ceiling Fans would reflect a 43-watt baseline.

The Commission proposes that the baseline for CFLs in Section 2.7 - Home Energy Conservation Kits[[69]](#footnote-69) and Section 2.35 - Low Income Lighting[[70]](#footnote-70) of the 2012 TRM also be updated per the EISA 2007 standards.

* + - 1. **ENERGY STAR LEDs**

The 2012 TRM included separate energy and demand algorithms for each baseline lamp type in the ENERGY STAR LED protocols (four sets of energy and demand algorithms for the general service 40-watt, 60-watt, 75-watt and 100-watt incandescent equivalent).[[71]](#footnote-71) The algorithms were identical and therefore the Commission proposes condensing them into one set of energy and demand equations for general service lamps and one set for reflector lamps.

* 1. **ENERGY STAR Appliances**
     + 1. **Protocols**

The 2012 TRM provided deemed energy and demand savings for all ENERGY STAR appliances in one protocol.[[72]](#footnote-72) The protocol did not provide the underlying algorithms or assumptions for the baseline and efficient appliances. As such, the protocol did allow EDCs the opportunity to calculate model-specific savings if model information was known.

The Commission proposes to divide the existing protocol into individual protocols for each ENERGY STAR appliance, which include algorithms and underlying assumptions to calculate savings, if appliance information is known. The change to the ENERGY STAR appliance protocols should provide transparency and flexibility, which will aid in planning for future code and standards changes. If appliance information is not tracked, default energy and demand savings are proposed in each protocol.

* + - 1. **Baselines and Deemed Values**

The 2012 TRM energy savings for ENERGY STAR Appliances were derived from the ENERGY STAR Savings Calculator.[[73]](#footnote-73) The ENERGY STAR Savings Calculators are typically updated every two to four years and are therefore not necessarily representative of the most current available models likely to be purchased by consumers.

The Commission proposes that the ENERGY STAR default values be updated during each TRM update to reflect the energy usage of the ENERGY STAR models, and their equivalent baselines, available at the time of the TRM update. ENERGY STAR periodically updates its qualified products list for each appliance, which contains information such as annual energy usage and equivalent federal baselines. For example, the equivalent federal baseline of each ENERGY STAR refrigerator is determined based on volume and refrigerator and freezer configuration of each ENERGY STAR-qualified model. Averaging the annual energy usage of ENERGY STAR products available to consumers and their equivalent federal baselines will produce a credible estimation of savings that can be updated annually. This method is also preferred as federal and ENERGY STAR standards for several appliances will change over the course of the next three years.

* + - 1. **Future Federal and ENERGY STAR Standards**

There are several federal minimum efficiency and ENERGY STAR standards updates that will be occurring over the course of the next three years. The Commission proposes the changes to the baseline and efficient appliances and their effective date, which is to coincide with the beginning on the appropriate program year, for each appliance’s respective protocol. The change in baseline or ENERGY STAR standard is to coincide with the beginning on the appropriate program year in order to prevent implementation and evaluation problems relating to changing deemed savings over the course of a program year. The federal standard changes affect dehumidifiers and dishwashers as of June 1, 2013.

Because the federal standards changes would affect room air conditioners in 2014 and refrigerators, freezers and clothes washers in 2015, the Commission proposes that these protocols be reviewed during future TRM updates in order to incorporate the changes at a more appropriate point in time.

* + - 1. **ENERGY STAR Most Efficient Appliances**

In 2012, ENERGY STAR unveiled a new designation recognizing the most efficient of certain ENERGY STAR qualified products.[[74]](#footnote-74) The Commission is proposing inclusion of ENERGY STAR Most Efficient deemed savings protocols for refrigerators and televisions.

* 1. **Refrigerator/Freezer Replacement and Recycling Protocols**

In the 2012 TRM Final Order, the Commission directed the TWG to investigate and evaluate alternative savings protocols for refrigerator/freezer replacement and recycling used in other jurisdictions to inform future TRM updates. Specifically, the Commission directed the TWG to evaluate the applicability of the California regression model[[75]](#footnote-75) to Pennsylvania to improve savings estimates and propose any applicable changes for future TRM updates.[[76]](#footnote-76)

The SWE and Commission Staff reviewed three methods for calculating the annual kWh savings relating to removal and/or replacement of refrigerators and freezers. The three methods are as follows:

1. Calculation based on the US Environmental Protection Agency (US EPA) ENERGY STAR calculator for removed refrigerators and freezers;
2. Calculation based on regression analysis of metered data on kWh consumption from other states; and
3. Calculation based on an *in situ* metering study conducted in Pennsylvania.

After reviewing the advantages and disadvantages of these three methods, the Commission proposes the use of the second method, a regression analysis of metered data from other states, to determine deemed kWh savings for removed and/or replaced refrigerators and freezers.

The Commission proposes to report deemed energy savings for refrigerators/freezers for the following three scenarios:

1. Refrigerator/freezer removed but not replaced;
2. Refrigerator/freezer removed and replaced with an ENERGY STAR unit; and
3. Refrigerator/freezer removed and replaced with a non-ENERGY STAR unit.
   * + 1. **Refrigerator Deemed Savings**

The SWE and Commission Staff reviewed multiple documents and data sources[[77]](#footnote-77),[[78]](#footnote-78),[[79]](#footnote-79),[[80]](#footnote-80) to obtain the regression equation used to develop the proposed deemed savings[[81]](#footnote-81) for removal and/or replacement of a refrigerator in Pennsylvania. After reviewing approaches by other jurisdictions, the Commission proposes to use the regression equation from the US DOE Uniform Methods Project for the 2013 TRM as the basis for deemed savings for refrigerator removal/replacement.

**i. Refrigerators Removed but not Replaced**

Using a regression analysis, the Commission proposes a unit energy consumption (UEC) of 967 kWh[[82]](#footnote-82) for refrigerators removed through the Act 129 refrigerator removal program, before adjustment with the part-use factor. The Commission proposes a part-use factor of 96.9%.[[83]](#footnote-83) After adjustment for part use, the proposed deemed kWh savings per refrigerator are 937 kWh annually for a refrigerator that is removed but not replaced. The refrigerator summer peak demand deemed savings is 0.116 kW.

The following methodology is used to calculate the proposed deemed energy savings value of 937 kWh annually:

DEEMED\_kWhsaved Per Unit = EXISTING\_UEC \* PART\_USE

Where:

DEEMED\_kWhsaved = Annual electricity savings per unit measured in kilowatt hours after adjustment for part-use factor.

EXISTING\_UEC = The average annual unit energy consumption of participating refrigerators. The PY3 value is 966.996 kWh.

PART\_USE = The portion of the year the average refrigerator would likely have operated if not recycled through the program. For PY3, the average refrigerator was plugged in 96.9% of the year.

For removed refrigerators, the annual UEC is based upon a regression analysis of data from 452 refrigerators metered and recycled through five utilities:[[84]](#footnote-84)

Existing UEC

= 365.25 \* [0.487 + 0.015 \* (26.617 years) + 0.782

\* (65.8% manufactured before 1990) + 0.084 \* (17.870 ft3) – 1.442

\* (9.25% single door units) + 1.090 \* (16.1% side – by – side) + 0.544 \* (22.6% primary usage) + 0.02 \* (3.347 unconditioned CDDs) – 0.045 \* (10.791 unconditioned HDDs)] = 966.996

The Commission proposes using the above regression equation based on *in situ* metering study results from these five other utilities as an *in situ* metering study for Pennsylvania is not currently available. The Commission has computed the values that are needed as inputs to the regression equation based on Act 129 Program Year Three (PY3) data for removed refrigerators. Once these input values were determined, they were substituted into the above equation in order to estimate the UEC for removed refrigerators. The details related to equation inputs and values[[85]](#footnote-85) used to calculate the UEC for removed refrigerators is described in more detail in the proposed 2013 TRM.

When calculating per-unit deemed kWh savings for a removed refrigerator, it is necessary to calculate and apply a “part-use” factor. Part-use is an appliance recycling-specific adjustment factor used to convert the UEC (determined through the methods detailed above) into an average per-unit deemed savings value. The UEC itself is not equal to the deemed savings value, because the UEC model yields an estimate of annual consumption and not all recycled refrigerators would have operated year-round.

In PY3, the Commission determined that the average removed refrigerator was plugged in and used 96.9% of the year. Thus, the deemed value the Commission proposes for the part-use factor is 96.9% based on PY3 data for all EDCs. The Commission proposes that the EDCs be allowed the option of calculating their own territory-specific part-use factor. In the event an EDC desires to calculate an EDC-specific part-use factor, the Commission proposes that, using participant surveys, EDC evaluators should determine the amount of time a removed refrigerator was plugged in.

