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

ΔkWh = $\Delta kWh_{cool} + \Delta kWh_{heat}$

ΔkWh_{cool} = $((CAPY_{cool}/(1000 \text{ X } SEER_m)) \text{ X } EFLH_{cool}) \text{ X } MF_{cool}$

ΔkWh_{heat} *(ASHP Only)* = $((CAPY_{heat}/(1000 \text{ X } HSPF_m)) \text{ X } EFLH_{heat}) \text{ X } MF_{heat}$

ΔkW_{peak} = $((CAPY_{cool}/(1000 \text{ X } EER_m)) \text{ X } CF) \text{ X } MF_{cool}$

Ground Source Heat Pumps (GSHP)

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

ΔkWh = $\Delta kWh_{cool} + \Delta kWh_{heat}$

COP_{sys} = $COP_g \text{ x } GSHPDF$

EER_{sys} = $EER_g \text{ x } GSHPDF$

ΔkWh_{cool} = $CAPY_{cool}/1000 \text{ X } (1/SEER_b – (1/(EER_{sys} \text{ X } GSER))) \text{ X } EFLH_{cool}$

ΔkWh_{heat} = $CAPY_{heat}/1000 \text{ X } (1/HSPF_b – (1/(COP_{sys} \text{ X } GSOP))) \text{ X } EFLH_{heat}$

ΔkW = $CAPY_{cool}/1000 \text{ X } (1/EER_b – (1/(EER_{sys} \text{ X } GSPK))) \text{ X } CF$

GSHP Desuperheater

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

$$\Delta kWh = \frac{\left\{EFDSH \times \left(\frac{1}{EF_{Base}}\right) \times \left(HW \times 365 \times 8.3 \frac{lb}{gal} \times (T_{hot} - T_{cold})\right)\right\}}{3413 \frac{Btu}{kWh}}$$

= ~~576~~ 567 kWh

ΔkW = $EDSH \text{ x } Energy \text{ to } Demand \text{ } Factor$

Furnace High Efficiency Fan

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

ΔkWh_{heat} = HFS

ΔkWh_{cool} = CFS

ΔkW_{peak} = $PDFS$

Component	Type	Value	Sources
$EFLH_{heat}$	Default	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	4
	Optional	An EDC can either use the Alternate EFLH Table or estimate its own EFLH based on customer billing data analysis.	Alternate EFLH Table (See Section 2.1.4); EDC Data Gathering
PSF	Fixed	5%	5
MF_{cool}	Fixed	5%	15
MF_{heat}	Fixed	5%	15
CF	Fixed	70%	6
$HSPF_b$	Fixed	Replace on Burnout: 7.7	7
	Variable	Early Retirement: EDC Data Gathering	EDC Data Gathering
$HSPF_e$	Variable	EDC Data Gathering	AEPS Application; EDC's Data Gathering
$HSPF_m$	Fixed	6.8	13
COP_g	Variable	EDC Data Gathering	AEPS Application; EDC's Data Gathering
GSHPDF	Fixed	0.885	19 (Engineering Estimate – See 2.15)
COP_{sys}	Variable	Calculated	Calculated
GSOP	Fixed	3.413	8
GSPK	Fixed	0.8416	9
EFDSH	Fixed	17%	10, 11
EDSH	Fixed	56776 kWh	Calculated
EF_{base}	Fixed	0.904	Table 2-4
HW	Fixed	50	Table 2-4
T_h	Fixed	123	Table 2-4
T_c	Fixed	55	Table 2-4

2.5 Furnace Whistle

Measure Name	Furnace Whistle
Target Sector	Residential Establishments
Measure Unit	Furnace whistle (promote regular filter change-out)
Unit Energy Savings	Varies
Unit Peak Demand Reduction	Varies
Measure Life	~~15~~ 14 years

Savings estimates are based on reduced furnace blower fan motor power requirements for winter and summer use of the blower fan motor. This furnace whistle measure applies to central forced-air furnaces, central AC and heat pump systems. Each table in this protocol (2 through 6) presents the annual kWh savings for each major urban center in Pennsylvania based on their respective estimated full load hours (EFLH). Where homes do not have A/C or heat pump systems for cooling, only the annual heating savings will apply.

