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Efficiency Vermont

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Technical Reference User Manual (TRM) Measure Savings Algorithms and Cost Assumptions

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Introduction

This reference manual provides methods, formulas and default assumptions for estimating energy and peak impacts from measures and projects promoted by Efficiency Vermont's energy efficiency programs.

The reference manual is organized by program (or program component), end use and measure. Each section provides mathematical equations for determining savings (algorithms), as well as default assumptions for all equation parameters that are not based on site-specific information. In addition, any descriptions of calculation methods or baselines are provided, as appropriate. The parameters for calculating savings are listed in the same order for each measure. In order to maintain a similar appearance for all of the measure assumption pages, large tables are located at the end of the measure assumptions under the Reference Tables category. Algorithms are provided for estimating annual energy and demand impacts. Data assumptions are based on Vermont data, where available. Where Vermont data was not available, data from neighboring regions is used, including New York, New Jersey and New England, where available. In some cases, engineering judgment is used.

Gross-to-Net Savings Calculation

The algorithms shown with each measure calculate gross customer electric savings without counting the effects of line losses from the generator to the customer, freeridership, spillover, or persistence. The algorithms also do not distribute the savings among the different costing periods. The formulae for converting gross customer-level savings to net generation-level savings (counting freeridership, spillover and persistence) for the different costing periods is as follows:

$$\text{netkWh}_i = \Delta\text{kWh} \times (1 + \text{LLF}_i) \times (1 - \text{FR} + \text{SPL}) \times \text{PF} \times \text{RPF}_i$$

$$\text{netkW}_j = \Delta\text{kW} \times (1 + \text{LLF}_j) \times (1 - \text{FR} + \text{SPL}) \times \text{PF} \times \text{CF}_j$$

Where:

- netkWh_i = kWh energy savings at generation-level, net of free riders and persistence, and including spillover, for period i
- i = subscript used to denote variable energy rating periods (Winter Peak, Winter Off-Peak, Summer Peak, Summer Off-Peak).
- ΔkWh = gross customer annual kWh savings for the measure
- LLF_i = line loss factor for period i
- FR = freeridership
- SPL = spillover for measure
- PF = persistence factor for measure
- RPF_i = rating period factor for period i
- netkW_j = kW demand savings, net of free riders and persistence, and including spillover, for season j
- j = subscript used to denote variable seasonal peaks (Summer, Winter and Spring/Fall).
- ΔkW = gross customer connected load kW savings for the measure
- LLF_j = line loss factor for seasonal peak j
- CF_j = the percent of kW savings that is concurrent with Vermont's seasonal peak, for season j

All of the parameters except line loss factors (LLF) for the above equations may be found in the specific section for the measure. The line loss factors do not vary by measure, but by costing period, and are in the following table:

Line Loss Factors

Energy (LLF _i)				Peak (LLF _j)		
Winter Peak Period	Winter Off-Peak Period	Summer Peak Period	Summer Off-Peak Period	Winter Peak	Summer Peak	Spring/Fall Peak
13.466%	12.151%	13.697%	10.682%	9.97%	10.51%	

The free ridership and spillover factors are related to but slightly different from the freeridership and spillover rates used in the gross-to-net equation. Free ridership and spillover factors are defined as follows:

Free ridership factor = 1 – FR

Spillover factor = 1 + SPL

Interactive Effects

The TRM provides specific savings algorithms for many prescriptive measures. When a customer installs a prescriptive measure, the savings are determined according to these algorithms. In some cases these algorithms include the effects of interactions with other measures or end uses (e.g., cooling and heating effects from interior lighting waste heat). For “custom” measures, EVT performs site-specific customized calculations. In this case, EVT takes into account interactions between measures (e.g., individual savings from installation of window film and replacement of a chiller are not additive because the first measure reduces the cooling load met by the second measure). EVT will calculate total savings for the package of custom measures being installed, considering interactive effects, either as a single package or in rank order of measures as described below. If a “custom” project includes both prescriptive and custom measures, the prescriptive measures will be calculated in the normal manner. However, the prescriptive measures will be assumed to be installed prior to determining the impacts for the custom measures. Custom interior lighting measures will use the standard prescriptive algorithm to estimating waste heat impacts.