**ii. Refrigerators Removed and Replaced**

If a refrigerator is removed and replaced with a new ENERGY STAR unit, the proposed annual savings are 533 kWh. If a refrigerator is removed and replaced with a new non-ENERGY STAR unit, the proposed annual savings are 417 kWh. The following methodology is used to calculate an energy savings value of 533 kWh for refrigerators that are removed and replaced with new ENERGY STAR refrigerators and an energy savings value of 417 kWh for refrigerators that are removed and replaced with new non-ENERGY STAR refrigerators:

NET\_kWhsaved Per Unit = DEEMED kWhsaved Per Unit – (REPLACEMENTUEC \* PART\_USE)

Where:

REPLACEMENTUEC = The annual unit energy consumption of the average replacement unit. This comes from the ENERGY STAR calculator and is equal to 416.600 kWh for a new ENERGY STAR refrigerator, and 536.600 for a new non-ENERGY STAR refrigerator.

PART\_USE = The portion of the year the average replacement refrigerator is likely to operate. For PY3, the average refrigerator was plugged in 96.9% of the time.

* + - 1. **Freezer Deemed Savings Values**

The SWE and Commission staff reviewed multiple documents and data sources to obtain the regression equation proposed to develop deemed savings[[86]](#footnote-86) for removal and/or replacement of a freezer in Pennsylvania.[[87]](#footnote-87), [[88]](#footnote-88), [[89]](#footnote-89) After reviewing approaches by other jurisdictions, the Commission proposes to use the regression equation from the Cadmus Memo for the 2013 TRM as the basis for deemed savings for freezer removal/replacement.

##### **i. Freezers Removed but not Replaced**

The Commission proposes a UEC for freezers removed through the Act 129 freezer removal program of 1,188 kWh, before adjustment by the part-use factor. The Commission proposes a part-use factor of 98.5%.[[90]](#footnote-90) After adjustment using a part-use factor, the deemed kWh savings per freezer is 1,170 kWh annually for a freezer that is removed but not replaced. The freezer summer peak demand deemed savings is 0.145 kW.

The following methodology is used to calculate the proposed deemed energy savings value of 1,170 kWh annually for a freezer that is removed but not replaced:

DEEMED\_kWhsaved Per Unit = EXISTING\_UEC \* PART\_USE

Where:

DEEMED\_kWhsaved = Annual electricity savings measured in kilowatt hours after adjustment for part-use factor.

EXISTING\_UEC = The average annual unit energy consumption of participating freezers. The PY3 value is 1,187.475 kWh.

PART\_USE = The portion of the year the average freezer would likely have operated if not recycled through the program. For PY3, the average freezer was plugged in 98.5% of the year.

For removed freezers, the annual UEC is based on the following proposed regression equation:[[91]](#footnote-91)

Freezer UEC

= 365.25 days \* [-2.297 + 0.067 \* (31.300 years old) + 0.401 \* (81.8% units manufactured pre-1993) + 0.150 \* (16.030 ft3) + 0.854 \* (35.0% units that are chest freezers) + 0.1046 \* [4.010 CDDs)] = 1,187.475 kWh

The Commission has computed the values that are needed as inputs to the regression equation based on Act 129 PY3 data for removed freezers. Once these input values were determined, they were substituted into the above equation in order to estimate the UEC for removed freezers. Information related to equation inputs and values[[92]](#footnote-92) used to calculate the UEC for removed refrigerators is described in more detail in the proposed 2013 TRM.

As with refrigerators, when calculating deemed per-unit kWh savings for a removed freezer, it is necessary to calculate and apply a part-use factor. In PY3, the Commission determined that the average removed freezer was plugged in and used 98.5% of the year. Thus, the proposed deemed value for the part-use factor is 98.5% based on PY3 data for all EDCs. The Commission proposes that the EDCs be allowed the option of calculating its own territory-specific part-use factor. In the event an EDC desires to calculate an EDC-specific part-use factor, the Commission proposes that, using participant surveys, EDC evaluators should determine the amount of time a removed freezer was plugged in.

##### **ii. Freezers Removed and Replaced**

If a freezer is removed and replaced with a new ENERGY STAR unit, the proposed annual savings are 753 kWh. If a freezer is removed and replaced with a new non-ENERGY STAR unit, the proposed annual savings are 667 kWh. The following methodology is used to calculate energy savings value of 753 kWh for freezers that are removed and replaced with new ENERGY STAR freezers and energy savings value of 667 kWh for freezers that are removed and replaced with new non-ENERGY STAR freezers:

NET\_kWhsaved Per Unit = DEEMED kWhsaved Per Unit - (REPLACEMENTUEC \* PART\_USE)

Where:

REPLACEMENTUEC = The annual unit energy consumption of the average replacement unit. This comes from the ENERGY STAR calculator and is equal to 423.000 kWh for a new ENERGY STAR freezer, and 510.000 for a new non-ENERGY STAR freezer.

PART\_USE = The portion of the year the average replacement freezer is likely to operate. For PY3, the average freezer was plugged in 98.5% of the time.

* 1. **Electric Hot Water Heater Protocols**

The 2012 TRM assumes a daily hot water usage per household of 64.3 gallons per day, taken from the 1998 electric water heater testing protocols,[[93]](#footnote-93) which are currently still in effect. This same document, however, states that, while 64.3 gallons per day is the testing standard, it is most likely too high of an assumption and the actual usage of a household is closer to 50 gallons per day.[[94]](#footnote-94)

Other studies confirm that 50 gallons per day is a more accurate assumption. In a 1998 sub-group analysis of the Retail Energy Consumption Survey (RECS) data for residential hot water heaters, the average hot water usage per day was found to be 46.9 gallons.[[95]](#footnote-95) A 2001 water heater technical support document using the Lawrence Berkeley National Laboratory draw model estimated daily consumption ranging from 45.3-49.9 gallons.[[96]](#footnote-96) Additionally, Natural Resources Canada, the organization that provided the background for the initial 64.3 gallons per day standard, recently found that daily hot water usage has decreased to an average of 49 gallons per day.[[97]](#footnote-97)

The Commission, therefore, proposes the use of the DOE-supported assumption of 50 gallons per day as the hot water usage assumption per household. This change affects the following 2012 TRM sections: Section 2.3 – Efficient Electric Water Heaters,[[98]](#footnote-98) Section 2.6 – Heat Pump Water Heaters,[[99]](#footnote-99) Section 2.14 – Solar Water Heaters,[[100]](#footnote-100) Section 2.15 – Electric Water Heater Pipe Insulation,[[101]](#footnote-101) Section 2.18 – Fuel Switching: Domestic Hot Water Electric to Gas,[[102]](#footnote-102) and Section 2.19 – Fuel Switching: Heat Pump Water Heater to Gas Water Heater.[[103]](#footnote-103)

* 1. **Low Flow Faucet Aerator and Showerhead Protocols**
     + 1. **Recovery Efficiency**

The 2012 TRM incorrectly values the recovery efficiency of an electric water heater as equal to the energy factor of an electric water heater, or 0.904.[[104]](#footnote-104) The recovery efficiency of an electric water heater is defined as “how efficiently the heat from the energy source is transferred to the water.” The energy factor is the overall efficiency which includes the recovery efficiency, standby losses and cycling losses.[[105]](#footnote-105) As such, the correct recovery efficiency of an electric water heater should be 0.98.[[106]](#footnote-106) The Commission therefore proposes correcting the value from 0.904 to 0.98 in both Sections 2.9 – Low Flow Faucet Aerators and Section 2.10 – Low Flow Showerheads.

* + - 1. **Single Family and Multifamily Low Flow Showerhead Protocols**

The 2012 TRM deemed a single, statewide savings estimate for an aerator or showerhead installed in residential homes. With the completion of the Residential Baseline Study, there was enough Pennsylvania-specific data to estimate deemed savings by housing type, both single family and multifamily. Having different deemed savings values for these two housing types should provide more accurate estimations of savings for low flow faucet aerators and showerheads. For faucet aerators, using the separate housing types did not produce significantly different deemed savings based on the Residential Baseline Study data. Showerheads, however, showed significant difference between the two housing types.

The Commission proposes to keep a single statewide savings value for faucet aerators and to have both single family and multifamily savings values, in addition to a statewide value, for showerheads. This will allow EDCs to more accurately account for the savings achieved through programs which distribute these measures and track the housing type in which they are installed.

* + - 1. **Low Flow Faucet Aerator Algorithm and Assumptions**

The 2012 TRM algorithm for low flow faucet aerators assumes the baseline and low flow rates of the faucet are equal to the rated flow rates of the baseline and low flow aerators. This assumption would be correct if the faucet were always operating at full flow. In residential homes, faucet flow is throttled and is not always equal to the rated flow rates. A more appropriate assumption for flow rates would be the average flow of water over an extended period of time rather than an instantaneous, maximum flow measurement. Furthermore, the 2012 TRM cites only a single source for the average usage of a faucet per person per day.[[107]](#footnote-107) There are many studies with conflicting findings on this value, and thus a single study may not be accurate.