2.5.1 Algorithms

$\Delta kWh = \Delta kWh_{heating} + \Delta kWh_{cooling}$

$\Delta kWh_{heating} = MkW \; X \; EFLH_{heating} \; X \; EI \; X \; ISR$

$\Delta kWh_{cooling} = MkW \; X \; EFLH_{cooling} X \; EI \; X \; ISR$

$\Delta kW_{peak} = \Delta kWh_{cooling} / \; EFLH_{cooling} X \; CF$

2.5.2 Definition of Terms

MkW = *Average motor full load electric demand (kW)*

$EFLH_{Heating}$ = *Estimated Full Load Hours (Heating) for the EDC region.*

$EFLH_{Cooling}$ = *Estimated Full Load Hours (Cooling) for the EDC region.*

EI = *Efficiency Improvement*

ISR = In-service Rate

2.7 LED Nightlight

Measure Name	LED Nightlight
Target Sector	Residential Establishments
Measure Unit	LED Nightlight
Unit Energy Savings	~~22~~ 25.49 kWh
Unit Peak Demand Reduction	0 kW
Measure Life	8 years

Savings from installation of LED nightlights are based on a straightforward algorithm that calculates the difference between existing and new wattage and the average daily hours of usage for the lighting unit being replaced. An "installation" rate is used to modify the savings based upon the outcome of participant surveys, which will inform the calculation. Demand savings is assumed to be zero for this measure.

2.7.1 Algorithms

Assumes a 1 Watt LED nightlight replaces a 7 Watt incandescent nightlight. The nightlight is assumed to operate 12 hours per day, 365 days per year; estimated useful life is 8 years (manufacturer cites 11 years 100,000 hours). Savings are calculated using the following algorithm:

$\Delta kWh = ((Watts_{base} - Watts_{NL}) \times (NL_{hours} \times 365))/1000) \times ISR$

$\Delta kW_{peak} = 0$ *(assumed)*

2.7.2 Definition of Terms

$Watts_{base}$ = *Wattage of baseline nightlight*

$Watts_{NL}$ = *Wattage of LED nightlight*

NL_{hours} = *Average hours of use per day per Nightlight*

ISR = *In-service rate*

(The EDC EM&V contractors will reconcile the ISR through survey activities)

Table 2-18: LED Nightlight - References

Component	Type	Value	Sources
$Watts_{base}$	Variable	Default = 7 Watts; EDC Data Gathering	EDC Data Gathering
$Watts_{NL}$	Variable	Default= 1 Watt; EDC Data Gathering	EDC Data Gathering
NL_{hours}	Fixed	12	1
ISR	Fixed	0.97 or EDC Data Gathering	PA CFL ISR value
EUL	Fixed	8 years	1

Sources:

1. Southern California Edison Company, "LED, Electroluminescent & Fluorescent Night Lights", Work Paper WPSCRELG0029 Rev. 1, February 2009, p. 2 & p. 3.

2.7.3 Deemed Savings

The default energy savings is based on a delta watts assumption ($Watts_{base}$ – $Watts_{EE}$) of 6 watts.

ΔkWh = ((6 X (12 X 365))/1000) X 0.97 = 25.49 kWh ~~(rounded to 22kWh)~~

0.0064 kW (7-plug power strip, unspecified use, or multiple purchased)

0.0068 kW (5-plug power strip, entertainment center)

0.0082 kW (7 plug power strip, entertainment center)

2.12.5 Measure Life

4 years[55].

2.12.6 Evaluation Protocols

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

[55] "Smart Strip Electrical Savings and Usability", David Rogers, Power Smart Engineering, October 2008.

Equation 2:

NET_kWhsaved Per Unit = *DEEMED kWhsaved Per Unit – (REPLACEMENTUEC * PART_USE)*

1.1.1 Definition of Terms

DEFAULT_kWhsaved = Annual electricity savings measured in kilowatt hours.

