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| PUC logo | COMMONWEALTH OF PENNSYLVANIA  PENNSYLVANIA PUBLIC UTILITY COMMISSION  P.O. BOX 3265, HARRISBURG, PA 17105-3265 | **IN REPLY PLEASE REFER TO OUR FILE**  M‑2012-2313373 |

**April 16, 2015**

TO ALL INTERESTED PARTIES:

Re: Implementation of the Alternative Energy Portfolio Standards Act of 2004: Standards for the Participation of Demand Side Management Resources – Technical Reference Manual 2015 Update

Docket No. M-2012-2313373

On December 18, 2014, the Pennsylvania Public Utility Commission (Commission) entered an Order adopting the 2015 Technical Reference Manual (TRM) update in the above-referenced matter. The TRM Annual Update Order and 2015 TRM update are posted on the Commission’s website at: <http://www.puc.pa.gov/filing_resources/issues_laws_regulations/act_129_information/technical_reference_manual.aspx>.

With this Secretarial Letter, the Commission releases Errata to the 2015 TRM. The Errata correct the following:

* Errors in Section 2.1.1 – ENERGY STAR Lighting. The errors are as follows:
  + The inclusion of a 365 days-per-year (days/yr) constant in the ΔkWpeak equation for ENERGY STAR LED Bulbs (screw-in). The ΔkWpeak equation does not determine a per-year value; therefore, the 365 days/yr constant is unnecessary. Page 18 of the 2015 TRM has been updated to reflect the removal of this value.
  + Incorrect information in Table 2-2: Baseline Wattage by Lumen Output for General Service Lamps (GSL). For the minimum-maximum lumen range of 310-449, the Wattsbase post-2020 value is listed as 25. Based on the reference provided for this table, this value should be 9. Table 2-2 on page 21 of the 2015 TRM has been updated to reflect the appropriate Wattsbase post-2020 value of 9.
* Errors in Section 2.2.1 – Electric HVAC [Heating, Ventilation and Air Conditioning]. The errors are as follows:
  + An incorrect change in kilowatt-hours (ΔkWh) value for the ground source heat pump (GSHP) desuperheater measure. The ΔkWh listed in the measure is 567. However, during the 2015 TRM update, the Commission amended the temperature-of-hot-water (Thot) variable to 119 °F. This amended variable is included in the algorithm for the ΔkWh; however, the kWh savings value included in the protocol were not updated based on the amended Thot variable. The ΔkWh should be 534 using the updated variable. Page 36 has been updated to reflect the appropriate ΔkWh value.
  + A lack of clarity regarding the applicability of the energy efficiency ratios contained in Table 2-10: Residential Electric HVAC – References. For the energy efficiency ratio of the baseline unit (EERb) and the energy efficiency ratio of the unit being installed (EERe), clarification is needed regarding what values apply to early retirement versus replacement on burnout scenarios, as well as what values apply to central air conditioning (A/C) systems. Table 2-10 on page 37 has been updated to clarify which EERb values should be used for central A/C systems and for early replacement scenarios. The table has also been updated to clarify which EERe value should be used for central A/C systems.
* Errors in the conversion factor used to convert watt-hours (Wh) (or its variations, such as kWh) to British thermal units (Btu) (or its variations, such as MMBtu). The conversion factor is listed as 3.413 (or other variations, such as 3,413 or 0.003413), where applicable), when it should be 3.412 (or other variations, such as 3,412 or 0.003412, where applicable). The following pages have been updated accordingly:
  + Page 39 – 3.413 to 3.412;
  + Page 42 – 3.413 to 3.412;
  + Page 77 – 3.413 to 3.412;
  + Page 91 – 3,413 to 3,412;
  + Page 160 – 0.003413 to 0.003412;
  + Page 161 – 0.003413 to 0.003412;
  + Page 188 – 3.413 to 3.412;
  + Page 190 – 3.413 to 3.412;
  + Page 279 – 3.413 to 3.412;
  + Page 280 – 3.413 to 3.412;
  + Page 323 – 3.413 to 3.412; and,
  + Page 447 – 3,413 to 3,412.
* An update to the default unit energy savings and default unit peak demand reduction for Section 2.3.3 – Solar Water Heaters on page 90. As noted previously, page 91 has been updated to reflect the appropriate kWh to Btu conversion factor of 3,412. This amendment, as well as the previously noted change to the Thot variable, required the recalculation of the default unit energy savings (kWh) and default unit peak demand reduction (kW) values. The summary table on page 90 has been updated to reflect the recalculated values of 1,598.8 kWh and 0.2529 kW for the default unit energy savings and default unit peak demand reduction, respectively.
* Inconsistencies between summary tables at the beginning of measures and the unit energy savings and unit peak demand reductions calculated within the protocol. To ensure consistency in values, the following pages have been updated to reflect the appropriate values in the summary tables:
  + Page 32 – 10.6 kWh per strand to 20.2 kWh per strand;
  + Page 93 – unit energy savings from 3,338 kWh/yr to 3,143 kWh/yr and unit peak demand reductions from 0.2687 kW to 0.2529 kW;
  + Page 97 - unit energy savings from 1,734.5 kWh/yr to 1,632.9 kWh/yr and unit peak demand reductions from 0.140 kW to 0.1314 kW;
  + Page 166 – 0.0098 kW to “varies based on capacity” as the default savings provided in Table 2 90: Dehumidifier Default Energy Savings on pages 167 and 168 provide the default kW values for various dehumidifiers based on their capacity;
  + Page 169 – Unit energy savings updated to 47.5 kWh from 47 kWh for Cold Only ENERGY STAR Water Coolers and unit energy savings for Hot and Cold Storage and Hot and Cold On-Demand ENERGY STAR Water Coolers provided in summary table. Unit peak demand reduction value for Cold Only ENERGY STAR Water Coolers amended from 0.0232 kW to 0.00532 kW to reflect the reductions calculated within the measure. Unit peak demand reduction values for Hot and Cold Storage and Hot and Cold On-Demand ENERGY STAR Water Coolers provided in summary table. The summary table on page 169 has been updated to reflect the kWh and kW values calculated within the measure.
* Errors in fossil fuel consumption values in Sections 2.3.4 – Fuel Switching: Electric Resistance to Fossil Fuel Water Heater and 2.3.5 – Fuel Switching: Heat Pump Water Heater to Fossil Fuel Water Heater. As previously noted, the Commission, as part of the 2015 TRM update, amended the Thot variable to 119 °F. This variable affects the fossil fuel consumption values included within these two measures. The values in the protocol were not updated to reflect the usage of the new Thot variable. Table 2-53: Fuel Consumption for Fuel Switching, Domestic Hot Water Electric to Fossil Fuel on page 96 and Table 2-59: Gas, Oil, Propane Consumption for Heat Pump Water Heater to Fossil Fuel Water Heater on page 102 have been updated to reflect the newly-calculated values. Specifically, the fossil fuel consumption value for gas has been updated from 15.37 MMBtu to 14.47 MMBtu; the value for propane has been updated from 15.37 MMBtu to 14.47 MMBtu; and the value for oil has been updated from 20.04 MMBtu to 18.86 MMBtu. The measure summary tables on pages 93 and 97 have also been updated to reflect these new fossil fuel consumption values.
* Errors in Section 2.3.8 – Water Heater Pipe Insulation. The errors are as follows:
  + As previously noted, the Commission, as part of the 2015 TRM update, amended the Thot variable to 119 °F. This variable affects the annual energy use of an electric water heater. The kWh in the protocol were not updated to reflect the usage of the new Thot variable. Page 111 has been updated to reflect the amending of the kWh from 3,338 to 3,143 and amending the kWh based on ten feet of insulation from 100.14 to 94.29.
  + The amendment to the kWh values also requires an update to the change in kWh per year (ΔkWh/yr) value, from 10 kWh/yr per foot to 9.43 kWh/yr per foot. Page 111 has been updated to reflect this change.
  + The amendment to the kWh/yr per foot value also requires an update to the summer peak kW savings (ΔkWpeak) per foot of installed pipe insulation value. The updated 9.43 kWh/yr per foot value is included in the calculation for ΔkWpeak per foot of installed pipe insulation. Therefore, pages 111 and 112 have been updated to reflect the newly-calculated value of 0.000759.
* A missing footnote on page 130. Page 130 of the 2015 TRM included a reference to footnote 132; however, this footnote was inadvertently omitted from the footer of the page. Page 130 has been amended to include footnote 132.
* A reference to the incorrect program year on page 141. The “UEC [Unit Energy Consumption] Equations and Default Values” section on page 141 includes language that each UEC value represents various information inputs from program year four (June 1, 2012 – May 31, 2013) data. This is incorrect. The correct year is program year five (June 1, 2013 – May 31, 2014). Page 141 has been updated to reflect the appropriate program year information.
* The inclusion, on page 235, of erroneous language regarding Appendix E – Lighting Audit and Design Tool for New Construction. Specifically, page 235 includes a paragraph discussing the use of Appendix E for determining the change in kW (ΔkW) based on different control strategies (SVG), hours of use (HOU), coincidence factors (CF) or interactive factors (IF). This language was inadvertently included on this page and does not accurately reflect the functionality of the Appendix E tool. Page 235 has been updated to reflect the removal of this paragraph.
* An error in consistency between the measure life for the ENERGY STAR LEDs [Light-Emitting Diodes] measure in Section 2.2.1 – ENERGY STAR Lighting and Appendix A – Measure Lives. The correct measure life for ENERGY STAR LEDs is that listed in Section 2.2.1, 15 years. Page 505 in Appendix A has been updated accordingly.
* The omission of ENERGY STAR Ceiling Fans from the Appliances End-Use section of Appendix A – Measure Lives. The ENERGY STAR Ceiling Fans measure was inadvertently omitted from Appendix A. Page 506 has been updated to include this measure in the Appliances End-Use section.