Additionally, the current algorithm claims savings for all flow that passes through an aerator. If the faucet is used to fill a container of fixed volume, such as a cup or bowl, the same amount of water, and therefore energy, is consumed whether or not a low flow aerator is used, resulting in no savings. Savings are only achieved for flow that goes down the drain. Also, the definition used for the parameter “ΔT” is incorrect. The 2012 TRM defines “ΔT” as “average temperature differential between hot and cold water.”[[108]](#footnote-108) This definition is incorrect because the water that flows through the aerator is a mix of both hot and cold water, not solely hot water.

Based on these facts, the Commission proposes adjusting the baseline and low flow aerator flow rates. The new values, from the 2012 Illinois TRM,[[109]](#footnote-109) take throttling into account and are confirmed by multiple sources. As such, the Commission proposes the adoption of the daily faucet water usage assumption from the 2012 Illinois TRM of 9.85 minutes per person per day,[[110]](#footnote-110) an increase from the current assumption of 4.95 minutes per person per day.[[111]](#footnote-111) The new value is consistent with the range of values cited in Illinois TRM from multiple sources.

In addition, the Commission proposes adding a “Drain Factor” of 79.5% to account for the fact that not all water that flows through an aerator goes down the drain.[[112]](#footnote-112) Finally, the Commission proposes updating the definition for “ΔT” to the “average temperature differential between outgoing mixed faucet water and supply water” and updating the value to 35°F to reflect this change in definition.[[113]](#footnote-113)

* + - 1. **Low Flow Showerhead Temperature Assumptions**

The 2012 TRM assumes a temperature of 120°F as the average temperature of water used by a shower.[[114]](#footnote-114) This assumption is fundamentally incorrect as a shower uses a mix of both hot and cold water, resulting in the mixed temperature being lower than 120°F, the temperature of water leaving the electric water heater. We believe a more appropriate assumption should be the 105°F found in the2012 Illinois TRM. The Commission, therefore, proposes changing the assumed temperature leaving the shower from 120°F to 105°F, consistent with the 2012 Illinois TRM, as well as the 2011 Mid-Atlantic TRM.[[115]](#footnote-115)

* 1. **Residential New Construction Protocols**

The Residential New Construction section of the 2012 TRM is comprised of three sections: 1) Insulation Up-Grades, Efficient Windows, Air Sealing, Efficient HVAC Equipment and Duct Sealing; 2) Lighting and Appliances; and 3) Ventilation Equipment.[[116]](#footnote-116) The section for Insulation Up-Grades, Efficient Windows, Air Sealing, Efficient HVAC Equipment and Duct Sealing states that energy savings for these measures shall be a direct output of the Home Energy Ratings (HERS) software, while demand savings will be estimated using algorithms presented in the section. The algorithms for demand savings estimation include the use of the Seasonal Energy Efficiency Ratio (SEER) of the HVAC unit for the baseline home multiplied by a Baseline Energy Efficiency Ratio (BLEER) factor, which converts SEER to Energy Efficiency Ratio (EER), and the use of the EER of the HVAC unit for the qualifying home.

The Lighting and Appliances section states that all additional savings due to the addition of high-efficiency lighting and clothes washers[[117]](#footnote-117) will be based on the algorithms for each appliance in the ENERGY STAR Appliances section of the TRM. The Ventilation Equipment section adds 175 kWh and 0.060 kW of savings to each home to account for the installation of high-efficiency ventilation equipment.[[118]](#footnote-118)

First, the Commission proposes to refer to the Insulation Up-Grades, Efficient Windows, Air Sealing, Efficient HVAC Equipment and Duct Sealing as “Weather-Sensitive Measures” and Lighting and Appliances as “Non-Weather-Sensitive Measures.” This will help prevent confusion between the methodologies used for estimating savings for the two different categories of measures. The algorithm for Weather-Sensitive Measures is also being modified to allow for the use of either the unit’s actual EER or the product of SEER multiplied by BLEER, a method of estimating the EER when only the SEER is known, for both the baseline and qualifying homes. This makes the algorithm consistent between the baseline and qualifying home.

Second, the Commission proposes to make the Non-Weather-Sensitive Measures section more general to allow for the inclusion of all appliances, rather than specifically listing only high-efficiency lighting and clothes washers. This will allow EDCs to claim savings for all high-efficiency non-weather-sensitive appliances installed in a new home.

Lastly, the Commission proposes the removal of the Ventilation Equipment section. The modeling software already takes into account mechanical ventilation equipment, and therefore, the addition of kWh and kW savings leads to double-counting of savings for homes that have mechanical ventilation and overstatement of savings for homes which do not have mechanical ventilation.

1. **Commercial and Industrial EE&C Measure Protocols and Processes**

**1. Lighting Protocols**

* + - 1. **Hours of Use and Coincidence Factor Values**

The HOU and CF values for 22 of the 37 different building types listed in Table 3-4 of 2012 TRM[[119]](#footnote-119) were adopted from the 2009 New Jersey TRM,[[120]](#footnote-120) which were derived from a 1999 Pacific Gas & Electric (PG&E) study[[121]](#footnote-121) in California, and are dated. These values have not been through a major update since 2009. Other secondary sources[[122]](#footnote-122) are used to report HOU values for the remaining 15 building types in the 2012 TRM.

The SWE and Commission Staff did further research aimed at improving current assumptions based on more recent evaluations, metering studies and TRMs from other states, including Pennsylvania-specific data collected by the EDCs and their evaluators, that were not available during previous TRM update cycles. The primary data collected by the EDC evaluators through the normal evaluation process was used as an indicator to identify measure assumptions that need updating.

The SWE and Commission Staff conducted a cross-sectional study to compare HOU and CF values by building type found in the 2012 TRM with TRMs from other regions (2011 Mid-Atlantic TRM, Wisconsin,[[123]](#footnote-123) California,[[124]](#footnote-124) 2012 Connecticut TRM, New York,[[125]](#footnote-125) Vermont,[[126]](#footnote-126) 2010 Ohio TRM, Delaware,[[127]](#footnote-127) 2012 Illinois TRM, Massachusetts[[128]](#footnote-128) and Maine[[129]](#footnote-129)). The SWE and Commission Staff found that the HOU and CF values varied widely depending on the actual source. Some sources did not fully document the data sources and methods used to determine HOU and CF values. Some sources were based on old data or studies. Some sources did not provide HOU values for important building types. Most sources were not based on actual lighting logger data but instead used secondary research or referenced one or more TRMs from other states.

After reviewing all of these sources, the Commission considers the 2011 Mid-Atlantic TRM as the most applicable source for Pennsylvania in the absence of Pennsylvania-specific primary data. As such, the Commission proposes to use the 2011 Mid-Atlantic TRM as the primary source for reporting HOU and CF values in the 2013 TRM. The HOU and CF values reported in the 2011 Mid-Atlantic TRM are based on a secondary research study conducted by Itron, Inc. in December, 2010, entitled *Development of Interior Lighting Hours of Use and Coincidence Factor Values for EmPOWER Maryland Commercial Lighting Program Evaluations*, which was presented to the Maryland Public Service Commission. The results reported in the study were derived from the California 2006-2008 Commercial Lighting Study[[130]](#footnote-130) supplemented by the California Database for Energy Efficiency Resources (DEER) 2008 Database.[[131]](#footnote-131)

The Commission proposes using the 2011 Mid-Atlantic TRM values for the following reasons:

* The California lighting study is the largest and most comprehensive study of lighting use ever conducted with a random sample of 6,774 loggers installed in over 1,202 sites for two to three months each;
* The metered data is considered more accurate and valuable compared to estimates derived based on simulation modeling, customer surveys or averages taken from different sources;
* The study provides HOU estimates for almost all of the 12 critical building types with high precision and confidence;
* The data sources and methods are well documented and are less than five years old, compared to the 2012 TRM where HOU values for the majority of the building types are based on the 1999 PG&E study; and
* Methods used in the study to develop these estimates are not only transparent but the result of eight months of vigorous review by stakeholders in California.

The Commission realizes that there may be differences between California and Pennsylvania lighting conditions that could affect annual HOU for some building types. These values, however, represent the best available information based on a comprehensive metering study and will be an improvement over the 2009 New Jersey TRM, which was used as the source for a number of building types in the 2012 TRM. The Commission clarifies that these values may be supplemented by Pennsylvania-specific primary logged data obtained from evaluations, where possible, during future TRM updates. In addition, the EDCs are also allowed to calculate and use site-specific CFs using the non-weather-dependent peak demand calculator in lieu of the recommended CFs, if the operating schedules are known with reasonable certainty.