EXISTING_UEC = The average annual unit energy consumption of participating refrigerators and freezers for Program year 4. Table 2-46 to Table 2-49 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.

PART_USE = The portion of the year the average refrigerator or freezer would likely have operated if not recycled through the program. For PY3, the average refrigerator was plugged in 96.9% of the year and the average freezer was plugged in 98.5% of the year.

REPLACEMENTUEC = The annual unit energy consumption of the average replacement unit. The appropriate UEC values for replacement refrigerator and freezer units were obtained from the Energy Star calculator ~~.~~ and is equal to 417 kWh for a new Energy Star refrigerator, and 537 for a new non Energy Star refrigerator. It is equal to 423 kWh for a new Energy Star freezer, and 510 for a new non Energy Star freezer.

1.1.2 Default Savings Calculations

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 Four (PY4) Appliance Removal programs. Therefore, each UEC represents the average ages, sizes, etc of the fleet of refrigerators removed removed in Program Year Four.

$$\begin{aligned} &Existing\ Refrigerator\ UEC \\ &= 365.25 * (0.582 + 0.027 * (average\ age\ of\ appliance) + 1.055 \\ &* (\%\ of\ appliances\ manufactured\ before\ 1990) + 0.067 \\ &* (number\ of\ \ cubic\ feet) - 1.977 * (\%\ of\ single\ door\ units) + 1.071 * (\%\ of\ side - by \\ &- side) + 0.605 * (\%\ of\ primary\ usage) + 0.02 * (unconditioned\ space\ CDDs) - 0.045 \\ &* (unconditioned\ HDDs)) = \text{~~537~~}\ kWh \end{aligned}$$

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

Freezer Unit Energy Consumption Equation	
Equation Intercept and Independent Variables	**Estimate Coefficient (Daily kWh)**
Intercept	365.25
Appliance Age (years)	0.401
Dummy: Manufactured Pre-1993	0.067
Appliance Size (cubic feet)	0.15
% of appliances that are chest freezers	0.854
Cooling Degree Days (CDD)	0.1046

Freezer Unit Energy Consumption Equation	
Equation Intercept and Independent Variables	Estimate Coefficient (Daily kWh)
Intercept	-2.297
Appliance Age (years)	0.401
Dummy: Manufactured Pre-1993	0.067
Appliance Size (cubic feet)	0.15
% of appliances that are chest freezers	0.854
Cooling Degree Days (CDD)	0.1046

Freezer Savings - No Replacement:

DEFAULT_kWhsaved Per Unit $_{NO\ REP}$ *= EXISTING_UEC * PART_USE =kWh*

Freezer Savings - Replacement with Energy Star Unit:

DEFAULT_kWhsaved Per Unit $_{WITH\ ES\ REP}$ *= DEFAULT kWhsaved Per Unit* $_{NO\ REP}$ *– (REPLACEMENTUEC* $_{ES}$ ** PART_USE) = kWh*

Freezer Savings - Replacement with non-Energy Star Unit:

DEFAULT_kWhsaved Per Unit $_{WITH\ NON\ ES\ REP}$ *= kWhsaved Per Unit* $_{NO\ REP}$ *– (REPLACEMENTUEC* $_{NON\ ES}$ ** PART_USE) = kWh*

The Commission has computed the EDC-specific values that are needed for input to the regression equations for determining the Unit Energy Consumption based on Act 129 PY4 data provided by each EDC for refrigerators and freezers removed in PY4. Once these input values were determined, they were substituted into the above equation in order to estimate the UEC for removed refrigerators and freezers for each EDC.