This Secretarial Letter, the corrected 2015 TRM and redlined versions of all affected pages are available on the Commission’s website at the aforementioned link.

 Sincerely,

Rosemary Chiavetta

Secretary

## CC: Darren Gill, Deputy Director, TUS

## Joseph Sherrick, Supervisor, TUS

## Megan Good, Analyst, TUS

## Kriss Brown, Attorney, LAW

STAR indoor fluorescent fixture, ENERGY STAR outdoor fluorescent fixture, or an ENERGY STAR ceiling fan with a fluorescent light fixture.[[1]](#footnote-1)

**Definition of Baseline Equipment**

The baseline equipment is assumed to be a socket, fixture, torchiere, or ceiling fan with a standard or specialty incandescent light bulb(s).

An adjustment to the baseline wattage for general service and specialty screw-in CFLs and LEDs is made to account for the Energy Independence and Security Act of 2007 (EISA 2007), which requires that all general service lamps and some specialty lamps between 40W and 100W meet minimum efficiency standards in terms of amount of light delivered per unit of energy consumed. The standard was phased in between January 1, 2012 and January 1, 2014. This adjustment affects any efficient lighting where the baseline condition is assumed to be a general service, standard screw-in incandescent light bulb, or specialty, screw-in incandescent lamp.

For upstream buy-down, retail (time of sale), or efficiency kit programs, baseline wattages can be determined using the tables included in this protocol below. For direct install programs where wattage of the existing bulb is known, and the existing bulb was in working condition, wattage of the existing lamp removed by the program may be used in lieu of the tables below.

**Algorithms**

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

*Total Savings =*

**ENERGY STAR CFL Bulbs (screw-in):**

**ENERGY STAR LED Bulbs (screw-in):**

**Variable Input Values**

**Baseline Wattage Values – General Service Lamps**

Baseline wattage is dependent on lumens, shape of bulb, and EISA qualifications. Commonly used EISA exempt bulbs include 3-way bulbs, globes with ≥5” diameter or ≤749 lumens, and candelabra base bulbs with ≤1049 lumens. See EISA legislation for the full list of exemptions.

For direct installation programs where the removed bulb is known, and the bulb is in working condition, EDCs may use the wattage of the replaced bulb in lieu of the tables below.[[2]](#footnote-2) For bulbs with lumens outside of the lumen bins provided, EDCs should use the manufacturer rated comparable wattage as the WattsBase. For EISA exempt bulbs, EDCs also have the option of using manufacturer rated comparable wattage as the WattsBase, rather than the tables below.

To determine the WattsBase for General Service Lamps[[3]](#footnote-3) , follow these steps:

1. Identify the rated lumen output of the energy efficient lighting product
2. Identify if the bulb is EISA exempt[[4]](#footnote-4)
3. In Table Error! No text of specified style in document.**‑1**, find the lumen range into which the lamp falls (see columns (a) and (b).
4. Find the baseline wattage (WattsBase) in column (c) or column (d). If the bulb is exempt from EISA legislation, use column (c), else, use column (d).

**Table** Error! No text of specified style in document.**‑1: Baseline Wattage by Lumen Output for General Service Lamps (GSL)[[5]](#footnote-5)**

| **Minimum Lumens**  **(a)** | **Maximum Lumens**  **(b)** | **Incandescent Equivalent**  **WattsBase  (Exempt Bulbs)**  **(c)** | **WattsBase  (Post-EISA 2007)**  **(d)** | **Wattsbase post 2020[[6]](#footnote-6)**  **(e)** |
| --- | --- | --- | --- | --- |
| 2000 | 2600 | 150 | 72 | 23 |
| 1600 | 1999 | 100 | 72 | 23 |
| 1100 | 1599 | 75 | 53 | 18 |
| 800 | 1099 | 60 | 43 | 15 |
| 450 | 799 | 40 | 29 | 9 |
| 310 | 449 | 25 | 25 | 9 |

1. * 1. **Holiday Lights**

|  |  |
| --- | --- |
| **Measure Name** | **Holiday Lights** |
| Target Sector | Residential Applications |
| Measure Unit | One 25-bulb Strand of Holiday lights |
| Unit Energy Savings | 21.2 kWh per strand |
| Unit Peak Demand Reduction | 0 kW |
| Measure Life | 10 years[[7]](#footnote-7),[[8]](#footnote-8) |
| Vintage | Replace on Burnout |

LED holiday lights reduce light strand energy consumption by up to 90%. Up to 25 strands can be connected end-to-end in terms of residential grade lights. Commercial grade lights require different power adapters and as a result, more strands can be connected end-to-end.

**Eligibility**

This protocol documents the energy savings attributed to the installation of LED holiday lights indoors and outdoors. LED lights must replace traditional incandescent holiday lights.

**Algorithms**

Algorithms yield kWh savings results *per package* (kWh/yr per package of LED holiday lights).

**Key assumptions**

* All estimated values reflect the use of residential (50ct. per strand) LED bulb holiday lighting.
* Secondary impacts for heating and cooling were not evaluated.
* It is assumed that 50% of rebated lamps are of the “mini” variety, 25% are of the C7 variety, and 25% are of the C9 variety. If the lamp type is known or fixed by program design, then the savings can be calculated as described by the algorithms above. Otherwise, the savings for the mini, C7, and C9 varieties should be weighted by 0.5, 0.25 and 0.25, respectively, as in the algorithm below.

**Central A/C (Proper Sizing)[[9]](#footnote-9)**

This algorithm is specifically intended for new units (Quality installation).

*ΔkWh/yr*  *=*

*ΔkWhpeak*  =

**Central A/C and ASHP (Maintenance)**

This algorithm is used for measures providing services to maintain, service or tune-up central A/C and ASHP units. The tune-up must include the following at a minimum:

* Check refrigerant charge level and correct as necessary
* Clean filters as needed
* Inspect and lubricate bearings
* Inspect and clean condenser and, if accessible, evaporator coil

*ΔkWh/yr*

ΔkWhcool

*ΔkWhheat(ASHP Only)*

*ΔkWpeak*

**Ground Source Heat Pumps (GSHP)**

This algorithm is used for the installation of new GSHP units. For GSHP systems over 65,000 , see commercial algorithm stated in Section **Error! Reference source not found.**.

*ΔkWh*

*COPsys*

*EERsys*

*ΔkWhcool*

*ΔkWhheat*

ΔkW =

**GSHP Desuperheater**

This algorithm is used for the installation of a desuperheater for a GSHP unit.

*= 534 kWh*

*ΔkW*

**Furnace High Efficiency Fan**

This algorithm is used for the installation of new high efficiency furnace fans.

*ΔkWhheat = HFS*

*ΔkWhcool = CFS*

*ΔkWpeak = PDFS*

**Definition of Terms**

**Table** Error! No text of specified style in document.**‑2: Residential Electric HVAC - References**

| **Component** | **Unit** | **Value** | **Sources** |
| --- | --- | --- | --- |
| *CAPYcool* , The cooling capacity of the central air conditioner or heat pump being installed[[10]](#footnote-10) | *Btu/hr* | EDC Data Gathering | AEPS Application; EDC Data Gathering |
| *CAPYheat* , The heating capacity of the central air conditioner or heat pump being installed[[11]](#footnote-11) | *Btu/hr* | EDC Data Gathering | AEPS Application; EDC Data Gathering |
| *SEERb ,* Seasonal Energy Efficiency Ratio of the Baseline Unit (split or package units) |  | Replace on Burnout: 13 SEER (Central A/C) or 14 SEER (ASHP) | 1 |
|  | Early Retirement  EDC Data Gathering  Default = 11 (Central A/C) or  12 (ASHP) | 13; EDC Data Gathering |
| *SEERe ,* Seasonal Energy Efficiency Ratio of the qualifying unit being installed[[12]](#footnote-12) |  | EDC Data Gathering | AEPS Application; EDC Data Gathering |
| *SEERm ,* Seasonal Energy Efficiency Ratio of the Unit receiving maintenance |  | EDC Data Gathering  Default= 11 (Central A/C) or 12 (ASHP) | 13; EDC Data Gathering |
| *EERb ,* Energy Efficiency Ratio of the Baseline Unit |  | Replace on Burnout: 11.3 (Central A/C) or 12 (ASHP) | 2 |
|  | Early Retirement:  EDC Data Gathering  Default= 8.69 | 14; EDC Data Gathering |
| *EERe ,* Energy Efficiency Ratio of the unit being installed[[13]](#footnote-13) |  | For Central A/C:  Or for ASHP: | 2 |

|  |  |  |  |
| --- | --- | --- | --- |
| **Component** | **Unit** | **Value** | **Sources** |
| *PSF* , Proper Sizing Factor or the assumed savings due to proper sizing and proper installation | *None* | 0.05 | 5 |
| *MFcool*, Maintenance Factor or assumed savings due to completing recommended maintenance on installed cooling equipment | *None* | 0.05 | 15 |
| *MFheat*, Maintenance Factor or assumed savings due to completing recommended maintenance on installed heating equipment | *None* | 0.05 | 15 |
| *CF* , Demand Coincidence Factor (See Section **Error! Reference source not found.**) | *Decimal* | 0.647 | 6 |
| *HSPFb ,* Heating Seasonal Performance Factor of the Baseline Unit |  | Replace on Burnout: 8.2 | 7 |
|  | Early Replacement: EDC Data Gathering  Default = 6.9 | 20 |
| *HSPFe* , Heating Seasonal Performance Factor of the unit being installed[[14]](#footnote-14) |  | EDC Data Gathering | AEPS Application; EDC’s Data Gathering |
| *HSPFm*, Heating Seasonal Performance Factor of the unit receiving maintenance |  | 6.9 | 20 |
| *COPg ,* Coefficient of Performance. This is a measure of the efficiency of a heat pump | *None* | EDC Data Gathering | AEPS Application; EDC’s Data Gathering |
| *GSHPDF* , Ground Source Heat Pump De-rate Factor | *None* | 0.885 | 19  (Engineering Estimate - See System Performance of Ground Source Heat Pumps) |
| *COPsys*, Ground Source Heat Pump effective system COP | Variable | Calculated | Calculated |
| *GSOP* , Factor to determine the HSPF of a GSHP based on its COPg | *None* | 3.412 | 8 |
| *GSPK* , Factor to convert EERg to the equivalent EER of an air conditioner to enable comparisons to the baseline unit | *None* | 0.8416 | 9 |
| *EFDSH* , Energy Factor per desuperheater | *None* | 0.17 | 10, 11 |