The 2011 Mid-Atlantic TRM is the proposed source to update HOU values for the 11 existing building types in 2012 TRM that used the 2009 New Jersey TRM as the source. For existing building types where the 2011 Mid-Atlantic TRM does not report HOU values and where the 2012 TRM source was the 2009 New Jersey TRM, the Commission proposes using values from the California DEER 2011 database,[[132]](#footnote-132) 2012 Illinois TRM, 2010 Ohio TRM, 2010 Wisconsin Deemed Savings Manual and 2012 Connecticut TRM to update the HOU values. Sources other than the 2011 Mid-Atlantic TRM listed above are proposed for six building types. Of these, three are existing building types in 2012 TRM and three are new building types proposed for 2013 TRM. For the building types where CF values are not available in the 2011 Mid-Atlantic TRM, the Commission proposes to use a calculated average of CF values available for all building types in the 2011 Mid-Atlantic TRM.

In addition, the Commission proposes to use the same reference document to report HOU values listed in the 2012 TRM for 11 existing building types until better data is available. The Commission proposes to use a calculated average of CF values available for all building types in the 2011 Mid-Atlantic TRM and apply it to these 11 existing building types.

In sum, the Commission-proposed list for the 2013 TRM includes a total of 28 building types. The 2011 Mid-Atlantic TRM is the proposed source for 11 building types; the same reference document listed in the 2012 TRM is the proposed source for 11 existing building types (no changes were made to the HOU values); and other sources (California DEER 2011 database, 2012 Illinois TRM, 2010 Ohio TRM and 2010 Wisconsin Deemed Savings Manual) are proposed for 6 building types (of these, three are new building types).

* + - 1. **Building Types**

The Commission proposes to add three new building types to Table 3-4[[133]](#footnote-133) of the 2012 TRM to provide additional granularity to the stipulated measure assumptions resulting in reduced uncertainty from averaged values. The proposed list includes public assembly (one shift), public services (nonfood), and multifamily (common areas) building types. The Commission elected to minimize the number of additional building types to reduce administrative burden on the EDCs.

* + - 1. **Lighting Control Technologies**

The Commission proposes to add 13 lighting control technologies with savings factors to Table 3-6[[134]](#footnote-134) of the 2012 TRM based on a more recent comprehensive study conducted by the Lawrence Berkeley National Laboratory in September 2011, entitled *A Meta-Analysis of Energy Savings from Lighting Controls in Commercial Buildings*.[[135]](#footnote-135) The lighting controls measures are divided into five major strategies: occupancy, day lighting, personal tuning, institutional tuning and multiple types. Each of these strategies may have one or more technologies. These strategies will replace the lighting control technologies and the corresponding savings factors in the 2012 TRM. The Commission clarifies that the EDC evaluators will be allowed to use site-specific HOU values or control savings factors based on actual metering results for all projects.

In addition, the lighting protocol was constructed in such a way to account for energy savings only for lighting control retrofits. The savings algorithms[[136]](#footnote-136) do not account for demand savings. The Commission proposes to modify the savings algorithms to allow the EDCs to claim demand savings for lighting control retrofits in addition to the energy savings.

* + - 1. **New Construction Calculator**

Based on feedback from the EDCs, the Commission will provide a New Construction calculator used to calculate the savings impacts for new construction lighting projects as an optional tool for the EDCs. The Commission believes this will help EDCs by simplify their lighting application forms.

* + - 1. **Federal Legislation and Regulations**

In the 2012 TRM Final Order, the Commission directed the TWG to investigate the impacts of new lighting standards and recommend future adjustments to the TRM when necessary.[[137]](#footnote-137)

The Energy Policy Act of 2005 (EPAct 2005)[[138]](#footnote-138) and EISA 2007 standards introduced new efficacy standards for linear fluorescent bulbs and ballasts, effectively phasing out magnetic ballasts (effective October 1, 2010) and T-12 bulbs (effective July 14, 2012). This induces a shift in what a participant would have purchased in the absence of the program because T-12 bulbs on magnetic ballasts are no longer viable options and, therefore, adjusts the baseline assumption. Leftover retail stock may sustain sales for T-12 bulbs and use of T-12 systems for a period, but its market share is expected to decrease naturally as T-8 systems are adopted and the existing stock of T-12s is exhausted. In addition, C&I lighting retrofit projects for Act 129 are all considered early replacement scenarios, i.e. the baseline is defined as what was previously in place rather than minimally code compliant equipment.

The SWE and Commission Staff conducted research of existing energy efficiency programs from various jurisdictions to understand the full impact of these upcoming regulatory changes in order to make reasonable modifications regarding savings values achieved by C&I lighting measures when the existing lighting system contains T12 lamps and/or magnetic ballast.

After reviewing approaches by other jurisdictions, the Commission believes that the assumptions made by the 2012 Illinois TRM are reasonable and that the same methodology could be used in future TRM updates to account for new code changes. The baseline for a lighting retrofit project will be the existing lighting system until 2016. This is to reflect the time required for the market to adjust to the new code standards, taking into account the fact that end-users may have an existing stock of T-12s and do not need to purchase new replacement lamps for several years. For Phase II, Program Year 1, we will assume the baseline is the T-12 system, but this assumption will be revisited in subsequent TRMs. With this understanding, the Commission believes that there is no immediate need to incorporate these new code standards into the 2013 TRM. As such, the Commission proposes that these new code standards be reviewed during future TRM updates in order to incorporate the changes at a more appropriate point in time.

* + - 1. **Temperature Ranges of Space Types for Interactive Factor Values**

Table 3-5[[139]](#footnote-139) of 2012 TRM lists interactive factor values for different space types defined by temperature ranges. There are, however, a few gaps in these temperature ranges. The Commission proposes to update the temperature ranges for freezers from (-20°F to 27°F) to (-35°F to 20°F); medium-temp refrigerated ranges from (28°F to 40°F) to (20°F to 40°F); high-temp refrigerated ranges from (47°F to 60°F) to (40°F to 60°F); and cooled space ranges from (68°F-79°F) to (60°F-79°F).

**2. HVAC Protocols**

The 2012 TRM calculates EFLH[[140]](#footnote-140) for HVAC measures by adjusting EFLH values reported in the Connecticut Program Savings Documentation[[141]](#footnote-141) using full load hours from the DOE ENERGY STAR Calculator[[142]](#footnote-142) based on a degree-day scaling methodology. Degree-day scaling ratios were calculated using heating degree day and cooling degree day values for seven Pennsylvania cities: Allentown, Erie, Harrisburg, Philadelphia, Pittsburgh, Scranton, and Williamsport. These reference cities provide a representative sample of the various climate and utility regions in Pennsylvania.

The SWE and Commission Staff did further research for more recent evaluation studies and TRMs from other regions. The SWE and Commission Staff reviewed assumptions from other jurisdictions, focusing on neighboring states, to include Maryland, Delaware and the District of Columbia, to minimize differences in weather conditions.

The EFLH values reported in the 2011 Mid-Atlantic TRM and 2012 Delaware TRM are based on simulations performed for a set of prototypical small and large C&I building types using eQUEST[[143]](#footnote-143) modeling. These prototypical simulation models were derived from the publically-available commercial building types created for the California DEER Study, with adjustments made to the models for local building practices and climate. A prototype was created for each building type and differed by HVAC systems and other building characteristics, including, but not limited to, operating schedule, facility size, number of floors, building envelope.

This review revealed that the EFLH values derived from the 2011 Mid-Atlantic TRM and the 2012 Delaware TRM do not provide any improvement over the methodology used in the current TRM. Nor is there adequate secondary source information available to inform an update to the EFLH values for Pennsylvania.

Therefore, the Commission proposes to use the existing EFLH values in the 2012 TRM for the 2013 TRM until more accurate information is available. The Commission proposes running computer simulation models to determine EFLH values for HVAC measures using eQUEST software for future TRM updates. This will provide state-specific values that do not need to be scaled using degree-days.

**3. Motor and Variable Frequency Drive Protocols**

The Commission proposes to update the Energy Savings Factor (ESF) and Demand Savings Factor (DSF) values for VFDs using the 2012 Connecticut TRM as the primary source. The ESF and DSF values listed in Table 3-17[[144]](#footnote-144) of the 2012 TRM were taken from the 2011 Mid-Atlantic TRM, which references the 2009 Connecticut TRM[[145]](#footnote-145) as the source document. These values, however, do not match the 2009 Connecticut manual. In addition, the algorithms used in the 2011 Mid-Atlantic TRM do not include a load factor to calculate savings in contrast to the 2012 TRM or 2009 Connecticut TRM.

The Commission also proposes to use the 2012 Connecticut TRM to update the motor and VFD operating hours listed in Table 3-14[[146]](#footnote-146) of the 2012 TRM, similar to the source used for ESF and DSF values to accurately estimate savings. Furthermore, as indicated above,the Commission proposes running computer simulation models to determine ESF and DSF values for VFD protocols and operating hours for motor and VFD protocols using eQUEST software for future TRM updates. This will provide state-specific values which are considered to be the most credible information after metered data.