In most cases of multiple custom measures EVT models a single custom package including all measures the customer will install. This modeling effectively accounts for all interactions between measures, and the “package” is tracked in FastTrack as a single “measure.” In instances where modeling is not completed on a package of measures, and where individual measures are separately listed in FastTrack with measure-specific savings EVT will use the following protocol (typically lighting only projects). To determine custom measure savings EVT will calculate measure impacts in descending order of measure life (i.e., starting with the longest lived measure). The procedure is to calculate savings for the longest lived measure first, then consider that measure’s impact on the next longest lived measure, and so on. This is because a short-lived measure can reduce savings from a long-lived measure, but only for part of its life. Since tracking system limitations require that annual measure savings remain constant for all years, this is the only way to ensure proper lifetime savings and total resource benefits are captured. For example, fixing compressed air leaks can reduce savings from installing a new compressor. However, leak repair only lasts 1 year. If the leak repair savings were calculated first the calculated lifetime savings and benefits from the compressor would be unreasonably low because compressor savings would go back up starting in year 2.

Persistence

Persistence factors may be used to reduce lifetime measure savings in recognition that initial engineering estimates of annual savings may not persist long term. This might be because a measure is removed or breaks prior to the end of its normal engineering lifetime, because it is not properly maintained over its lifetime, because it is overridden or goes out of calibration (controls only), or some other reason. Each measure algorithm contains an entry for persistence factor. The default value if none is indicated is 1.00

(100%). A value lower than 1.00 will result in a downward adjustment of lifetime savings and total resource benefits. For any measure with a persistence value less than 1.00, the normal measure life ("Engineering Measure Life") will be reduced to arrive at an "Adjusted Measure Life" for purposes of measure screening, savings and TRB claims, and tracking. The "Adjusted Measure Life" used will be equal to the product of the Engineering Measure Life and the persistence factor. Both the Engineering Measure Life and the Adjusted Measure Life will be shown in each measure algorithm. All data in FastTrack and CAT indicating "measure life" shall be equal to "Adjusted Measure Life."

Glossary

The following glossary provides definitions for necessary assumptions needed to calculate measure savings.

Baseline Efficiency (η_{base}): The assumed standard efficiency of equipment, absent an Efficiency Vermont program.

Coincidence Factor (CF): Coincidence factors represent the fraction of connected load expected to be coincident with a particular system peak period, on a diversified basis. Coincidence factors are provided for summer, winter and spring/fall peak periods.

Connected Load: The maximum wattage of the equipment, under normal operating conditions.

Freeridership (FR): The fraction of gross program savings that would have occurred despite the program.

Full Load Hours (FLH): The equivalent hours that equipment would need to operate at its peak capacity in order to consume its estimated annual kWh consumption (annual kWh/connected kW).

High Efficiency (η_{effic}): The efficiency of the energy-saving equipment installed as a result of an efficiency program.

Lifetimes: The number of years (or hours) that the new high efficiency equipment is expected to function. These are generally based on engineering lives, but sometimes adjusted based on expectations about frequency of remodeling or demolition.

Line Loss Factor (LLF): The marginal electricity losses from the generator to the customer – expressed as a percent of meter-level savings. The Energy Line Loss Factors vary by period. The Peak Line Loss Factors reflect losses at the time of system peak, and are shown for three seasons of the year. Line loss factors are the same for all measures. See the Gross-to-Net Calculation section for specific values.

Load Factor (LF): The fraction of full load (wattage) for which the equipment is typically run.

Operating Hours (HOURS): The annual hours that equipment is expected to operate.

Persistence (PF): The fraction of gross measure savings obtained over the measure life.

Rating Period Factor (RPF): Percentages for defined times of the year that describe when energy savings will be realized for a specific measure.

Spillover (SPL): Savings attributable to the program, but generated by customers not directly participating in the program. Expressed as a fraction of gross savings. All values can be changed as new information becomes available.

Business Energy Services

Motors End Use Efficient Motors

Measure Number: I-A-1-e (Business Energy Services, Motors End Use)

Version Date & Revision History

Draft date: Portfolio 29
Effective date: 1/1/04
End Date: TBD

Referenced Documents: none.

Description

Three phase ODP & TEFC motors less than or equal to 200 HP meeting a minimum qualifying efficiency. The baseline efficiency is that defined by EPACT and the 2001 Vermont Guidelines for Energy Efficient Commercial Construction.