1. Federal Code of Regulations 10 CFR 430. <http://www1.eere.energy.gov/buildings/appliance_standards/product.aspx/productid/75>
2. Engineering calculation, HSPF/COP=3.412.
3. VEIC Estimate. Extrapolation of manufacturer data.
4. ”Residential Ground Source Heat Pumps with Integrated Domestic Hot Water Generation: Performance Results from Long-Term Monitoring”, U.S. Department of Energy, November 2012.
5. Desuperheater Study, New England Electric System, 1998 42 U.S.C.A 6295(i) (West Supp. 2011) and 10 C.F.R. 430.32 (x) (2011).
6. Northeast Energy Efficiency Partnerships, Inc., “Benefits of HVAC Contractor Training”, (February 2006): Appendix C Benefits of HVAC Contractor Training: Field Research Results 03-STAC-01.
7. 2014 Pennsylvania Residential Baseline Study. The Act 129 2014 Residential Baseline Study may be found at <http://www.puc.pa.gov/Electric/pdf/Act129/SWE-2014_PA_Statewide_Act129_Residential_Baseline_Study.pdf>
8. The same EER to SEER ratio used for SEER 13 units applied to SEER 10 units. EERm = (11.3/13) \* 10.
9. 2013 Illinois Statewide TRM (Central Air Conditioning in Wisconsin, Energy Center of Wisconsin, May 2008)
10. Scott Pigg (Energy Center of Wisconsin), “Electricity Use by New Furnaces: A Wisconsin Field Study”, Technical Report 230-1, October 2003, page 20. The average heating-mode savings of 400 kWh multiplied by the ratio of average heating degree days in PA compared to Madison, WI (5568/7172).
11. Ibid, page 34. The average cooling-mode savings of 88 kWh multiplied by the ratio of average EFLH in PA compared to Madison, WI (749/487).
12. Ibid, page 34. The average kW savings of 0.1625 multiplied by the coincidence factor from **Table** Error! No text of specified style in document.**‑2**.
13. McQuay Application Guide 31-008, Geothermal Heat Pump Design Manual, 2002.
14. Based on building energy model simulations and residential baseline characteristics determined from the 2014 Residential End-use Study and applied to an HSPF listing for 12 SEER Air Source Heat Pumps at <https://www.ahridirectory.org> on July 28th, 2014.

**Table** Error! No text of specified style in document.**‑3: Residential Electric HVAC Calculation Assumptions**

| **Component** | **Unit** | **Value** | **Sources** |
| --- | --- | --- | --- |
| *CAPYCOOL*, Capacity of air conditioning unit |  | EDC Data Gathering of  Nameplate data | EDC Data Gathering |
| Default= 32,000 | 1 |
| *CAPYHEAT*, Normal heat capacity of Electric Furnace |  | EDC Data Gathering of  Nameplate Data | EDC Data Gathering |
| Default= 32,000 | 1 |
| *SEER* , Seasonal Energy Efficiency Ratio |  | EDC Data Gathering of  Nameplate data | EDC Data Gathering |
| Default= 11.9 | 1 |
| *HSPF* , Heating Seasonal Performance Factor of heat pump |  | EDC Data Gathering of  Nameplate data | EDC Data Gathering |
| Default= 3.412 (equivalent to electric furnace COP of 1) | 2 |
| *Effduct*, Duct System Efficiency | *None* | 0.8 | 3 |
| *ESFCOOL*, Energy Saving Factor for Cooling | *None* | 0.02 | 4 |
| *ESFHEAT*, Energy Saving Factor for Heating | *None* | 0.036 | 5 |
| *EFLHCOOL*, Equivalent Full Load hour for Cooling |  | Allentown Cooling = 487 Hours  Erie Cooling = 389 Hours  Harrisburg Cooling = 551 Hours  Philadelphia Cooling = 591 Hours  Pittsburgh Cooling = 432 Hours  Scranton Cooling = 417 Hours  Williamsport Cooling = 422 Hours | 6 |
| Optional | Can use the more EDC-specific values in **Error! Reference source not found.** | Alternate EFLH **Error! Reference source not found.** |
| Optional | An EDC can estimate it’s own EFLH based on customer billing data analysis. | EDC Data Gathering |
| *EFLHHEAT*, Full Load Hours for Heating |  | Allentown Heating = 1,193 Hours  Erie Heating = 1,349 Hours  Harrisburg Heating = 1,103 Hours  Philadelphia Heating = 1,060 Hours  Pittsburgh Heating = 1,209 Hours  Scranton Heating = 1,296 Hours  Williamsport Heating = 1,251 Hours | 6 |
| Optional | An EDC can use the Alternate EFLH values in **Error! Reference source not found.** | Alternate EFLH **Error! Reference source not found.** |
| Optional | An EDC can estimate it’s own EFLH based on customer billing data analysis. | EDC Data Gathering |

* + 1. **Solar Water Heaters**

|  |  |
| --- | --- |
| **Measure Name** | **Solar Water Heaters** |
| **Target Sector** | Residential Establishments |
| **Measure Unit** | Water Heater |
| **Default Unit Energy Savings** | 1,598.8 kWh |
| **Default Unit Peak Demand Reduction** | 0.2529 kW |
| **Measure Life** | 15 years[[15]](#footnote-15) |
| **Vintage** | Retrofit |

Solar water heaters utilize solar energy to heat water, which reduces electricity required to heat water.

**Eligibility**

This protocol documents the energy savings attributed to solar water in PA. The target sector primarily consists of single-family residences.

**Algorithms**

The energy savings calculation utilizes average performance data for available residential solar and standard water heaters and typical water usage for residential homes. The energy savings are obtained through the following formula:

The energy factor used in the above equation represents an average energy factor of market available solar water heaters[[16]](#footnote-16).

The demand reduction is taken as the annual energy usage of the *baseline* water heater multiplied by the ratio of the average demand between 2PM and 6PM on summer weekdays to the total annual energy usage. Note that this is a different formulation than the demand savings calculations for other water heaters. This modification of the formula reflects the fact that a solar water heater’s capacity is subject to seasonal variation, and that during the peak summer season, the water heater is expected to fully supply all domestic hot water needs.

*ΔkWpeak  = ETDF*

ETDF (Energy to Demand Factor) is defined below:

The ratio of the average demand between 2 PM and 6 PM on summer weekdays to the total annual energy usage is taken from an electric water heater metering study performed by BG&E (pg 95 of Source 2).

**Definition of Terms**

The parameters in the above equation are listed in Table Error! No text of specified style in document.**‑4**.

**Table** Error! No text of specified style in document.**‑4: Solar Water Heater Calculation Assumptions**

|  |  |  |  |
| --- | --- | --- | --- |
| **Component** | **Unit** | **Values** | **Source** |
| *EFbase* , Energy Factor of baseline electric water heater | *Fraction* | See **Error! Reference source not found.** | 3 |
| Default= 0.904  (50 gallon) | 3 |
| *EFee* , Year-round average Energy Factor of proposed solar water heater | *Fraction* | EDC Data Gathering | EDC Data Gathering |
| Default=1.84 | 1 |
| *HW* , Hot water used per day in gallons |  | 50 | 4 |
| *Thot* , Temperature of hot water |  | 119 | 5 |
| *Tcold* , Temperature of cold water supply |  | 55 | 6 |
| Default Baseline Energy Usage for an electric water heater without a solar water heater (kWh) | Calculated | 3,338 |  |
| *ETDF* , Energy to Demand Factor (defined above) |  | 0.00008047 | 2 |

**Energy Factors Based on Tank Size**

Federal standards for Energy Factors (EF) are equal to 0.97 – (.00132 x Rated Storage in Gallons). The following table shows the baseline Energy Factors for various tank sizes:

* + 1. **Fuel Switching: Electric Resistance to Fossil Fuel Water Heater**

|  |  |
| --- | --- |
| **Measure Name** | **Fuel Switching: Electric Resistance to Fossile Fuel Water Heater** |
| **Target Sector** | Residential |
| **Measure Unit** | Water Heater |
| **Unit Energy Savings** | 3,143 kWh/yr |
| **Unit Peak Demand Reduction** | 0.2529 kW |
| **Gas, Fossil Fuel Consumption Increase** | Gas: 14.47 MMBtu  Propane: 14.47 MMBtu  Oil: 18.86 MMBtu |
| **Measure Life** | Gas:13 years[[17]](#footnote-17)  Propane: 13 years[[18]](#footnote-18)  Oil: 8 years[[19]](#footnote-19) |
| **Vintage** | Replace on Burnout |

Natural gas, propane and oil water heaters generally offer the customer lower costs compared to standard electric water heaters. Additionally, they typically see an overall energy savings when looking at the source energy of the electric unit versus the fossil fuel-fired unit. Federal standard electric water heaters have energy factors of 0.904 for a 50 gal unit and an ENERGY STAR gas and propane-fired water heater have an energy factor of 0.67 for a 40gal unit and 0.514 for an oil-fired 40 gal unit.