**4. Office Equipment Network Power Management Systems**

The 2012 TRM[[147]](#footnote-147) deemed savings for the Office Equipment Network Power Management System measure are 148 kWh per unit and 0.020 kW per unit. The energy savings were based on actual field measurements for a single project in Duquesne’s service territory. The demand savings were taken from a study conducted by Southern California Edison over a period of one month. The Commission proposes to update the deemed savings to 135 kWh per unit and 0.0078 kW per unit based on a recent evaluation study conducted in Pacific Northwest.[[148]](#footnote-148) This study contains a broader sample and investigated a variety of applications that are more representative of this technology.

**5. LED Channel Signage**

The Commission proposes to update the savings algorithms and assumptions table for the LED Channel Signage measure. The current algorithm in the 2012 TRM[[149]](#footnote-149) uses kW = kW/foot \* Q \* N. As Q represents average stroke length per letter width and N represents the number of letters in the sign, which is equal to L, the total length of the sign. The Commission proposes to revise the algorithm to KW = KW/foot \* L. This will allow the EDCs’ independent evaluators to calculate savings based on actual total length for installed channel signs, resulting in more accurate savings estimates. In addition, the Commission will add a reference for the SVG factor[[150]](#footnote-150) in Table 3-93 of the 2012 TRM.[[151]](#footnote-151)

**6. Refrigeration**

The SWE and Commission Staff reviewed all of the refrigeration measures in the 2012 TRM to ensure that the methods used to determine the EFLH values was consistent. The refrigeration measures are found in Sections 3.8, 3.9, 3.10, 3.11, 3.17, 3.21, 3.23, 3.24, 3.25, 3.26, and 3.33,with only Sections 3.26 and 3.33 using EFLH values for calculating savings.

Measure 3.26 - Evaporator Fan Controllers - uses a variable Hours CP listed in Table 3-83[[152]](#footnote-152) of the 2012 TRM, which represents the EFLH of compressor operation. There is no default value provided for this variable in the assumptions table. As such, the EDCs must collect this information. Measure 3.33 - Special Doors with Low or No Anti-Sweat Heat for Low Temp Case - includes a variable EFLH whose default value is 5,700 and found in Table 3-97[[153]](#footnote-153) of the 2012 TRM. This value was determined by multiplying annual available operation hours of 8,760 by overall duty cycle factors. Duty cycle is a function of compressor capacity, defrost and weather. The Commission proposes a default value of 5,700 for EFLH for Measure 3.26 to be consistent with Measure 3.33.

**7. Low Flow Pre-Rinse Sprayers**

The existing Low Flow Pre-Rinse Sprayer protocol in the 2012 TRM assumes a baseline flow rate of 2.25 gallons per minute (GPM)[[154]](#footnote-154) and 2.15 GPM[[155]](#footnote-155) for non-grocery and grocery applications, respectively, as listed in Table 3-94.[[156]](#footnote-156) These flow rates, however, only apply to retrofit applications. The Commission proposes to add an additional option for a Time of Sale (TOS)/Retail program protocol, with a baseline flow rate of 1.6 GPM[[157]](#footnote-157) to incorporate the current minimum code requirement.

* 1. **Refrigeration – Evaporator Fan Controllers**

The existing Refrigeration – Evaporator Fan Controller protocol in the 2012 TRM[[158]](#footnote-158) was taken from the 2011 Massachusetts TRM. This protocol, however, does not clearly define how to determine the power demand for the evaporator fan (kW Fan) or the compressor motor (kW CP). The Commission proposes the following as acceptable methods for determining the kW Fan and kW CP variables:

1. Calculate using the nameplate horsepower and load factor

* kW Fan, CP = [(Motor HP \* LF \* 0.746 kW/HP) / Motor efficiency] where the HP and efficiency are taken from the nameplate and the load factor is assumed.

1. Calculate using the nameplate amps and volts and a power factor

* kW Fan, CP = [V \* A \* PF motor \* LF] where the volts and the amps are taken from the nameplate, the power factor and load factor is assumed.

1. Measure the input kW Fan, CP using a power meter reading true RMS power.

In addition, the Commission proposes to update the assumptions table and amend the definitions for this measure accordingly.

* 1. **Geothermal Heat Pumps**

The Commission proposes minor editorial changes to the Geothermal Heat Pumps protocol.[[159]](#footnote-159) In addition, the Commission proposes the addition of a conversion factor for SEER to EER for this protocol.

* 1. **Appendix C (Lighting Inventory Tool) and Appendix D (Motor and Variable Frequency Drive Inventory Tool)**

The proposed expansion and improvements to the C&I Lighting protocols will be captured in Appendix C - Lighting Inventory Tool. The major changes will include updating the list of building types, HOU and CF values, control technologies, and savings factors. In addition, the Commission proposes minor edits to Appendix D - Motor and Variable Frequency Drive Inventory Tool - to be consistent with the protocol in the TRM.

1. **Demand Response**

In its *Phase II Implementation Order*, the Commission determined that it must make a determination as to whether or not the benefits of a demand response program exceed the costs before it may set additional peak demand reduction targets. As such, the Commission declined to propose additional peak demand reduction targets in Phase II of the Act 129 EE&C Program.[[160]](#footnote-160)

As the 2013 TRM will be applicable for the first program year of Phase II, the Commission does not deem it necessary to include a discussion of demand response in this update. As such, Section 4 – Demand Response – of the 2012 TRM has been removed for the 2013 TRM update.[[161]](#footnote-161) Should the Commission determine that demand response programs are cost-effective within Act 129 and set additional peak demand reduction targets for Phase III, it will address the associated EM&V in its initial Phase III TRM.

# CONCLUSION

With this Tentative Order, the Commission seeks comments on the proposed additions and updates to the TRM. This Tentative Order represents the Commission’s continuing efforts in establishing a comprehensive TRM with a purpose of supporting both the AEPS Act and the EE&C Program provisions of Act 129. We look forward to receiving comments from interested stakeholders regarding the proposed changes to the TRM. This Tentative Order, the proposed TRM update and filed comments will be made available to the public on the Commission’s Act 129 Information web page. [[162]](#footnote-162)

**THEREFORE,**

**IT IS ORDERED:**

1. That the proposed 2013 Technical Reference Manual update be issued for comment.

2. That a copy of this Tentative Order shall be served upon the Office of Consumer Advocate, the Office of Small Business Advocate, the Commission’s Bureau of Investigation and Enforcement, the Pennsylvania Department of Environmental Protection and all parties who commented on the 2012 Technical Reference Manual update.

3. That the Secretary shall deposit a notice of this Tentative Order and proposed 2013 version of the TRM with the Legislative Reference Bureau for publication in the *Pennsylvania Bulletin*.

4. That interested parties shall have 30 days from the date the notice is published in the *Pennsylvania Bulletin* to file written comments referencing Docket Number M-2012-2313373 to the Pennsylvania Public Utility Commission, Attention: Secretary, P.O. Box 3265, Harrisburg, PA 17105‑3265.

5. That interested parties shall have 40 days from the date the notice is published in the *Pennsylvania Bulletin* to written reply comments referencing Docket Number M-2012-2313373 to the Pennsylvania Public Utility Commission, Attention: Secretary, P.O. Box 3265, Harrisburg, PA 17105‑3265.

6. That a Word formatted copy of all comments and reply comments shall be electronically mailed to Megan G. Good at [megagood@pa.gov](mailto:megagood@pa.gov) and Kriss Brown at [kribrown@pa.gov](mailto:kribrown@pa.gov). Attachments may not exceed three megabytes.

7. That this Tentative Order, the proposed 2013 version of the TRM and all filed comments and reply comments related to this Tentative Order be published on the Commission’s website.

8. That the contact person for technical issues related to this Tentative Order and the proposed 2013 version of the TRM is Megan G. Good, Bureau of Technical Utility Services, 717-425-7583 or [megagood@pa.gov](mailto:megagood@pa.gov). The contact person for legal and process issues related to this Tentative Order and the proposed 2013 version of the TRM is Kriss Brown, Law Bureau, 717-787-4518 or [kribrown@pa.gov](mailto:kribrown@pa.gov).