Table 2-46 to Table 2-49 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. Note that equation inputs in

Table 2-46: Default ~~Savings~~ values for Residential Refrigerator Recycling Without Replacement With a New Refrigerator

Variable Name	Duquesne Light	Met Ed	PECO	PennElec	PennPower	PPL	West Penn Power
Age of appliance	32.67	27.96	25.55	22.88	29.06	30.06	30.94
% manufactured pre 1990	68.18%	61.83%	49.86%	61.84%	60.56%	60.43%	64.98%
Appliance Size (volume in cubic feet)	16.03	18.47	18.65	16.11	16.25	18.07	16.57
Dummy: percent that are single-door appliances	12.13%	4.39%	8.12%	8.56%	7.71%	7.03%	8.27%
Dummy: percent that are side-by-side configuration	12.40%	21.43%	19.89%	10.78%	12.96%	18.31%	13.71%
Dummy: primary usage type (in absence of the program)	18.45%	10.12%	24.71%	17.22%	16.76%	26.01%	14.03%
Located in unconditioned space X CDD	0.98	1.78	2.47	1.07	1.22	0.92	1.20
Located in unconditioned space X HDD	7.90	10.86	9.51	9.93	10.17	9.85	9.42
ESTIMATED UEC (Annual kWh per year) for a removed refrigerator that is not replaced	1068.9	1087.3	1048.5	933.8	1003.9	1107.2	1052.4

Variable Name	Duquesne Light	Met Ed	PECO	PennElec	PennPower	PPL	West Penn Power
Age of appliance	32.67	27.96	25.55	22.88	29.06	30.06	30.94
% manufactured pre 1990	68.18%	61.83%	49.86%	61.84%	60.56%	60.43%	64.98%
Appliance size (volume in square feet)	16.03	18.47	18.65	16.11	16.25	18.07	16.57
Dummy: percent that are single-door appliances	12.13%	4.39%	8.12%	8.56%	7.71%	7.03%	8.27%
Dummy: percent that are side by side configuration	12.40%	21.43%	19.89%	10.78%	12.96%	18.31%	13.71%
Dummy: primary usage type (in absence of the program)	18.45%	10.12%	24.74%	17.22%	16.76%	26.01%	14.03%
Located in unconditioned space X CDD	0.98	1.78	2.47	1.07	1.22	0.92	1.20
Located in unconditioned space X HDD	7.90	10.86	9.51	9.93	10.17	9.85	9.42
ESTIMATED UEC Savings (Annual kWh per year) for a removed refrigerator that is not replaced	1068.9	1087.3	1048.5	933.8	1003.9	1107.2	1052.4

Table 2-47: Default ~~Savings~~ values for Residential Freezer Recycling Without Replacement With a New Freezer

Variable Name	Duquesne Light	Met Ed	PECO	PennElec	PennPower	PPL	West Penn Power
Age of appliance	35.51	32.21	29.05	32.88	34.17	32.68	33.21
% manufactured pre 1990	89.41%	87.03%	76.60%	86.94%	88.55%	88.20%	86.85%
Appliance Size (volume in cubic feet)	15.40	15.44	15.59	15.70	15.80	15.65	15.74
Dummy: percent that are chest appliances	27.45%	36.47%	22.70%	34.83%	37.89%	30.14%	33.5%
Located in unconditioned space X CDD	0.78	1.55	1.97	0.88	0.99	0.88	1.08
ESTIMATED UEC (Annual kWh per year) for a removed freezer that is not replaced	1120.3	1095.4	983.9	1095.6	1148.7	1074.9	1109.1

Variable Name	Duquesne Light	Met Ed	PECO	PennElec	PennPower	PPL	West Penn Power
Age of appliance	35.51	32.21	29.05	32.88	34.17	32.68	33.21
% manufactured pre 1993	89.41%	87.03%	76.60%	86.94%	88.55%	88.20%	86.85%
Appliance size (volume in square feet)	15.40	15.44	15.59	15.70	15.80	15.65	15.74
Dummy: percent that are chest appliances	27.45%	36.47%	22.70%	34.83%	37.89%	30.14%	33.45%
Located in unconditioned space X CDD	0.78	1.55	1.97	0.88	0.99	0.88	1.08
ESTIMATED UEC Savings (Annual kWh per year) for a removed refrigerator that is not replaced	1120.3	1095.4	983.9	1095.6	1148.7	1074.9	1109.1

When calculating default per unit kWh savings for a removed refrigerator or freezer, 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 default savings value, because: (1) the UEC model yields an estimate of annual consumption, and (2) not all recycled refrigerators and freezers would have operated year-round had they not been decommissioned through the program.