**Eligibility**

This protocol documents the energy savings attributed to converting from a standard electric water heater to an ENERGY STAR natural gas or propane water heater with Energy Factor of 0.67 or greater and 0.514 for oil water heater. If a customer submits a rebate for a product that has applied for ENERGY STAR Certification but has not yet been certified, the savings will be counted for that product contingent upon its eventual certification as an ENERGY STAR measure. If at any point the product is rejected by ENERGY STAR, the product is then ineligible for the program and savings will not be counted.

The target sector primarily consists of single-family residences.

**Algorithms**

The energy savings calculation utilizes average performance data for available residential standard electric and fossil fuel-fired water heaters and typical water usage for residential homes. Because there is little electric energy associated with a fossil fuel-fired water heater, the energy savings are the full energy utilization of the electric water heater. The energy savings are obtained through the following formula:

**Table** Error! No text of specified style in document.**‑5: Fuel Consumption for Fuel Switching, Domestic Hot Water Electric to Fossil Fuel**

|  |  |  |
| --- | --- | --- |
| **Fuel Type** | **Energy Factor** | **Fossil Fuel Consumption (MMBtu)** |
| Gas | 0.67 | 14.47 |
| Propane | 0.67 | 14.47 |
| Oil | 0.514 | 18.86 |

**Note:** 1 MMBtu of propane is equivalent to 10.87 gals of propane, and 1 MMBtu of oil is equivalent to 7.19 gals of oil[[20]](#footnote-20).

**Evaluation Protocols**

The most appropriate evaluation protocol for this measure is verification of installation coupled with assignment of stipulated energy savings.

**Sources**

1. Federal Standards are 0.97 -0.00132 x Rated Storage in Gallons. For a 50-gallon tank this is 0.904. “Energy Conservation Program: Energy Conservation Standards for Residential Water Heaters, Direct Heating Equipment, and Pool Heaters” US Dept of Energy Docket Number: EE–2006–BT-STD–0129, p. 30
2. Commission Order[[21]](#footnote-21) requires fuel switching to ENERGY STAR measures, not standard efficiency measures. The Energy Factor has therefore been updated to reflect the EnergyStar standard for Gas Storage Water Heaters beginning September 1, 2010. From Residential Water Heaters Key Product Criteria. <http://www.energystar.gov/index.cfm?c=water_heat.pr_crit_water_heaters> Accessed June 2013
3. Federal Standards are 0.67 -0.0019 x Rated Storage in Gallons for oil-fired storage water heater. For a 40-gallon tank this 0.514. “Energy Conservation Program: Energy Conservation Standards for Residential Water Heaters, Direct Heating Equipment, and Pool Heaters” US Dept of Energy Docket Number: EE–2006–BT-STD–0129, p. 307. “Energy Conservation Program for Consumer Products: Test Procedure for Water Heaters”, Federal Register / Vol. 63, No. 90, p. 26005-26006.
4. “Energy Conservation Program for Consumer Products: Test Procedure for Water Heaters”, Federal Register / Vol. 63, No. 90, p. 26005-26006.
5. Pennsylvania Statewide Residential End-Use and Saturation Study, 2014.
6. Mid-Atlantic TRM Version 3.0, March 2013, footnote #314
7. Straub, Mary and Switzer, Sheldon. "Using Available Information for Efficient Evaluation of Demand Side Management Programs". Study by BG&E. The Electricity Journal. Aug/Sept, 2011. http://www.sciencedirect.com/science/article/pii/S1040619011001941
   * 1. **Fuel Switching: Heat Pump Water Heater to Fossil Fuel Water Heater**

|  |  |
| --- | --- |
| **Measure Name** | **Fuel Switching: Heat Pump Water Heater to Fossil Fuel Heater** |
| Target Sector | Residential |
| Measure Unit | Water Heater |
| Unit Energy Savings | 1,632.9 kWh (for EF = 2.0) |
| Unit Peak Demand Reduction | 0.1314 kW |
| Gas, Fossil Fuel Consumption Increase | Gas: 14.47 MMBtu  Propane: 14.47 MMBtu  Oil: 18.86 MMBtu |
| Measure Life | Gas:13 years[[22]](#footnote-22)  Propane: 13 years[[23]](#footnote-23)  Oil: 8 years[[24]](#footnote-24) |
| Vintage | Replace on Burnout |

Natural gas, propane and oil water heaters reduce electric energy and demand compared to heat pump water heaters. Standard heat pump water heaters have energy factors of 2.0 and ENERGY STAR gas and propane water heaters have an energy factor of 0.67 for a 40 gal unit and 0.514 for an oil-fired 40 gal unit.

**Eligibility**

This protocol documents the energy savings attributed to converting from a standard heat pump water heater with Energy Factor of 2.0 or greater to an ENERGY STAR natural gas or propane water heater with Energy Factor of 0.67 or greater and 0.514 for an oil water heater. If a customer submits a rebate for a product that has applied for ENERGY STAR Certification but has not yet been certified, the savings will be counted for that product contingent upon its eventual certification as an ENERGY STAR measure. If at any point the product is rejected by ENERGY STAR, the product is then ineligible for the program and savings will not be counted.

The target sector primarily consists of single-family residences.

**Algorithms**

The energy savings calculation utilizes average performance data for available residential standard heat pump water heaters and fossil fuel-fired water heaters and typical water usage for residential homes. Because there is little electric energy associated with a fossil fuel-fired water heater, the energy savings are the full energy utilization of the heat pump water heater. The energy savings are obtained through the following formula:

**Table** Error! No text of specified style in document.**‑6: Gas, Oil, Propane Consumption for Heat Pump Water Heater to Fossil Fuel Water Heater**

|  |  |  |
| --- | --- | --- |
| **Fuel Type** | **Energy Factor** | **Gas Consumption (MMBtu)** |
| Gas | 0.67 | 14.47 |
| Propane | 0.67 | 14.47 |
| OIl | 0.514 | 18.86 |

**Evaluation Protocols**

The most appropriate evaluation protocol for this measure is verification of installation coupled with assignment of stipulated energy savings.

**Sources**

1. Heat pump water heater efficiencies have not been set in a Federal Standard. However, the Federal Standard for water heaters does refer to a baseline efficiency for heat pump water heaters as EF = 2.0 “Energy Conservation Program: Energy Conservation Standards for Residential Water Heaters, Direct Heating Equipment, and Pool Heaters” US Dept of Energy Docket Number: EE–2006–BT-STD–0129.
2. Commission Order[[25]](#footnote-25) requires fuel switching to ENERGY STAR measures, not standard efficiency measures. The Energy Factor has therefore been updated to reflect the EnergyStar standard for Gas Storage Water Heaters beginning September 1, 2010. From Residential Water Heaters Key Product Criteria. <http://www.energystar.gov/index.cfm?c=water_heat.pr_crit_water_heaters> Accessed June 2013 Federal Standards are 0.67 -0.0019 x Rated Storage in Gallons. Federal Standards are 0.67 -0.0019 x Rated Storage in Gallons. For a 40-gallon tank this is 0.594. “Energy Conservation Program: Energy Conservation Standards for Residential Water Heaters, Direct Heating Equipment, and Pool Heaters” US Dept of Energy Docket Number: EE–2006–BT-STD–0129**,** p. 30
3. Federal Standards are 0.67 -0.0019 x Rated Storage in Gallons for oil-fired storage water heater. For a 40-gallon tank this 0.514. “Energy Conservation Program: Energy Conservation Standards for Residential Water Heaters, Direct Heating Equipment, and Pool Heaters” US Dept of Energy Docket Number: EE–2006–BT-STD–0129, p. 307. “Energy Conservation Program for Consumer Products: Test Procedure for Water Heaters”, Federal Register / Vol. 63, No. 90, p. 26005-26006.
4. “Energy Conservation Program for Consumer Products: Test Procedure for Water Heaters”, Federal Register/ Vol. 63, No. 90, p. 26005-26006.
5. Pennsylvania Statewide Residential End-Use and Saturation Study, 2014.
6. Mid-Atlantic TRM Version 3.0, March 2013, footnote #314
7. NEEA Heat Pump Water Heater Field Study Report. Prepared by Fluid Market Strategies, 2013. <http://neea.org/docs/default-source/reports/heat-pump-water-heater-field-study-report.pdf?sfvrsn=5> (Note: when this source discusses “ducted” vs “non-ducted” systems it refers to the water heater’s heat pump exhaust, not to the HVAC ducts.)
   * 1. **Water Heater Pipe Insulation**

|  |  |
| --- | --- |
| **Measure Name** | **Electric Water Heater Pipe Insulation** |
| **Target Sector** | Residential Establishments |
| **Measure Unit** | Water Heater |
| **Unit Energy Savings** | 9.43 kWh per foot of installed insulation |
| **Unit Peak Demand Reduction** | 0.000759 kW per foot of installed insulation |
| **Measure Life** | 13 years[[26]](#footnote-26) |
| **Vintage** | Retrofit |

This measure relates to the installation of foam insulation on 10 feet of exposed pipe in unconditioned space, ¾” thick. The baseline for this measure is a standard efficiency electric water heater (EF=0.904) with an annual energy usage of 3143 kWh.[[27]](#footnote-27)

**Eligibility**

This protocol documents the energy savings for an electric water heater attributable to insulating 10 feet of exposed pipe in unconditioned space, ¾” thick. The target sector primarily consists of residential establishments.

**Algorithms**

The annual energy savings are assumed to be 3% of the annual energy use of an electric water heater (3143 kWh), or 94.29 kWh based on 10 feet of insulation. This estimate is based on a recent report prepared by the ACEEE for the State of Pennsylvania (Source 1). On a per foot basis, this is equivalent to 9.43 kWh.