**BY THE COMMISSION**

Rosemary Chiavetta

Secretary

(SEAL)

ORDER ADOPTED: September 13, 2012

ORDER ENTERED: September 13, 2012

1. Order entered on October 3, 2005, at Docket No. M-00051865 (October 3, 2005 Order). [↑](#footnote-ref-1)
2. As of August 11, 2011, the Bureau of CEEP was eliminated and its functions and staff transferred to the newly created Bureau of Technical Utility Services. *See Implementation of Act 129 of 2008; Organization of Bureaus and Offices*, Final Procedural Order, entered August 11, 2011, at Docket No. M-2008-2071852, at page 4. [↑](#footnote-ref-2)
3. *See* October 3, 2005 Order at page 13. [↑](#footnote-ref-3)
4. *See Energy Efficiency and Conservation Program* Implementation Order at Docket No. M-2008-2069887, (Phase I Implementation Order), at page 13, entered January 16, 2009. [↑](#footnote-ref-4)
5. *Id*. [↑](#footnote-ref-5)
6. *See Implementation of the Alternative Energy Portfolio Standards Act of 2004: Standards for the Participation of Demand Side Management Resources – Technical Reference Manual* Update Order at Docket No. M‑00051865, (2009 TRM), entered June 1, 2009. [↑](#footnote-ref-6)
7. *Id*. at pages 17 and 18. [↑](#footnote-ref-7)
8. *See Energy Efficiency and Conservation Program* Implementation Order, at Docket No. M-2012-2289411, (*Phase II Implementation Order*), entered August 3, 2012, at page 71. [↑](#footnote-ref-8)
9. *Id*. at page 75. [↑](#footnote-ref-9)
10. The PEG is chaired by Commission Staff and is comprised of representatives from the EDCs and the SWE for the purpose of encouraging discussion of EDC program-specific issues and associated evaluation, measurement and verification. [↑](#footnote-ref-10)
11. The TWG is chaired by Commission Staff and is comprised of representatives from the EDCs, the SWE and other interested parties for the purpose of encouraging discussion of the technical issues related to the evaluation, measurement and verification of savings programs to be implemented pursuant to Act 129. [↑](#footnote-ref-11)
12. The Commission held a TWG meeting on August 7, 2012, to provide stakeholders with the opportunity to review proposed high impact changes to residential, commercial and industrial measures, and also allow for a question and answer session regarding those changes. Additionally, stakeholders had the opportunity to propose any other changes they would like to have made to the TRM. [↑](#footnote-ref-12)
13. *See Implementation of the Alternative Energy Portfolio Standards Act of 2004: Standards for the Participation of Demand Side Management Resources – Technical Reference Manual Update*, Tentative Order at Docket No. M‑00051865, entered February 2, 2010. [↑](#footnote-ref-13)
14. *See Implementation of the Alternative Energy Portfolio Standards Act of 2004: Standards for the Participation of Demand Side Management Resources – Technical Reference Manual Update*, Final Order at Docket No. M-00051865, (2010 TRM), entered June 8, 2010. [↑](#footnote-ref-14)
15. *See Implementation of the Alternative Energy Portfolio Standards Act of 2004: Standards for the Participation of Demand Side Management Resources – Technical Reference Manual Update*, Tentative Order at Docket No. M‑00051865, entered November 24, 2010. [↑](#footnote-ref-15)
16. *See Implementation of the Alternative Energy Portfolio Standards Act of 2004: Standards for the Participation of Demand Side Management Resources – Technical Reference Manual Update*, Final Order at Docket No. M-00051865, (2011 TRM), entered February 28, 2011. [↑](#footnote-ref-16)
17. *See Implementation of the Alternative Energy Portfolio Standards Act of 2004: Standards for the Participation of Demand Side Management Resources – Technical Reference Manual 2012 Update*, Tentative Order at Docket No. M‑00051865, entered September 23, 2011. [↑](#footnote-ref-17)
18. *See Implementation of the Alternative Energy Portfolio Standards Act of 2004: Standards for the Participation of Demand Side Management Resources – Technical Reference Manual 2012 Update*, Final Order at Docket No. M‑00051865, (2012 TRM), entered December 16, 2011. [↑](#footnote-ref-18)
19. *See* Section 1.9, page 6, of the 2012 TRM. [↑](#footnote-ref-19)
20. *See* Section 2.1.1, pages 15and 16, Table 2-1, of the 2012 TRM. [↑](#footnote-ref-20)
21. The Market Potential Study can be found on the Commission’s website at <http://www.puc.state.pa.us/electric/Act_129_info.aspx>. [↑](#footnote-ref-21)
22. The Residential Baseline Study can be found on the Commission’s website at <http://www.puc.state.pa.us/electric/Act_129_info.aspx>. [↑](#footnote-ref-22)
23. Neme, Proctor, Nadal, “National Energy Savings Potential From Addressing Residential HVAC Installation Problems. ACEEE, February 1, 1999. [↑](#footnote-ref-23)
24. *Central Air Conditioning in Wisconsin, a compilation of recent field research.* Energy Center of Wisconsin. May 2008, amended December 15, 2010. [↑](#footnote-ref-24)
25. ACCA, “Verifying ACCA Manual S Procedures.” Accessed: <http://www.acca.org/Files/?id=67>. [↑](#footnote-ref-25)
26. *See* Section 2.1, page 15, Table 2-1, of the 2012 TRM. [↑](#footnote-ref-26)
27. *See* Section 2.5, page 27, Table 2-6, of the 2012 TRM. [↑](#footnote-ref-27)
28. *See* Section 2.11, page 48, Table 2-17, of the 2012 TRM. [↑](#footnote-ref-28)
29. *See* Section 2.17, page 69, Table 2-24, of the 2012 TRM. [↑](#footnote-ref-29)
30. *See* Section 2.20, page 84, Table 2-32, of the 2012 TRM. [↑](#footnote-ref-30)
31. *See* Section 2.21, page 89, Table 2-34, of the 2012 TRM. [↑](#footnote-ref-31)
32. *See* Section 2.1.1, page 12, of the 2011 TRM. [↑](#footnote-ref-32)
33. *See* Residential ENERGY STAR Lighting, pages 24-26, of the 2009 TRM. [↑](#footnote-ref-33)
34. *See* Section 4.2: Residential ENERGY STAR Lighting, pages 24-26, of the 2010 TRM. [↑](#footnote-ref-34)
35. *See* Section 2.26: Residential ENERGY STAR Lighting, pages 106-108, of the 2011 TRM. [↑](#footnote-ref-35)
36. *See* *Implementation of the Alternative Energy Portfolio Standards Act of 2004: Standards for the Participation of Demand Side Management Resources – Technical Reference Manual Update* Order at Docket No. M‑00051865, entered February 28, 2011, at page 36. (2011 TRM Final Order) [↑](#footnote-ref-36)
37. See *Implementation of the Alternative Energy Portfolio Standards Act of 2004: Standards for the Participation of Demand Side Management Resources – Technical Reference Manual Update* Order at Docket No. M‑00051865, entered December 16, 2011, at page 42. (2012 TRM Final Order) [↑](#footnote-ref-37)
38. “EmPOWER Maryland 2010 Interim Evaluation Report – Chapter 5: Lighting and Appliances” by Navigant Consulting. Presented to Baltimore Gas and Electric, Potomac Electric Power Company, Delmarva Power and Light, Southern Maryland Electric Cooperative, and Allegheny Power. Originally submitted January 15, 2011, and updated March 9, 2011. (Maryland Study) [↑](#footnote-ref-38)
39. *Id*. at page 43. [↑](#footnote-ref-39)
40. *See* Section 2.26, pages 106-109, of the 2012 TRM. [↑](#footnote-ref-40)
41. *See* 2012 TRM Final Order at page 42 and 43. [↑](#footnote-ref-41)
42. *Id*. at page 43. [↑](#footnote-ref-42)
43. United States Department of Energy, “2010 U.S. Lighting Market Characterization.” January 2012. [↑](#footnote-ref-43)
44. Glacier Consulting Group, LLC. “Adjustments to CFL Operating Hours-Residential.” Memo to Oscar Bloch, Wisconsin DOA. June 27, 2005. [↑](#footnote-ref-44)
45. Nexus Market Research, “Impact Evaluation of the Massachusetts, Rhode Island and Vermont 2003 Residential Lighting Programs”, Final Report, October 1, 2004 And Nexus Market Research, "Residential Lighting Markdown Impact Evaluation", Final Report, January 20, 2009. (2009 New England Study) [↑](#footnote-ref-45)
46. CFL Metering Study, Final Report. Prepared for PG&E, SDG&E, and SCE by KEMA, Inc. February 25, 2005 (2005 California Study) and KEMA, Inc., "Final Evaluation Report: Upstream Lighting Program." Prepared from the California Public Utilities Commission, February 8, 2010 (2010 California Study). [↑](#footnote-ref-46)
47. Nexus Market Research, "Process and Impact Evaluation of the Efficiency Maine Lighting Program", April 2007. (2007 Maine Study) [↑](#footnote-ref-47)
48. Itron, Inc. "Verification of Reported Energy and Peak Savings from the EmPOWER Maryland Energy Efficiency Programs." Prepared for the Maryland Public Service Commission, April 21, 2011 (2011 Maryland Study). [↑](#footnote-ref-48)
49. TecMarket Works, "Duke Energy Residential Smart Saver CFL Program in North Carolina and South Carolina", February 2011. [↑](#footnote-ref-49)
50. The United Illuminating Company and Connecticut Power and Light, *Connecticut Program Savings Documentation for Program Year 2012*, September 2011 (2012 Connecticut TRM). [↑](#footnote-ref-50)
51. *State of Illinois Energy Efficiency Technical Reference Manual*, June 2012 (2012 Illinois TRM). [↑](#footnote-ref-51)
52. *Efficiency Maine Residential Technical Reference Manual No. 2009-1*, February 2009. [↑](#footnote-ref-52)
53. Northeast Energy Efficiency Partnerships, *Mid-Atlantic Technical Reference Manual Version 2.0*, July 2011 (2011 Mid-Atlantic TRM). [↑](#footnote-ref-53)
54. New Jersey Board of Public Utilities, *New Jersey Clean Energy Program Protocols to Measure Resource Savings*, July 2011. [↑](#footnote-ref-54)
55. New York Department of Public Service, *New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs*, October 2010. [↑](#footnote-ref-55)
56. Prepared by Vermont Energy Efficiency Corporation for the Public Utilities Commission of Ohio, *State of Ohio Energy Efficiency Technical Reference Manual*, August 2010 (2010 Ohio TRM). [↑](#footnote-ref-56)
57. *See* Section 2.1, page 36, Table 2-14, of the 2012 TRM. [↑](#footnote-ref-57)
58. *See* Section 2.32, page 129, Table 2-54, of the 2012 TRM. [↑](#footnote-ref-58)
59. *See* Section 2.33, page 130, Table 2-55 of the 2012 TRM. [↑](#footnote-ref-59)
60. *See* Section 2.35, page 135, Table 2-57 of the 2012 TRM. [↑](#footnote-ref-60)
61. *See* Section 2.26, page 108, Table 2-42, of the 2012 TRM. [↑](#footnote-ref-61)
62. *See* Section 2.26, page 109, Table 2-43 of the 2012 TRM. [↑](#footnote-ref-62)
63. *See* Section 2.26, page 108, Table 2-42, of the 2012 TRM. [↑](#footnote-ref-63)
64. *See* Efficiency Vermont, *Technical Reference User Manual: Measure Savings Algorithms and Cost Assumptions,* July 2008. [↑](#footnote-ref-64)
65. ENERGY STAR Ceiling Fan Savings Calculator, updated April 2009. [↑](#footnote-ref-65)
66. *See* 42 U.S.C.A. § 6295(i) (West Supp. 2011) and 10 C.F.R. § 430.32(x) (2011). [↑](#footnote-ref-66)
67. *See* Section 2.26, pages 106-109, of the 2012 TRM. [↑](#footnote-ref-67)
68. *See* pages 21-29 of the 2011 Mid-Atlantic TRM. [↑](#footnote-ref-68)
69. *See* Section 2.6, page 36, Table 2-14, of the 2012 TRM. [↑](#footnote-ref-69)
70. *See* Section 2.35, page 136, Table 2-58, of the 2012 TRM. [↑](#footnote-ref-70)
71. *See* Section 2.32, pages 126-128, of the 2012 TRM. [↑](#footnote-ref-71)
72. *See* Section 2.25, pages 100-105, of the 2012 TRM. [↑](#footnote-ref-72)
73. *See* Section 2.25, pages 102-104, Table 2-40 and Table 2-41, of the 2012 TRM. [↑](#footnote-ref-73)
74. United States Department of Energy, “January 19, 2012 EPA Memo to Stakeholders,” January 19, 2012. <http://www.energystar.gov/ia/partners/downloads/EPA_Cover_Letter_ME_2012.pdf?2a4f-819c>. [↑](#footnote-ref-74)
75. The CA 2004-05 and 2006-08 regression models can be found within their respective evaluation reports at [www.calmac.org](http://www.calmac.org). [↑](#footnote-ref-75)
76. See 2012 TRM Final Order at page 48. [↑](#footnote-ref-76)
77. See U.S. Department of Energy, draft Uniform Methods Project protocol titled “Refrigerator Recycling Evaluation Protocol”, prepared by Doug Bruchs of the Cadmus Group, July 2012,