In Program Year 3, the Commission determined that the average removed refrigerator was plugged in and used 96.9% of the year and the average freezer was plugged in and used 98.5% of the year. Thus, the default value for the part-use factor is 96.9% (and 98.5%) based on program year 3 data for all EDCs. EDCs may elect to calculate an EDC specific part-use factor for a specific program year. In the event an EDC desires to calculate an EDC specific part-use factor, EDCs should use the following methodology. Using participant surveys, evaluators should determine the amount of time a removed refrigerator is plugged in.

Table 2-48 and Table 2-49 below shows the basis for the calculation of default per unit savings for refrigerators and freezers that are removed but then replaced.

Table 2-48: Default ~~Savings~~ values for Residential Refrigerator Recycling With Replacement With a New Energy Star Refrigerator[1]

Variable Name	Duquesne Light	Met Ed	PECO	PennElec	PennPower	PPL	West Penn Power
Age of appliance	25.97	19.39	22.47	22.54	23.21	30.06	25.50
% manufactured pre 1990	44.70%	30.88%	37.85%	41.57%	41.52%	60.43%	42.54%
Appliance Size (volume in cubic feet)	18.39	20.65	19.57	18.45	18.73	18.07	18.82
Dummy: percent that are single-door appliances	2.62%	0.61%	3.72%	3.01%	2.29%	7.03%	2.25%
Dummy: percent that are side-by-side configuration	15.44%	35.79%	24.51%	19.83%	18.67%	18.31%	22.15%
Dummy: primary usage type (in absence of the program)	58.73%	88.55%	43.53%	67.13%	62.86%	26.01%	61.83%
Located in unconditioned space X CDD	0.55	0.18	2.40	0.47	0.54	0.92	0.52
Located in unconditioned space X HDD	4.41	1.11	9.25	4.15	4.50	9.85	4.27
ESTIMATED UEC (Annual kWh per year) for a removed refrigerator that is replaced	1193.70	1342.50	1089.50	1186.00	1185.10	1107.20	1229.20
kWh Use of new refrigerator	431.22	431.22	431.22	431.22	431.22	431.22	431.22

Variable Name	Duquesne Light	Met Ed	PECO	PennElec	PennPower	PPL	West Penn Power
Age of appliance	25.97	19.39	22.47	22.54	23.21	30.06	25.50
% manufactured pre 1990	44.70%	30.88%	37.85%	41.57%	41.52%	60.43%	42.54%
Appliance Size (volume in square feet)	18.39	20.65	19.57	18.45	18.73	18.07	18.82
Dummy: percent that are single-door appliances	2.62%	61.00%	3.72%	3.01%	2.29%	7.03%	2.25%
Dummy: percent that are side-by-side configuration	15.44%	35.79%	24.51%	19.83%	18.67%	18.31%	22.15%
Dummy: primary usage type (in absence of the program)	58.73%	88.55%	43.53%	67.13%	62.86%	26.01%	61.83%
Located in unconditioned space X CDD	0.55	0.18	2.40	0.47	0.54	0.92	0.52
Located in unconditioned space X HDD	4.41	1.11	9.25	4.15	4.50	9.85	4.27
ESTIMATED UEC Savings (Annual kWh per year) for a removed refrigerator that is replaced	11193.70	1342.50	1089.50	1186.00	1185.10	1107.20	1229.20
kWh Use of new refrigerator	431.22	431.22	431.22	431.22	431.22	431.22	431.22

[1] kWh use of new refrigerator is average consumption of all ENERGY STAR qualifying models by configuration from ENERGY STAR Residential Refrigerators Qualified Products List. July 5, 2013.