Estimated Measure Impacts

Average Annual MWH Savings per unit	Average number of measures per year	Average Annual MWH savings per year
1.54	195	300.3

Algorithms

Energy Savings

$$\Delta kWh = (kW_{base} - kW_{effic}) \times HOURS$$

Demand Savings

$$\Delta kW = kW_{base} - kW_{effic}$$

$$kW_l = HP \times 0.746 \times (1/\eta_l) \times LF$$

Where:

- ΔkWh = gross customer annual kWh savings for the measure
- kW_{base} = baseline motor connected load kW
- kW_{effic} = efficient motor connected load kW
- HOURS = annual motor hours of use per year
- ΔkW = gross customer connected load kW savings for the measure
- HP = horsepower of motor (HP)
- 0.746 = conversion factor from horsepower to kW (kW/HP)
- η_l = efficiency of motor *l* (efficient or baseline)
- LF = load factor of motor (default = 0.75)

Baseline Efficiencies – New or Replacement

The Baseline reflects the minimum efficiency allowed under the Federal Energy Policy Act of 1992 (EPACT) that went into effect October 1997, which is the same as the Vermont 2001 Guidelines for Act 250. While EPACT generally reflects the floor of efficiencies available, most manufacturers produce models just meeting EPACT, and these are the most commonly purchased among customers not choosing high efficiency. Refer to the table of Baseline Motor Efficiencies in the reference table section.

High Efficiency

The efficiency of each motor installed more efficient than the baseline efficiency. Typically the minimum efficiency is that defined by the Consortium for Energy Efficiency (CEE) and promoted in the NEEP MotorUP initiative, and listed in the table of Minimum Efficiencies Qualifying for Incentives in the reference table section.

Operating Hours

If available, customer provided annual operating hours. If annual operating hours are not available, then refer to the table of Annual Motor Operating Hours in the reference table section for HVAC fan or pump motors by building type. For all other motors, use 4500 hours (E Source Technology Atlas Series Volume IV, Drivepower, p. 32).

Loadshapes

- Loadshape #16, Commercial Ventilation motor
- Loadshape #21, Industrial Motor
- Loadshape #26, HVAC Pump (heating)
- Loadshape #27, HVAC Pump (cooling)
- Loadshape #28, HVAC Pump (unknown use)

Freeridership/Spillover Factors

Measure Category	Motor		
Measure Code	MTRDP001, MTRDP002, MTRDP003, MTRDP005, MTRDP010, MTRDP015, MTRDP01H, MTRDP020, MTRDP025, MTRDP030, MTRDP040, MTRDP050, MTRDP060, MTRDP075, MTRDP07H, MTRDP100, MTRDP125, MTRDP150, MTRDP200, MTRTF001, MTRTF002, MTRTF003, MTRTF005, MTRTF010, MTRTF015, MTRTF01H, MTRTF020, MTRTF025, MTRTF030, MTRTF040, MTRTF050, MTRTF060, MTRTF075, MTRTF07H, MTRTF100, MTRTF125, MTRTF150, MTRTF200		
Product Description	Efficient Motor		
Track Name	Track No.	Freerider	Spillover
Act250 NC	6014A250	0.95	1
Cust Equip Rpl	6013CUST	0.89	0.70
Farm NC	6014FARM	n/a	n/a
Farm Equip Rpl	6013FARM	n/a	n/a
Non Act 250 NC	6014NANC	1	1
Pres Equip Rpl	6013PRES	0.90	0.70
C&I Retro	6012CNIR	0.89	0.70
MF Mkt Retro	6012MFMR	n/a	n/a
Efficient Products	6032EPEP	n/a	n/a
LISF Retrofit	6034LISF	n/a	n/a
LIMF Retrofit	6017RETR	n/a	n/a
LIMF NC	6018LINC	n/a	n/a
LIMF Rehab	6018LIRH	n/a	n/a
RES Retrofit	6036RETR	n/a	n/a
RNC VESH	6038VESH	n/a	n/a
MF Mkt NC	6019MFNC	n/a	n/a

* Freeridership of 0% per agreement between DPS and EVT. All Act 250 measures will also have a 5% Adjustment Factor applied, which will be implemented through the Freeridership factor.

Persistence

The persistence factor is assumed to be one.

Lifetimes

20 years for a premium-efficiency motor (Based on BPA measure life study II (Skumatz), which looked at life of motors in place in commercial buildings). An existing or baseline motor is expected to last for 15 years. Because of its lower operating temperature a premium-efficiency motor will typically last longer than a standard-efficiency motor.

Analysis period is the same as the lifetime.

Measure Cost

See the table of Incremental Costs and Customer Incentives for Efficient Motors in the reference table section for assumed measure cost by horsepower and enclosure type.