    <http://ump.pnnl.gov/showthread.php/4902-Refrigerator-Recycling-Evaluation-Protocol>. (US DOE Uniform Methods Project) [↑](#footnote-ref-77)
78. 2009-2010 Pacific Power/Rocky Mountain Power Impact Evaluations - PacifiCorp has impact evaluations for CA, ID, UT, WA, and WY that contain an earlier version of the multi-state Appliance Recycling Program regression models for both refrigerators and freezers. The SWE and Commission staff reviewed the report for the State of Washington, but all states include the same models and are publicly available online.

    <http://www.pacificorp.com/content/dam/pacificorp/doc/Energy_Sources/Demand_Side_Management/WA_2011_SYLR_Final_Report.pdf>. [↑](#footnote-ref-78)
79. 2010 Ontario Power Authority Impact Evaluation - This evaluation report contains a regression equation for annual consumption for refrigerators only.

    <http://www.powerauthority.on.ca/sites/default/files/new_files/2010/2010%20Residential%20Great%20Refrigerator%20Roundup%20Program%20Evaluation.pdf>. See page 10 for the regression equation. [↑](#footnote-ref-79)
80. Cadmus Memo - August 20, 2012 Technical Memo from the Cadmus Group to the Michigan Evaluation Working Group on the topic of Appliance Recycling Measure Savings Study. This memo summarizes research on the energy savings of recycled refrigerators and freezers conducted by The Cadmus Group, Inc. and Opinion Dynamics (together known as the evaluation team) on behalf Consumers Energy (Consumers) and DTE Energy (DTE). This memo provides an overview of the research conducted and Cadmus’ recommendations for deemed per-unit energy and demand savings values for affected measures in the Michigan Energy Measures Database (MEMD). [↑](#footnote-ref-80)
81. Rounding differences have been accounted for by providing deemed savings values rounded to the nearest kWh. [↑](#footnote-ref-81)
82. The average annual unit energy consumption of participating refrigerators is 967 kWh based on the PY3 data. [↑](#footnote-ref-82)
83. The average refrigerator was plugged in 96.9% of the year based on PY3 data. [↑](#footnote-ref-83)
84. See U.S. DOE Uniform Methods Project. [↑](#footnote-ref-84)
85. Average values used for each independent variable in the regression equation are based upon the entire fleet of refrigerators for all Pennsylvania EDCs removed during Act 129 PY3. [↑](#footnote-ref-85)
86. Rounding differences have been accounted for by providing deemed savings values rounded to the nearest kWh. [↑](#footnote-ref-86)
87. See Cadmus Memo - August 20, 2012 Technical Memo from the Cadmus Group to the Michigan Evaluation Working Group on the topic of Appliance Recycling Measure Savings Study. This memo summarizes research on the energy savings of recycled refrigerators and freezers conducted by The Cadmus Group, Inc. and Opinion Dynamics (together known as the evaluation team) on behalf Consumers Energy (Consumers) and DTE Energy (DTE). This memo provides an overview of the research conducted and Cadmus’ recommendations for deemed per-unit energy and demand savings values for affected measures in the Michigan Energy Measures Database (MEMD). (Cadmus Memo) [↑](#footnote-ref-87)
88. 2009-2010 Pacific Power/Rocky Mountain Power Impact Evaluations - PacifiCorp has impact evaluations for CA, ID, UT, WA, and WY that contain an earlier version of the multi-state Appliance Recycling Program regression models for both refrigerators and freezers. The SWE and Commission staff reviewed the report for the State of Washington, but all states include the same models and are publicly available online

    <http://www.pacificorp.com/content/dam/pacificorp/doc/Energy_Sources/Demand_Side_Management/WA_2011_SYLR_Final_Report.pdf>. [↑](#footnote-ref-88)
89. 2010 Ontario Power Authority Impact Evaluation - This evaluation report contains a regression equation for annual consumption for refrigerators only (the freezer sample was too small).