Table 2-49: Default ~~Savings~~ values for Residential Freezer Recycling With Replacement With a New Energy Star Freezer[1]

Variable Name	Duquesne Light	Met Ed	PECO	PennElec	PennPower	PPL	West Penn Power
Age of appliance	31.28	28.20	28.23	29.22	33.21	32.68	31.15
% manufactured pre 1990	80.90%	86.67%	70.42%	80.60%	91.43%	88.20%	77.95%
Appliance Size (volume in cubic feet)	16.12	16.67	16.15	16.41	16.29	15.65	16.97
Dummy: percent that are chest appliances	31.46%	33.33%	14.79%	35.78%	42.86%	30.14%	41.0%
Located in unconditioned space X CDD	0.87	0.64	2.33	0.69	0.95	0.88	0.72
ESTIMATED UEC (Annual kWh per year) for a removed freezer that is replaced	1059.80	1019.60	974.90	1031.10	1169.80	1074.90	1123.10
kWh Use of new freezer	351.00	351.00	351.00	351.00	351.00	351.00	351.00

Variable Name	Duquesne Light	Met Ed	PECO	PennElec	PennPower	PPL	West Penn Power
Age of Appliance	31.28	28.2	28.23	29.22	33.21	32.68	31.15
% manufactured pre 1990	80.90%	86.67%	70.42%	80.60%	91.43%	88.20%	77.95%
Appliance Size (volume in cubic feet)	16.12	16.67	16.15	16.41	16.29	15.65	16.97
Dummy: % that are chest appliances	31.46%	33.33%	14.79%	35.78%	42.86%	30.14%	41.00%
Located in unconditioned space X CCD	0.87	0.64	2.33	0.69	0.95	0.88	0.72
ESTIMATED UEC Savings (Annual kWh per year) for a removed refrigerator that is replaced	1059.80	1019.6	974.9	1031.1	1169.8	1074.9	1123.1
kWh use of new freezer	351.00	351.00	351.00	351.00	351.00	351.00	351.00

Per unit kW demand savings are based upon annual hours of use of 5,000 and a peak coincidence factor of 62%.

2.21.4 Measure Life

Refrigerator/Freezer Replacement programs: Measure Life = 7 yrs

[1] kWh use of new freezer is average consumption of all ENERGY STAR qualifying models by configuration from ENERGY STAR Residential Freezer Qualified Products List. July 5, 2013.

Sources:

1. ENERGY STAR Appliances Calculator. Accessed July 2013.
2. Statewide average for all housing types from Pennsylvania Statewide Residential End-Use and Saturation Study, 2012,Demand savings derived using dishwasher load shape.
3. Coincidence factor already embedded in summer peak demand reduction estimate

The default values for electric and non-electric water heating and the default fuel mix from Table 2-64 are given in Table 2-66.

Table Error! No text of specified style in document.**-1: Default Dishwasher Energy Savings**

Water Heating	ΔkWh/yr
Electric (%Electric$_{DHW}$ = 100%)	~~25~~60
Non-Electric (%Electric$_{DHW}$ = 0%)	~~11~~26.4
Default Fuel Mix (%Electric$_{DHW}$ = 43%)	~~17~~40.8

1.1.1 Measure Life

ENERGY STAR Dishwashers: Measure Life = 10 years[140]

[140] EnergyStar Calculator. Accessed July 2013.

ENERGY STAR CFL Bulbs (screw-in):

ΔkWh = $(Watts_{base} - Watts_{CFL})/1000 \times CFL_{hours} \times (1+IE_{kWh}) \times 365 \times ISR_{CFL}$

ΔkW_{peak} = $(Watts_{base} - Watts_{CFL})/1000 \times CF \times (1+IE_{kW}) \times ISR_{CFL}$

ENERGY STAR LED Bulbs (screw-in):

ΔkWh = $(Watts_{base} - Watts_{LED})/1000 \times CFL_{hours} \times (1+IE_{kWh\text{-}LED}) \times 365 \times ISR_{CFL}$

ΔkW_{peak} = $(Watts_{base} - Watts_{LED})/1000 \times CF \times (1+IE_{kW\text{-}LED}) \times ISR_{CFL}$

ENERGY STAR Torchieres:

ΔkWh = $(Watts_{base} - Watts_{Torch})/1000 \times Torch_{hours} \times (1+IE_{kWh}) \times 365 \times ISR_{Torch}$

ΔkW_{peak} = $(Watts_{base} - Watts_{Torch})/1000 \times CF \times (1+IE_{kW}) \times ISR_{Torch}$

ENERGY STAR Indoor CFL Fixture (hard-wired, pin-based):

ΔkWh = $(Watts_{base} - Watts_{IF})/1000 \times IF_{hours} \times (1+IE_{kWh\text{-}LED}) \times 365 \times ISR_{IF}$

ΔkW_{peak} = $(Watts_{base} - Watts_{IF})/1000 \times CF \times (1+IE_{kW\text{-}LED}) \times ISR_{IF}$

ENERGY STAR Indoor LED Fixture (hard-wired, pin-based):

ΔkWh = $(Watts_{base} - Watts_{IF})/1000 \times IF_{hours} \times (1+IE_{kWh\text{-}LED}) \times 365 \times ISR_{IF}$

ΔkW_{peak} = $(Watts_{base} - Watts_{IF})/1000 \times CF \times (1+IE_{kW\text{-}LED}) \times ISR_{IF}$

ENERGY STAR Outdoor Fixture (hard wired, pin-based):

ΔkWh = $(Watts_{base} - Watts_{OF})/1000 \times OF_{hours} \times 365 \times ISR_{OF}$

ΔkW_{peak} = $(Watts_{base} - Watts_{OF})/1000 \times CF \times ISR_{OF}$

Ceiling Fan with ENERGY STAR Light Fixture:

ΔkWh = $(Watts_{base} - Watts_{Fan})/1000 \times Fan_{hours} \times (1+IE_{kWh}) \times 365 \times ISR_{Fan}$

ΔkW_{peak} = $(Watts_{base} - Watts_{Fan})/1000 \times CF \times (1+IE_{kW}) \times ISR_{Fan}$

1.1.1 Definition of Terms

$Watts_{base}$	= Wattage of baseline case lamp/fixture.
$Watts_{CFL}$	= Wattage of CFL
CFL_{hours}	= Average hours of use per day per CFL
IE_{kWh}	=HVAC Interactive Effect for CFL energy
IE_{kW}	=HVAC Interactive Effect for CFL demand

of hours that the pump was set to run between 2 PM to 6 PM, divided by 4. If this information is not available, the recommended daily hours of operation to use are 5.18 and the demand coincidence factor is 0.27. These operation parameters are derived from the 2011 Mid Atlantic TRM.

1.1.1 Definition of Terms

The parameters in the above equation are listed below.

H_{SS} = *Hours of operation per day for Single Speed Pump. This quantity should be recorded by the applicant.*

H_{VFD} = *Hours of operation per day for Variable Frequency Drive Pump. This quantity should be recorded by the applicant.*

Days/yr = *Pool pump days of operation per year.*

kW_{SS} = *Electric demand of single speed pump at a given flow rate. This quantity should be recorded by the applicant or looked up through the horsepower in Table 2-93.*

$kW_{basepeak}$ = *Peak demand of single speed pump*

kW_{VFD} = *Electric demand of variable frequency drive pump at a given flow rate. This quantity should be measured and recorded by the applicant.*

$kW_{VFD\ peak}$ = *Peak demand of VFD pump.*

CF_{SS} = *Peak coincident factor of single speed pump from 2 PM to 6 PM in summer weekday. This quantity can be deduced from the pool pump timer settings for the old pump.*

CF_{VFD} = *Peak coincident factor of VFD pump from 2 PM to 6 PM in summer weekday. This quantity should be inferred from the new timer settings.*

Table 2-92: Residential VFD Pool Pumps Calculations Assumptions

Component	Type	Values	Source
H_{SS}	Variable	Default: 5.18	2
H_{VFD}	Variable	Default: 13.00	2
Days/yr	Fixed	Default: 100	2
kW_{SS}	Variable	EDC Data Gathering Default: 1.364 kW or See Table 2-93	1 and Table 2-91 and Table 2-93
kW_{VFD}	Variable	EDC Data Gathering	EDC Data Gathering
CF_{SS}	Variable	Default: 0.235	3

1. Northeast Energy Efficiency Partnerships, Mid Atlantic TRM Version 3.0. March 2013. Calculated from Itron eShapes, which is 8760 hourly data by end use for Upstate New York.