*ΔkWh/yr = 9.43 kWh/yr per foot of installed insulation*

The summer coincident peak kW savings are calculated as follows:

*ΔkWpeak =*

**Definition of Terms**

| **Term** | **Unit** | **Value** | **Source** |
| --- | --- | --- | --- |
| *ΔkWh/yr* , annual energy savings per foot of installed pipe insulation |  | 9.43 | 1 |
| *ETDF*, Energy to Demand Factor |  | 0.00008047 | 2 |

|  |  |  |  |
| --- | --- | --- | --- |
| **Term** | **Unit** | **Value** | **Source** |
| *ΔkWpeak*, Summer peak kW savings per foot of installed pipe insulation |  | 0.000759 |  |

The demand reduction is taken as the annual energy savings multiplied by the ratio of the average energy usage during 2 PM to 6 PM on summer weekdays to the total annual energy usage. The Energy to Demand Factor is defined as:

The ratio of the average energy usage between 2 PM to 6 PM on summer weekdays to the total annual energy usage is taken from an electric water heater metering study performed by BG&E (pg 95 of Source 2).

**Evaluation Protocols**

The most appropriate evaluation protocol for this measure is verification of installation coupled with assignment of stipulated energy savings.

**Sources**

1. American Council for an Energy-Efficient Economy, Summit Blue Consulting, Vermont Energy Investment Corporation, ICF International, and Synapse Energy Economics, Potential for Energy Efficiency, Demand Response, and Onsite Solar Energy in Pennsylvania, Report Number E093, April 2009, p. 117.
2. Straub, Mary and Switzer, Sheldon. "Using Available Information for Efficient Evaluation of Demand Side Management Programs". Study by BG&E. The Electricity Journal. Aug/Sept. 2011.

|  |  |  |
| --- | --- | --- |
| **Refrigerator Category** | **Federal Standard Maximum Usage in kWh/yr** | **ENERGY STAR Maximum Energy Usage in kWh/yr** |
| 7. Refrigerator-freezers—automatic defrost with side-mounted freezer with through-the-door ice service. | 8.54AV + 432.8 | 7.69 \* AV + 397.9 |
| 7-BI. Built-In Refrigerator-freezers—automatic defrost with side-mounted freezer with through-the-door ice service. | 10.25AV + 502.6 | 9.23 \* AV + 460.7 |
| **Compact Size Models: Less than 7.75 cubic feet and 36 inches or less in height** | | |
| 11. Compact refrigerator-freezers and refrigerators other than all-refrigerators with manual defrost. | 9.03AV + 252.3 | 8.13 \* AV + 227.1 |
| 11A.Compact all-refrigerators—manual defrost. | 7.84AV + 219.1 | 7.06 \* AV + 197.2 |
| 12. Compact refrigerator-freezers—partial automatic defrost | 5.91AV + 335.8 | 5.32 \* AV + 302.2 |
| 13. Compact refrigerator-freezers—automatic defrost with top-mounted freezer. | 11.80AV + 339.2 | 10.62 \* AV + 305.3 |
| 13I. Compact refrigerator-freezers—automatic defrost with top-mounted freezer with an automatic icemaker. | 11.80AV + 423.2 | 10.62 \* AV + 389.3 |
| 13A. Compact all-refrigerators—automatic defrost. | 9.17AV + 259.3 | 8.25 \* AV + 233.4 |
| 14. Compact refrigerator-freezers—automatic defrost with side-mounted freezer. | 6.82AV + 456.9 | 6.14 \* AV + 411.2 |
| 14I. Compact refrigerator-freezers—automatic defrost with side-mounted freezer with an automatic icemaker. | 6.82AV + 540.9 | 6.14 \* AV + 495.2 |
| 15. Compact refrigerator-freezers—automatic defrost with bottom-mounted freezer. | 11.80AV + 339.2 | 10.62 \* AV + 305.3 |
| 15I. Compact refrigerator-freezers—automatic defrost with bottom-mounted freezer with an automatic icemaker. | 11.80AV + 423.2 | 10.62 \* AV + 389.3 |

The default values for each configuration are given in

Table Error! No text of specified style in document.**‑7**.

**Table** Error! No text of specified style in document.**‑7: Default Savings Values for ENERGY STAR Refrigerators[[28]](#footnote-28)**

| **Refrigerator Category** | **Assumed Volume of Unit (cubic feet)[[29]](#footnote-29)** | **Conventional Unit Energy Usage in kWh/yr** | **ENERGY STAR Energy Usage in kWh/yr** | **ΔkWh/yr** | **ΔkWpeak** |
| --- | --- | --- | --- | --- | --- |
| 1A. All-refrigerators—manual defrost. | 12.2 | 276 | 249 | 28 | 0.0031 |
| 2. Refrigerator-freezers—partial automatic defrost | 12.2 | 322 | 290 | 32 | 0.0036 |

**Table** Error! No text of specified style in document.**‑8: Calculation Assumptions and Definitions for Refrigerator and Freezer Recycling**

|  |  |  |  |
| --- | --- | --- | --- |
| **Component** | **Unit** | **Values** | **Source** |
| *EXISTING\_UEC ,* The average annual unit energy consumption of participating refrigerators and freezers for Program year 5. **Error! Reference source not found.** and **Error! Reference source not found.** below provide the equation inputs needed to calculate the UEC for removed refrigerators and freezers respectively as well as the calculation of the default Unit Energy Consumption value for refrigerators or freezers for each EDC. | *kWh/yr* | EDC Data Gathering  Or Default = **Error! Reference source not found.** and **Error! Reference source not found.** | 1, 2 |
| *PART\_USE ,* The portion of the year the average refrigerator or freezer would likely have operated if not recycled through the program | *%* | EDC Data Gathering According to Section 4.3 of UMP Protocol  Default:  Refrigerator= 96.9%  Freezer= 98.5% | 7 |
| *N* , The number of refrigerators recycled through the program | *None* | EDC Data Gathering |  |
| *NET\_FR\_SMI\_kWh* , Average per-unit energy savings net of naturally occurring removal from grid and secondary market impacts | *kWh/yr* | EDC Data Gathering according to section 5.1 of UMP Protocol (Discussion Below) | 1 |
| *INDUCED\_kWh* , Average per-unit energy consumption caused by the program inducing participants to acquire refrigerators they would not have independent of program participation | *kWh/yr* | EDC Data Gathering according to section 5.2 of UMP Protocol (Discussion Below) | 1 |
| *ETDF* , Energy to Demand Factor |  | 0.0001119 | 8 |

**UEC Equations and Default Values**

For removed refrigerators, the annual Unit Energy Consumption (UEC) is based upon regression analyses of data from refrigerators metered and recycled through five utilities. The UEC for removed refrigerators was calculated specifically for each utility using data collected from each utility’s Program Year Five (PY5) Appliance Removal programs. Therefore, each UEC represents the average ages, sizes, etc of the fleet of refrigerators removed in Program Year Five.

Source for refrigerator UEC equation: *US DOE Uniform Method Project, Savings Protocol for Refrigerator Retirement, April 2013.*

| **Refrigerator UEC (Unit Energy Consumption) Equation** |
| --- |

* + 1. **Fuel Switching: Electric Clothes Dryer to Gas Clothes Dryer**

|  |  |
| --- | --- |
| **Measure Name** | **Fuel Switch: Electric Clothes Dryer to Gas Clothes Dryer** |
| Target Sector | Residential Establishments |
| Measure Unit | Fuel Switch: Electric Clothes Dryer to Gas Clothes Dryer |
| Unit Energy Savings | 875 kWh  -2.99 MMBtu (increase in gas consumption) |
| Unit Peak Demand Reduction | 0.149 kW |
| Measure Life | 14 years[[30]](#footnote-30) |

This protocol outlines the savings associated to purchasing a gas clothes dryers to replace an electric dryer. The measure characterization and savings estimates are based on average usage per person and average number of people per household. Therefore, this is a deemed measure with identical savings applied to all installation instances, applicable across all housing types.

**Eligibility**

This measure is targeted to residential customers that purchase a gas clothes dryer rather than an electric dryer.

**Algorithms**

|  |  |
| --- | --- |
|  |  |
|  | = |
|  |  |

**Definition of Terms**

**Table** Error! No text of specified style in document.**‑9 Electric Clothes Dryer to Gas Clothes Dryer – Values and Resources**

| **Term** | **Unit** | **Values** | **Source** |
| --- | --- | --- | --- |
| , Annual electricity savings, deemed |  | EDC Data Gathering  Default = 875 | Calculated |
| , Baseline annual electricity consumption of electric dryer, deemed |  | EDC Data Gathering  Default = 905 | 1 |
| , Annual electricity consumption of gas dryer, deemed |  | EDC Data Gathering  Default = 30 | 2 |

|  |  |  |  |
| --- | --- | --- | --- |
| **Term** | **Unit** | **Values** | **Source** |
| , Weighted average gas fuel increase | MMBtu | EDC Data Gathering  Default = -2.99 | Calculated, 3 |
| 0.003412, Conversion factor |  | EDC Data Gathering  Default = 0.003412 | None |
| , Number of washing machine cycles per year | cycles/yr | 260 | 4 |
| , Percentage of homes with a dryer that use the dryer every time clothes are washed | % | 95% | 5 |
| , Duration of average drying cycle in hours | hours | EDC Data Gathering  Default= 1 | Assumption |
| CF, Coincidence Factor | *Fraction* | EDC Data Gathering  Default = 0.042 | 6 |

**Default Savings**

Savings estimates for this measure are fully deemed and may be claimed using the algorithms above and the deemed variable inputs.

**Evaluation Protocols**

The appropriate evaluation protocol is to verify installation and proper selection of deemed values.