    <http://www.powerauthority.on.ca/sites/default/files/new_files/2010/2010%20Residential%20Great%20Refrigerator%20Roundup%20Program%20Evaluation.pdf>. See page 10 for the regression equation. [↑](#footnote-ref-89)
90. The average freezer was plugged in 98.5% fo the year based on PY3 data. [↑](#footnote-ref-90)
91. See Cadmus Memo. [↑](#footnote-ref-91)
92. Average values used for each independent variable in the regression equation are based upon the entire fleet of refrigerators for all Pennsylvania EDCs removed during Act 129 PY3. [↑](#footnote-ref-92)
93. Energy Conservation Program for Consumer Products: Test Procedure for Water Heaters”, Federal Register / Vol. 63, No. 90, at page 25996. [↑](#footnote-ref-93)
94. *Id.* at pages 26005 and 26006. [↑](#footnote-ref-94)
95. U.S. DOE EERE Water Heaters Technical Support Document from January 17, 2001, Final Rule, Chapter 9: Life-Cycle Cost Analysis, at pages 9-14. [↑](#footnote-ref-95)
96. *Baseline Results and Methodology of the Consumer Sub-Group Analysis for Residential Water Heater Efficiency Standards*, Submitted to U.S. DOE, October 1998. [↑](#footnote-ref-96)
97. Thomas, M. et al. “A New Study of Hot Water Use in Canada” Natural Resources Canada. Presented at ASHRAE Winter Meeting, Las Vegas, NV (2011). [↑](#footnote-ref-97)
98. *See* Section 2.3, page 22, Table 2-2, of the 2012 TRM. [↑](#footnote-ref-98)
99. *See* Section 2.6, page 32, Table 2-12, of the 2012 TRM. [↑](#footnote-ref-99)
100. *See* Section 2.14, page 58, Table 2-22, of the 2012 TRM. [↑](#footnote-ref-100)
101. *See* Section 2.15, page 62, of the 2012 TRM. [↑](#footnote-ref-101)
102. *See* Section 2.18, page 74, Table 2-26, of the 2012 TRM. [↑](#footnote-ref-102)
103. *See* Section 2.19, page 78, Table 2-29, of the 2012 TRM. [↑](#footnote-ref-103)
104. *See* Sections 2.9 and 2.10, pages 42 and 45, of the 2012 TRM. [↑](#footnote-ref-104)
105. U.S. DOE EERE Energy Savers, <http://www.energysavers.gov/your_home/water_heating/index.cfm/mytopic=13000>. [↑](#footnote-ref-105)
106. See the 2010 Ohio TRM at page 90 and the 2011 Mid-Atlantic TRM at page 83. [↑](#footnote-ref-106)
107. *See* Section 2.9, page 42, Table 2-16, of the 2012 TRM. [↑](#footnote-ref-107)
108. *See* Section 2.9, page 42, of the 2012 TRM. [↑](#footnote-ref-108)
109. *See* Section 7.4.4, page 412, of the 2012 Illinois TRM. [↑](#footnote-ref-109)
110. *Id*., page 413. [↑](#footnote-ref-110)
111. *See* Section 2.9, page 42, Table 2-16, of the 2012 TRM. [↑](#footnote-ref-111)
112. *See* Section 7.4.4, page 414, of the 2012 Illinois TRM. [↑](#footnote-ref-112)
113. *Id.*, page 414. [↑](#footnote-ref-113)
114. *See* Section 2.10.3, page 45, of the 2012 TRM. [↑](#footnote-ref-114)
115. *See* the 2012 Illinois TRM at page 422 and the 2011 Mid-Atlantic TRM at page 82. [↑](#footnote-ref-115)
116. *See* Section 2.24, page 95, of the 2012 TRM. [↑](#footnote-ref-116)
117. *Id*. [↑](#footnote-ref-117)
118. *Id.* [↑](#footnote-ref-118)
119. *See* Section 3.2.7, pages 159-160, of the 2012 TRM. [↑](#footnote-ref-119)
120. New Jersey's Clean Energy Program Protocols, December 2009 (2009 New Jersey TRM). [↑](#footnote-ref-120)
121. Quantum Consulting, Inc., for Pacific Gas & Electric Company , Evaluation of Pacific Gas & Electric Company’s 1997 Commercial Energy Efficiency Incentives Program: Lighting Technologies”, March 1, 1999 (1999 PG&E Study). [↑](#footnote-ref-121)
122. *See* Section 3.2.7, pages 160-161, of the 2012 TRM. [↑](#footnote-ref-122)
123. State of Wisconsin Public Service Commission of Wisconsin Focus on Energy Evaluation Business Programs: Deemed Savings Manual V1.0”, KEMA, March, 2010 (2010 Wisconsin Deemed Savings Manual). [↑](#footnote-ref-123)
124. The Database for Energy Efficiency Resources (DEER) 2011– <http://www.deerresources.com>. [↑](#footnote-ref-124)
125. New York Standard Approach for Estimating Energy Savings from Energy Efficiency Measures in Commercial and Industrial Programs, TecMarket Works, September 1, 2009. [↑](#footnote-ref-125)
126. Technical Reference User Manual (TRM) Measure Savings Algorithms and Cost Assumptions, Efficiency Vermont, February 2010. [↑](#footnote-ref-126)
127. Delaware Technical Reference Manual, Opinion Dynamics Corporation, April 2012 (2012 Delaware TRM). [↑](#footnote-ref-127)
128. Massachusetts Technical Reference Manual for 2011 Program Year, October 2010 (2011 Massachusetts TRM). [↑](#footnote-ref-128)
129. Technical Reference Manual, Efficiency Maine, August 2010. [↑](#footnote-ref-129)
130. Small Commercial Contract Group Direct Impact Evaluation Report prepared by Itron for the California Public Utilities Commission Energy Division, February 9, 2010. [↑](#footnote-ref-130)
131. Database for Energy Efficiency Resources (2008 version) - <http://www.deerresources.com/> . [↑](#footnote-ref-131)
132. The Database for Energy Efficiency Resources (DEER) 2011– <http://www.deerresources.com/>. [↑](#footnote-ref-132)
133. *See* Section 3.2.7, pages 159 and 160, of the 2012 TRM. [↑](#footnote-ref-133)
134. *See* Section 3.2.7, page 163, of the 2012 TRM. [↑](#footnote-ref-134)
135. *See* <http://efficiency.lbl.gov/drupal.files/ees/Lighting%20Controls%20in%20Commercial%20Buildings_LBNL-5095-E.pdf>. [↑](#footnote-ref-135)
136. *See* Section 3.2.2, page 151, of the 2012 TRM. [↑](#footnote-ref-136)
137. *See* 2012 TRM Final Order at page 49. [↑](#footnote-ref-137)
138. *See* 42 U.S.C.A. § 6295(g)(8) (West Supp. 2011). [↑](#footnote-ref-138)
139. *See* Section 3.2.7, pages 162, of the 2012 TRM. [↑](#footnote-ref-139)
140. *See* Section 3.6, pages 184 and 185, of the 2012 TRM. [↑](#footnote-ref-140)
141. UI and CL&P Program Savings Documentation for 2008 Program Year, United Illuminating Company, September 2007. [↑](#footnote-ref-141)
142. <http://www.energystar.gov/ia/business/bulk_purchasing/bpsavings_calc/Calc_CAC.xls>. [↑](#footnote-ref-142)
143. eQUEST stands for “the QUick Energy Simulation Tool” which is a building energy analysis tool used to perform detailed analysis of today's state-of-the-art building design technologies. More information regarding the software can be found at: <http://doe2.com/equest/>. [↑](#footnote-ref-143)
144. *See* Section 3.4, page 176, of the 2012 TRM. [↑](#footnote-ref-144)
145. UI and CL&P Program Savings Documentation for 2009 Program Year, United Illuminating Company, September 2008. (2009 Connecticut TRM) [↑](#footnote-ref-145)
146. *See* Section 3.2, pages 172 and 173, of the 2012 TRM. [↑](#footnote-ref-146)
147. *See* Section 3.22, page 258, of the 2012 TRM. [↑](#footnote-ref-147)
148. <http://www.nwcouncil.org/energy/rtf/measures/measure.asp?id=95&decisionid=117> [↑](#footnote-ref-148)
149. *See* Section 3.30, page 285, of the 2012 TRM. [↑](#footnote-ref-149)
150. An SVG factor represents the percentage of time that lights are off due to lighting controls relative to the baseline controls system (typically manual switch). [↑](#footnote-ref-150)
151. *See* Section 3.30, page 287, of the 2012 TRM. [↑](#footnote-ref-151)
152. *See* Sections 3.26, page 268, of the 2012 TRM. [↑](#footnote-ref-152)
153. *See* Sections 3.33, page 299, of the 2012 TRM. [↑](#footnote-ref-153)
154. Impact and Process Evaluation Final Report for California Urban Water Conservation Council 2004-5 Pre-Rinse Spray Valve Installation Program (Phase 2), SBW Consulting, 2007, Table 3-4, p. 23. [↑](#footnote-ref-154)
155. *Id.* [↑](#footnote-ref-155)
156. *See* Sections 3.31, page 291, of the 2012 TRM. [↑](#footnote-ref-156)
157. EPAct 2005 sets the maximum flow rate for pre-rinse spray valves at 1.6 GPM at 60 pounds per square inch of water pressure when tested in accordance with ASTM F2324-03. This performance standard went into effect January 1, 2006. [↑](#footnote-ref-157)
158. *See* Sections 3.26, page 267, of the 2012 TRM. [↑](#footnote-ref-158)
159. *See* Sections 3.18, page 236-244, of the 2012 TRM. [↑](#footnote-ref-159)
160. *See Phase II Implementation Order* at page 33. [↑](#footnote-ref-160)
161. *See* Section 4, pages 302-305, of the 2012 TRM. [↑](#footnote-ref-161)
162. <http://www.puc.state.pa.us/electric/Act_129_info.aspx>. [↑](#footnote-ref-162)