Table 3-30: Refrigeration Case Efficiencies

Volume (ft^3)	Glass Door		Solid Door	
	kWh_{ee}/day	kWh_{base}/day	kWh_{ee}/day	kWh_{base}/day
V < 15	0.118*V + 1.382	0.12*V + 3.34	0.089*V + 1.411	0.10*V + 2.04
15 ≤ V < 30	0.140*V + 1.050		0.037*V + 2.200	
30 ≤ V < 50	0.088*V + 2.625		0.056*V + 1.635	
50 ≤ V	0.110*V + 1.50		0.060*V + 1.416	

Table 3-31: Freezer Case Efficiencies

Volume (ft^3)	Glass Door		Solid Door	
	kWh_{ee}/day	kWh_{base}/day	kWh_{ee}/day	kWh_{base}/day
V < 15	0.607*V+0.893	0.75*V + 4.10	0.250*V + 1.25	0.4*V + 1.38
15 ≤ V < 30	0.733*V - 1.00		0.40*V – 1.00	
30 ≤ V < 50	0.250*V + 13.50		0.163*V + 6.125	
50 ≤ V	0.450*V + 3.50		0.158*V + 6.333	

If precise case volume is unknown, default savings given in tables below can be used.

Table 3-32: Refrigeration Case Savings

Volume (ft^3)	Annual Energy Savings (kWh)		Demand Impacts (kW)	
	Glass Door	Solid Door	Glass Door	Solid Door
V < 15	722	268	0.~~0824~~0636	0.~~0306~~0236
15 ≤ V < 30	683	424	0.~~0779~~0602	0.~~0484~~0374
30 ≤ V < 50	763	838	0.~~0871~~0672	0.~~0957~~0739
50 ≤ V	927	1,205	0.~~1058~~0817	0.~~1427~~1062

Table 3-33: Freezer Case Savings

Volume (ft^3)	Annual Energy Savings (kWh)		Demand Impacts (kW)	
	Glass Door	Solid Door	Glass Door	Solid Door
V < 15	1,901	814	0.~~2170~~1675	0.~~0929~~0717
15 ≤ V < 30	1,992	869	0.~~2274~~1756	0.~~0992~~0766
30 ≤ V < 50	4,417	1,988	0.~~5042~~3893	0.~~2269~~1752
50 ≤ V	6,680	3,405	0.~~7625~~5887	0.~~3887~~3001

3.8.3 Measure Life

12 years

Sources:

1. Food Service Technology Center (as stated in ENERGY STAR calculator).

5 APPENDICES

5.1 Appendix A: Measure Lives

Measure Lives Used in Cost-Effectiveness Screening
August 2013

*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~~6.8~~
Recessed Can Fluorescent Fixture	20*
Torchieres	10
Fixtures Other	20*
ENERGY STAR LEDs	14.7
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~~14~~
Air Source Heat Pump proper sizing/install	12
ENERGY STAR Thermostat (Central Air Conditioner)	15
ENERGY STAR Thermostat (Heat Pump)	15
Ground Source Heat Pump	30*
Room Air Conditioner Retirement	4
Furnace Whistle	~~15~~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	
Electric Clothes Dryer with Moisture Sensor	~~11~~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	~~11~~10
ENERGY STAR Dehumidifers	12
ENERGY STAR Room Air Conditioners	9
ENERGY STAR Televisions	~~15~~6
ENERGY STAR Water Coolers	10
Office Equipment / Electronics End-Use	
Smart Strip Plug Outlets	~~5~~4
ENERGY STAR Computer	4
ENERGY STAR Monitor	5
ENERGY STAR Fax	4
ENERGY STAR Multifunction Device	6
ENERGY STAR Printer	5