**Sources**

1. Average annual dryer kWh without moisture sensor per 2014 PA TRM protocol 2.2 *Electric Clothes Dryer with Moisture Sensor*.
2. 2011-04 Technical Support Document: Energy Efficiency Program for Consumer Products and Commercial and Industrial Equipment. Residential Clothes Dryers and Room Air Conditioners, Chapter 7. Median annual electricity consumption of gas dryers from Table 7.3.4: Electric Standard and Gas Clothes Dryer: Average Annual Energy Consumption Levels by Efficiency http://www.regulations.gov/#!documentDetail;D=EERE-2007-BT-STD-0010-0053
3. Negative gas fuel savings indicate increase in fuel consumption. It is assumed that gas and electric dryers have similar efficiencies. All heated air passes through the clothes and contributes to drying.
4. Statewide average for all housing types from Pennsylvania Statewide Residential End-Use and Saturation Study, 2014.
5. 2011-04 Technical Support Document: Energy Efficiency Program for Consumer Products and Commercial and Industrial Equipment. Residential Clothes Dryers and Room Air Conditioners, Chapter 7. Clothes Dryer Frequency from Table 7.3.3 for Electric Standard. http://www.regulations.gov/contentStreamer?objectId=0900006480c8ee11&disposition=attachment&contentType=pdf
   * 1. **ENERGY STAR Dehumidifiers**

|  |  |
| --- | --- |
| **Measure Name** | **Dehumidifiers** |
| **Target Sector** | Residential Establishments |
| **Measure Unit** | Dehumidifier |
| **Unit Energy Savings** | Varies based on capacity |
| **Unit Peak Demand Reduction** | Varies based on capacity |
| **Measure Life** | 12 years[[31]](#footnote-31) |
| **Vintage** | Replace on Burnout |

ENERGY STAR qualified dehumidifiers are 15 percent more efficient than non-qualified models due to more efficient refrigeration coils, compressors and fans.

**Eligibility**

This protocol documents the energy and demand savings attributed to purchasing an ENERGY STAR dehumidifier instead of a standard one. Dehumidifiers must meet ENERGY STAR Version 3.0 Product Specifications to qualify. The target sector is residential.

**Algorithms**

The general form of the equation for the ENERGY STAR Dehumidifier measure savings algorithm is:

*Total Savings*

To determine resource savings, the per-unit estimates in the algorithms will be multiplied by the number of dehumidifiers. The number of dehumidifiers will be determined using market assessments and market tracking.

Per unit energy and demand savings algorithms:

* + 1. **ENERGY STAR Water Coolers**

|  |  |
| --- | --- |
| **Measure Name** | **ENERGY STAR Water Coolers** |
| **Target Sector** | Residential Establishments |
| **Measure Unit** | Water Cooler |
| **Unit Energy Savings** | Cold Only: 47.5 kWh  Hot & Cold Storage: 481.8 kWh  Hot & Cold On-Demand: 733.65 kWh |
| **Unit Peak Demand Reduction** | Cold Only: 0.00532 kW  Hot & Cold Storage: 0.0539 kW  Hot & Cold On-Demand: 0.0821 kW |
| **Measure Life** | 10 years[[32]](#footnote-32) |
| **Vintage** | Replace on Burnout |

This protocol estimates savings for installing ENERGY STAR Water Coolers compared to standard efficiency equipment in residential applications. The measurement of energy and demand savings is based on a deemed savings value multiplied by the quantity of the measure.

**Eligibility**

In order for this measure protocol to apply, the high-efficiency equipment must meet the ENERGY STAR 2.0 efficiency criteria: Cold Only or Cook & Cold Units ≤0.16 kWh /day, Hot & Cold Storage Units ≤0.87 kWh/day, and Hot & Cold On-Demand ≤0.18 kWh/day.

**Algorithms**

The general form of the equation for the ENERGY STAR Water Coolers measure savings algorithms is:

*Total Savings =*

To determine resource savings, the per unit estimates in the algorithms will be multiplied by the number of water coolers. Per unit savings are primarily derived from the May 2012 release of the ENERGY STAR calculator for water coolers.

Per unit energy and demand savings algorithms:

|  |  |  |  |
| --- | --- | --- | --- |
| **Term** | **Unit** | **Value** | **Source** |
|  |  | Heat Pump = 16.2 |  |
| Nameplate | EDC Gathering |
| *GSER* , Factor to determine the SEER of a GSHP based on its EER | *None* | 1.02 | 6 |
| *COPGSHP* , Coefficient of Performance for existing home ground source heat pump | *None* | Default for Ground Source Heat Pump = 3.1  Default for Groundwater Source Heat Pump = 3.6 | 5 |
| Nameplate | EDC Gathering |
| *GSOP* , Factor to determine the HSPF of a GSHP based on its COP |  | 3.412 | 7 |
| *GSHPDF* , Ground Source Heat Pump De-rate Factor | *None* | 0.885 | (Engineering Estimate - See **Error! Reference source not found.**) |
| *CFCAC* , Demand Coincidence Factor for central AC systems | *Fraction* | 0.647 | 8 |
| *CFRAC*, Demand Coincidence Factor for Room AC systems | *Fraction* | 0.647 | 9 |
| *CFASHP*, Demand Coincidence Factor for ASHP systems | *Fraction* | 0.647 | 8 |
| *CFGSHP*, Demand Coincidence Factor for GSHP systems | *Fraction* | 0.647 | 8 |
| *FRoom,AC*, Adjustment factor to relate insulated area to area served by Room AC units | *None* | 0.38 | Calculated[[33]](#footnote-33) |
| *CDD* , Cooling Degree Days |  | **Error! Reference source not found.** | 10 |
| *HDD* , Heating Degree Days |  | **Error! Reference source not found.** | 10 |
| *EFLHcool*, Equivalent Full Load Cooling hours for Room AC |  | **Error! Reference source not found.** | 11 |
| *EFLHcool RAC*, Equivalent Full Load Cooling hours for Central AC and ASHP |  | **Error! Reference source not found.** | 12 |

1. NOAA Climatic Data for Pennsylvania cities- Cloudiness (mean number of days Sunny, Partly Cloudy, and Cloudy), <http://ols.nndc.noaa.gov/plolstore/plsql/olstore.prodspecific?prodnum=C00095-PUB-A0001>.
2. US DOE Federal Standards for Central Air Conditioners and Heat Pumps. <http://www1.eere.energy.gov/buildings/appliance_standards/product.aspx/productid/75>
3. Minimum efficiency standards for Ground and Groundwater Source Heat Pumps. IECC 2009.
4. VEIC estimate. Extrapolation of manufacturer data.
5. Engineering calculation, HSPF/COP=3.412
6. Straub, Mary and Switzer, Sheldon. "Using Available Information for Efficient Evaluation of Demand Side Management Programs". Study by BG&E. The Electricity Journal. Aug/Sept. 2011. <http://www.sciencedirect.com/science/article/pii/S1040619011001941>
7. Consistent with CFs found in RLW Report: Final Report Coincidence Factor Study Residential Room Air Conditioners, June 23, 2008.[[34]](#footnote-34)
8. Climatography of the United States No. 81. Monthly Station Normals of Temperature, Precipitation, and Heating and Cooling Degree Days 1971-2000, 36 Pennsylvania. NOAA. <http://cdo.ncdc.noaa.gov/climatenormals/clim81/PAnorm.pdf>
9. Based on REM/Rate modeling using models from the PA 2012 Potential Study. EFLH calculated from kWh consumption for cooling and heating. Models assume 50% over-sizing of air conditioners and 40% oversizing of heat pumps.[[35]](#footnote-35)
10. 2014 PA TRM Section 2.2.4 Room AC Retirement.
    1. Lighting that is integral to:

Equipment or instrumentation and installed by its manufacturer,

Refrigerator and freezer cases (both open and glass-enclosed),

Equipment used for food warming and food preparation,

Medical equipment, or

Advertising or directional signage

1. Lighting specifically designed only for use during medical procedures
2. Lighting used for plant growth or maintenance
3. Lighting used in spaces designed specifically for occupants with special lighting needs
4. Lighting in retail display windows that are enclosed by ceiling height partitions.

Appendix E was developed to automate the calculation of energy and demand impacts for New Construction lighting projects, based on a series of entries by the user defining key characteristics of the retrofit project. The main sheet, “Interior Lighting Form”, is a detailed line-by-line inventory incorporating variables required to calculate savings. Each line item represents a specific area with installed fixtures, controls strategy, space cooling, and space usage.

Installed fixture wattages are determined by selecting the appropriate fixture code from the “06 Wattage Table” sheet. The “08 Fixture Code Locator” sheet can be used to find the appropriate code for a particular lamp-ballast combination[[36]](#footnote-36). Actual wattages of fixtures determined by manufacturer’s equipment specification sheets or other independent sources may not be used unless (1) the manufacturer's cut sheet indicates that the difference in delta-watts of fixture wattages (i.e. difference in delta watts of baseline and “actual” installed efficient fixture wattage and delta watts of baseline and nearest matching efficient fixture in standard wattage table of Appendix E is more than 10%[[37]](#footnote-37) or (2) the corresponding fixture code is not listed in the Standard Wattage Table. In these cases, alternate wattages for lamp-ballast combinations can be inputted using the “02 Interior User Input” or the “04 Exterior User Input” sheets of Appendix E: Lighting Audit and Design Tool for C&I New Construction Projects. Documentation supporting the alternate wattages must be provided in the form of manufacturer provided specification sheets or other industry accepted sources (e.g. ENERGY STAR listing, Design Lights Consortium listing). It must cite test data performed under standard ANSI procedures. These exceptions will be used as the basis for periodically updating the Standard Wattage Table to better reflect market conditions and more accurately represent savings.

Some lighting contractors may have developed in-house lighting inventory forms that are used to determine preliminary estimates of projects. In order to ensure standardization of all New

**Definition of Terms**

**Table** Error! No text of specified style in document.**‑10: DHP – Values and References**

| **Term** | **Unit** | **Values** | **Source** |
| --- | --- | --- | --- |
| , The cooling capacity of the indoor unit, given in as appropriate for the calculation. This protocol is limited to units < 65,000 (5.4 tons)  , The heating capacity of the indoor unit, given in as appropriate for the calculation. |  | Nameplate | EDC Data Gathering |
| , Equivalent Full Load Hours for cooling , Equivalent Full Load Hours for heating |  | Based on Logging, BMS data or Modeling[[38]](#footnote-38) | EDC Data Gathering  1 |
| Default: See **Error! Reference source not found.** and **Error! Reference source not found.** |
| , Heating Seasonal Performance Factor, heating efficiency of the installed DHP |  | Standard DHP: 7.7  Electric resistance: 3.412  ASHP: 7.7  PTHP[[39]](#footnote-39) (Replacements): 2.9 - (0.026 x Cap / 1000) COP  PTHP (New Construction): 3.2 - (0.026 x Cap / 1000) COP  Electric furnace: 3.241  For new space, no heat in an existing space, or non-electric heating in an existing space: use standard DHP: 7.7 | 2, 4,7 |
| , Seasonal Energy Efficiency Ratio cooling efficiency of baseline unit |  | DHP, ASHP, or central AC: 13  Room AC: 11.3  PTAC[[40]](#footnote-40) (Replacements): 10.9 - (0.213 x Cap / 1000) EER  PTAC (New Construction): 12.5 - (0.213 x Cap / 1000) EER  PTHP (Replacements): 10.8 - (0.213 x Cap / | 3,4,5,6,7 |

|  |  |  |  |
| --- | --- | --- | --- |
| **Term** | **Unit** | **Values** | **Source** |
|  |  | 1000) EER  PTHP (New Construction): 12.3 - (0.213 x Cap / 1000) EER  For new space or no cooling in an existing space: use Central AC: 13 |  |
| , Heating Seasonal Performance Factor, heating efficiency of the installed DHP |  | Based on nameplate information. Should be at least ENERGY STAR. | EDC Data Gathering |
| , Seasonal Energy Efficiency Ratio cooling efficiency of the installed DHP |  | Based on nameplate information. Should be at least ENERGY STAR. | EDC Data Gathering |
| , Demand Coincidence Factor | *Decimal* | See **Error! Reference source not found.** | 1 |

**Default Savings**

There are no default savings for this measure.

**Evaluation Protocols**

For most projects, the appropriate evaluation protocol is to verify installation and proper selection of default values. For projects using customer specific data for open variables, the appropriate evaluation protocol is to verify installation and proper application of TRM protocol along with verification of open variables. The Pennsylvania Phase II Evaluation Framework provides specific guidelines and requirements for evaluation procedures.

**Sources**

1. Based on Nexant’s eQuest modeling analysis 2014.
2. COP = HSPF/3.412. HSPF = 3.412 for electric resistance heating, HSPF = 7.7 for standard DHP. Electric furnace COP typically varies from 0.95 to 1.00 and thereby assumed a COP 0.95 (HSPF = 3.241).
3. Federal Register, Vol. 66, No. 14, Monday, January 22, 2001/Rules and Regulations, p. 7170-7200.
4. Air-Conditioning, Heating, and Refrigeration Institute (AHRI); the directory of the available ductless mini-split heat pumps and corresponding efficiencies (lowest efficiency currently available). Accessed 8/16/2010. <https://www.ahridirectory.org/ahridirectory/pages/home.aspx>
5. ENERGY STAR and Federal Appliance Standard minimum EERs for a 10,000 Btu/hr unit with louvered sides. <http://www.energystar.gov/index.cfm?c=roomac.pr_crit_room_ac>

Average EER for SEER 13 units as calculated by EER = -0.02 × SEER² + 1.12 × SEER based on U.S. DOE Building America House Simulation Protocol, Revised 2010. <http://www.nrel.gov/docs/fy11osti/49246.pdf>

**Table** Error! No text of specified style in document.**‑11: Default Motor Wattage (WATTSbase and WATTSee) for Circulating Fan**

|  |  |  |  |
| --- | --- | --- | --- |
| **Motor Type** | **Motor Category** | | |
| **1/40 HP (16-23 watts) (Using 19.5 watt as industry average)** | **1/20 HP (~37 watts)** | **1/15 HP (~49 watts)** |
| Motor Output Watts | 19.5 | 37 | 49 |
| SP | 93 | 142 | 191 |
| PSC | 48 | 90 | 120 |
| ECM | 30 | 56 | 75 |

**Default Savings**

Default savings may be claimed using the algorithms above and the variable defaults. EDCs may also claim savings using customer specific data.

**Evaluation Protocols**

For most projects, the appropriate evaluation protocol is to verify installation and proper selection of default values. For projects using customer specific data for open variables, the appropriate evaluation protocol is to verify installation and proper application of TRM protocol along with verification of open variables. The Pennsylvania Phase II Evaluation Framework provides specific guidelines and requirements for evaluation procedures.

**Sources**

1. Regional Technical Forum (RTF) as part of the Northwest Power & Conservation Council, Deemed Measures List. Grocery Display Case ECM, FY2010, V2. <http://rtf.nwcouncil.org/measures/measure.asp?id=107&decisionid=230>
2. Regional Technical Forum (RTF) as part of the Northwest Power & Conservation Council, Deemed Measures List. Deemed MeasuresV26 \_walkinevapfan.
3. AO Smith New Product Notification. I-motor 9 & 16 Watt. Stock Numbers 9207F2 and 9208F2. Web address: <http://www.electricmotorwarehouse.com/PDF/Bulletin%206029B.pdf>
4. PSC of Wisconsin, Focus on Energy Evaluation, Business Programs: Deemed Savings Manual V1.0, p. 4-103 to 4-106. <https://focusonenergy.com/sites/default/files/bpdeemedsavingsmanuav10_evaluationreport.pdf>
5. Assuming that the waste heat is within the conditioned air stream, then the energy associated with removing the waste heat during peak times is approximated as the inverse of the COP, or 3.412/EER = 0.30 if one uses 11.3 as a default value for cooling system EER.
6. This is an approximation that accounts for the coincidence between cooling and fan operation and corrects with a factor of 11.3/13 to account for seasonal cooling efficiency rather than peak cooling efficiency.
7. Nexant eQuest modeling analysis 2014.

**Ceiling/Wall Insulation**

|  |  |
| --- | --- |
|  |  |
|  |  |
|  |  |
|  |  |

Definition of Terms

Table Error! No text of specified style in document.‑12: Non-Residential Insulation – Values and References

| **Term** | **Unit** | **Values** | **Source** |
| --- | --- | --- | --- |
| , Area of the ceiling/attic insulation that was installed |  | EDC Data Gathering | EDC Data Gathering |
| , Area of the wall insulation that was installed |  | EDC Data Gathering | EDC Data Gathering |
| , Heating degree days with 65 degree base |  | Allentown = 5318  Erie = 6353  Harrisburg = 4997  Philadelphia = 4709  Pittsburgh = 5429  Scranton = 6176  Williamsport = 5651 | 1 |
| , Cooling degree days with a 65 degree base |  | Allentown = 787  Erie = 620  Harrisburg = 955  Philadelphia = 1235  Pittsburgh = 726  Scranton = 611  Williamsport = 709 | 1 |
| , Hours per day |  | 24 | Conversion Factor |
| , Watts per kilowatt |  | 1000 | Conversion Factor |
| Btu per kWh |  | 3,412 | Conversion Factor |
| , the R-value of the ceiling insulation and support structure before the additional insulation is installed |  | For new construction buildings and when variable is unknown for existing buildings: See **Error! Reference source not found.** and **Error! Reference source not found.** for values by building type | EDC Data Gathering; 2, 4 |

**Appendices**

**Appendix A: Measure Lives**

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

**August 2014**

\*For the purpose of calculating the total Resource Cost Test for Act 129, measure cannot claim savings for more than fifteen years.

| **Measure** | **Measure Life** |
| --- | --- |
| **RESIDENTIAL SECTOR** | |
| ***Lighting End-Use*** |  |
| Electroluminescent Nightlight | 8 |
| LED Nightlight | 8 |
| Compact Fluorescent Light Bulb | 5.2 |
| Recessed Can Fluorescent Fixture | 20\* |
| Torchieres | 10 |
| Fixtures Other | 20\* |
| ENERGY STAR LEDs | 15 |
| Residential Occupancy Sensors | 10 |
| Holiday Lights | 10 |
|  |  |
| ***HVAC End-Use*** |  |
| Central Air Conditioner (CAC) | 14 |
| Air Source Heat Pump | 12 |
| Central Air Conditioner proper sizing/install | 14 |
| Central Air Conditioner Quality Installation Verification | 14 |
| Central Air Conditioner Maintenance | 7 |
| Central Air Conditioner duct sealing | 20 |
| ENERGY STAR Room Air Conditioners | 9 |
| Air Source Heat Pump proper sizing/install | 12 |
| ENERGY STAR Thermostat (Central Air Conditioner) | 15 |
| ENERGY STAR Thermostat (Heat Pump) | 15 |
| Ground Source Heat Pump | 30\* |
| Room Air Conditioner Retirement | 4 |
| Furnace Whistle | 14 |
| Programmable Thermostat | 11 |
| Room AC (RAC) Retirement | 4 |
| Residential Whole House Fans | 15 |
| Ductless Mini-Split Heat Pumps | 15 |
| Fuel Switching: Electric Heat to Gas Heat | 20\* |
| Efficient Ventilation Fans with Timer | 10 |

|  |  |
| --- | --- |
| New Construction (NC): Single Family - gas heat with CAC | 20\* |
| NC: Single Family - oil heat with CAC | 20\* |
| NC: Single Family - all electric | 20\* |
| NC: Multiple Single Family (Townhouse) – oil heat with CAC | 20\* |
| NC: Multiple Single Family (Townhouse) - all electric | 20\* |
| NC: Multi-Family – gas heat with CAC | 20\* |
| NC: Multi-Family - oil heat with CAC | 20\* |
| NC: Multi-Family - all electric | 20\* |
|  |  |
| ***Hot Water End-Use*** |  |
| Efficient Electric Water Heaters | 14 |
| Heat Pump Water Heaters | 14 |
| Low Flow Faucet Aerators | 12 |
| Low Flow Showerheads | 9 |
| Solar Water Heaters | 15 |
| Electric Water Heater Pipe Insulation | 13 |
| Fuel Switching: Domestic Hot Water Electric to Gas or Propane Water Heater | 13 |
| Fuel Switching: Domestic Hot Water Electric to Oil Water Heater | 8 |
| Fuel Switching: Heat Pump Water Heater to Gas or Propane Water Heater | 13 |
| Fuel Switching: Heat Pump Water Heater to Oil Water Heater | 8 |
| Water Heater Tank Wrap | 7 |
|  |  |
| ***Appliances End-Use*** |  |
| ENERGY STAR Clothes Dryer | 13 |
| Refrigerator / Freezer Recycling without replacement | 8 |
| Refrigerator / Freezer Recycling with replacement | 7 |
| ENERGY STAR Refrigerators | 12 |
| ENERGY STAR Freezers | 12 |
| ENERGY STAR Clothes Washers | 11 |
| ENERGY STAR Dishwashers | 10 |
| ENERGY STAR Dehumidifers | 12 |
| ENERGY STAR Water Coolers | 10 |
| ENERGY STAR Ceiling Fans | 20\* |
|  |  |
| ***Consumer Electronics End-Use*** |  |
| ENERGY STAR Televisions | 6 |
| Smart Strip Plug Outlets | 10 |
| ENERGY STAR Computer | 4 |
| ENERGY STAR Monitor | 5 |
| ENERGY STAR Fax | 4 |
| ENERGY STAR Multifunction Device | 6 |

1. The protocol also applies to products that are pending ENERGY STAR qualification. [↑](#footnote-ref-1)
2. Bulbs that are not installed during the home visit do not qualify for this exemption. This includes bulbs that are left for homeowners to install. In these instances, baseline wattages should be estimated using Table Error! No text of specified style in document.‑1, Error! Reference source not found., & Error! Reference source not found.. [↑](#footnote-ref-2)
3. General Service Lamps (GSLs) are omnidirectional bulbs that are A, BT, P, PS, S, or T shape bulbs (as defined by the ANSI Standard Lamp Shapes). GSLs are not globe, bullet, candle, flood, reflector, or decorative shaped (B, BA, C, CA, DC, F, G, R, BR, ER, MR, MRX or PAR shapes). These bulbs do encompass both twist/spiral and a-lamp shaped bulbs. [↑](#footnote-ref-3)
4. The EISA 2007 standards apply to general service incandescent lamps. A complete list of the 22 incandescent lamps exempt from EISA 2007 can be found here: <http://www.lightingfacts.com/Library/Content/EISA>. [↑](#footnote-ref-4)
5. Lumen bins and incandescent equivalent wattages from ENERGY STAR labeling requirements, Version 1.1 <https://www.energystar.gov/sites/default/files/ENERGY%20STAR%20Lamps%20V1%201_Specification.pdf> EISA Standards from: United States Department of Energy. *Impact of EISA 2007 on General Service Incandescent Lamps: FACT SHEET.* <http://www1.eere.energy.gov/buildings/appliance_standards/residential/pdfs/general_service_incandescent_factsheet.pdf> [↑](#footnote-ref-5)
6. Example of cost-effectiveness calculation using column (e): If the LED life is 14.7 years, cost-effectiveness models for 2014 would model the first six years using column (d) as the Wattsbase, and the remaining 8.7 years using the Wattsbase,in column (e). [↑](#footnote-ref-6)
7. http://www.energyideas.org/documents/factsheets/HolidayLighting.pdf [↑](#footnote-ref-7)
8. The DSMore Michigan Database of Energy Efficiency Measures: Based on spreadsheet calculations using collected data: Franklin Energy Services; "FES-L19 – LED Holiday Lighting Calc Sheet" [↑](#footnote-ref-8)
9. Proper sizing requires Manual J calculations, following of ENERGY STAR QI procedures, or similar calculations. [↑](#footnote-ref-9)
10. This data is obtained from the AEPS Application Form or EDC’s data gathering based on the model number. [↑](#footnote-ref-10)
11. Ibid. [↑](#footnote-ref-11)
12. Ibid. [↑](#footnote-ref-12)
13. Ibid. [↑](#footnote-ref-13)
14. This data is obtained from the AEPS Application Form or EDC’s data gathering. [↑](#footnote-ref-14)
15. ENERGY STAR Solar Water Heater Benefits and Savings. Accessed 8/8/2014. http://www.energystar.gov/index.cfm?c=solar\_wheat.pr\_savings\_benefits [↑](#footnote-ref-15)
16. We have taken the average energy factor for all solar water heaters with collector areas of 50 ft2 or smaller from https://secure.solar-rating.org/Certification/Ratings/RatingsSummaryPage.aspx. As a cross check, we have calculated that the total available solar energy in PA for the same set of solar collectors is about twice as much as the savings claimed herein – that is, there is sufficient solar capacity to actualize an average energy factor of 1.84. [↑](#footnote-ref-16)
17. RECS 2009 data indicate that the most common size is 31 to 49 gal. An average of 40 gal unit is considered for this protocol. <http://www.eia.gov/consumption/residential/data/2009/>). [↑](#footnote-ref-17)
18. DEER Effective Useful Life values, updated October 10, 2008. [↑](#footnote-ref-18)
19. ibid. [↑](#footnote-ref-19)
20. <http://www.energystar.gov/ia/business/industry/industry_challenge/QuickConverter.xls> [↑](#footnote-ref-20)
21. See page 42 of the 2013 TRC Test Final Order [↑](#footnote-ref-21)
22. DEER Effective Useful Life values, updated October 10, 2008. [↑](#footnote-ref-22)
23. ibid. [↑](#footnote-ref-23)
24. ibid. [↑](#footnote-ref-24)
25. [↑](#footnote-ref-25)
26. Efficiency Vermont, Technical Reference User Manual: Measure Savings Algorithms and Cost Assumptions, TRM User Manual No. 2008-53, 07/18/08, http://www.veic.org/docs/ResourceLibrary/TRM-User-Manual-Excerpts.pdf. [↑](#footnote-ref-26)
27. See “Efficient Electric Water Heater” sectionfor assumptions used to calculate annual energy usage. [↑](#footnote-ref-27)
28. Lettering convention (1A, 2, etc) of Federal standard and ENERGY STAR specifications included for clear reference to the standards as well as for correspondence to entries in the default savings table. [↑](#footnote-ref-28)
29. ENERGY STAR Appliances Calculator. Accessed November 2013. [↑](#footnote-ref-29)
30. DOE life-cycle cost and payback period Excel-based calculator. http://www1.eere.energy.gov/buildings/appliance\_standards/residential/docs/rcw\_dfr\_lcc\_standard.xlsm [↑](#footnote-ref-30)
31. EnergyS tar Calculator Accessed July 2013 using ENERGY STAR Appliances. February 2008. U.S. Environmental Protection Agency and U.S. Department of Enegy. ENERGY STAR. <http://www.energystar.gov/>. [↑](#footnote-ref-31)
32. ENERGY STAR Water Coolers Savings Calculator (Calculator updated: May 2012) [↑](#footnote-ref-32)
33. From PECO baseline study, average home size = 2323 ft2, average number of room AC units per home = 2.1. Average Room AC capacity = 10,000 Btu/hr per ENERGY STAR Room AC Calculator, which serves 425 ft2 (average between 400 and 450 ft2 for 10,000 Btu/hr unit per ENERGY STAR Room AC sizing chart). FRoom,AC = (425 ft2 \* 2.1)/(2323 ft2) = 0.38 [↑](#footnote-ref-33)
34. In the absence of better, Pennsylvania-specific data, this is the same source and value as the Mid-Atlantic and Illinois TRMs. [↑](#footnote-ref-34)
35. ACCA, “Verifying ACCA Manual S Procedures,” <http://www.acca.org/Files/?id=67>. [↑](#footnote-ref-35)
36. The Locator is intended to assist users locate codes in the Standard Wattage Table. It does not generate new codes or wattages. In a few cases, the fixture code noted in the Standard Wattage Table may not use standard notation. Therefore, these fixtures may not be able to be found using the Locator and a manual search may be necessary to locate the code. [↑](#footnote-ref-36)
37. This value was agreed upon by the Technical Working Group convened to discuss updates to the TRM. This value is subject to adjustment based on implementation feedback during PY3 and PY4. [↑](#footnote-ref-37)
38. Ibid [↑](#footnote-ref-38)
39. Cap represents the rated cooling capacity of the product in Btu/h. If the unit’s capacity is less than 7,000 Btu/h, 7,000 Btu/h is used in the calculation. If the unit’s capacity is greater than 15,000 Btu/h, 15,000 Btu/h is used in the calculation. Use HSPF = COP X 3.412. [↑](#footnote-ref-39)
40. Cap represents the rated cooling capacity of the product in Btu/h. If the unit’s capacity is less than 7,000 Btu/h, 7,000 Btu/h is used in the calculation. If the unit’s capacity is greater than 15,000 Btu/h, 15,000 Btu/h is used in the calculation. Use SEER = EER X (13/11.3). [↑](#footnote-ref-40)