Incentive Level

Though incentives originally were intended to cover 100% of incremental cost, recent NEEP data indicates that the incentive covers significantly less – somewhere between 50% and 100%, depending on size. On average the incentive is estimated at $2/3^{\text{rd}}$ of the incremental cost. See the table of Incremental Costs and Customer Incentives for Efficient Motors in the reference table section for default incentive levels by horsepower and enclosure type.

O&M Cost Adjustments

There are no operation and maintenance cost adjustments for this measure.

Fossil Fuel Descriptions

There are no fossil-fuel algorithms or default values for this measure.

Water Descriptions

There are no water algorithms or default values for this measure.

Reference Tables

Annual Motor Operating Hours (HOURS)				
Building Type	HVAC Pump (heating)	HVAC Pump (cooling)	HVAC Pump (unknown use)	Ventilation Fan
Office	2,186	2,000	2,000	6,192
Retail	2,000	2,000	2,000	3,261
Manufacturing	3,506	2,000	2,462	5,573
Hospitals	2,820	2,688	2,754	8,374
Elem/Sec Schools	3,602	2,000	2,190	3,699
Restaurant	2,348	2,000	2,000	4,155
Warehouse	3,117	2,000	2,241	6,389
Hotels/Motels	5,775	2,688	4,231	3,719
Grocery	2,349	2,000	2,080	6,389
Health	4,489	2,000	2,559	2,000
College/Univ	5,716	2,000	3,641	3,631
Miscellaneous	2,762	2,000	2,000	3,720

Source:
Adapted from Southeastern NY audit data, adjusted for climate variations. Motors must operate a minimum of 2000 hours to qualify.

Incremental Costs and Customer Incentives for Efficient Motors				
Size HP	Open Drip-Proof (ODP)		Totally Enclosed Fan-Cooled (TEFC)	
	Incremental Cost	Customer Incentive	Incremental Cost	Customer Incentive
1	\$52	\$45	\$52	\$50
1.5	\$60	\$45	\$60	\$50
2	\$61	\$54	\$61	\$60
3	\$54	\$54	\$54	\$60
5	\$63	\$54	\$63	\$60
7.5	\$123	\$81	\$123	\$90
10	\$116	\$90	\$116	\$100
15	\$115	\$104	\$115	\$115
20	\$115	\$113	\$115	\$125
25	\$201	\$117	\$201	\$130
30	\$231	\$135	\$231	\$150
40	\$249	\$162	\$249	\$180
50	\$273	\$198	\$273	\$220
60	\$431	\$234	\$431	\$260
75	\$554	\$270	\$554	\$300
100	\$658	\$360	\$658	\$400
125	\$841	\$540	\$841	\$600
150	\$908	\$630	\$908	\$700
200	\$964	\$630	\$964	\$700

Sources:
1) MotorUp! Program Evaluation and Market Assessment, Pages 2-8, Prepared for NEEP Motors Initiative Working Group, Prepared by Xenergy, September 6, 2001
2) 2002 MotorUp! Three-Phase Electric Motor Incentive Application

Baseline Motor Efficiencies – η_{base} (EPACT)

2001 Vermont Guidelines for Energy Efficient Commercial Construction

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

Lighting End Use

CFL

Measure Number: IV-E-1-1 (Efficient Products Program, Lighting End Use)

Version Date & Revision History

Draft date: Portfolio No. 37
 Effective date: 1/1/05
 End date: TBD

Referenced Documents: 1) 2005_lighting_wattage_EPP.xls

Description

An existing incandescent screw-in bulb is replaced with a lower wattage ENERGY STAR qualified compact fluorescent screw-in bulb

Estimated Measure Impacts

	Average Annual MWH Savings per unit	Average number of measures per year	Average Annual MWH savings per year
Residential	0.0442	65,000	2,873.0
Commercial	0.1626	4,825	784.5

Algorithms

Demand Savings³¹⁴

$\Delta kW = ((\Delta Watts) / 1000) \times ISR \times WHF_d$
 $\Delta kW(\text{Residential}) = ((48.7) / 1000) \times 0.73 \times 1.0 = 0.0356$
 $\Delta kW(\text{Commercial}) = ((48.7) / 1000) \times 0.9 \times 1.2 = 0.0526$

Energy Savings

$\Delta kWh = \Delta kW \times HOURS \times WHF_c / WHF_d$
 $\Delta kWh(\text{Residential}) = (0.0356 \times 1241) \times 1.0 / 1.0 = 44.2$
 $\Delta kWh(\text{Commercial}) = (0.0526 \times 3500) \times 1.06 / 1.2 = 162.6$

Where:

$\Delta Watts$ = EVT and DPS October 2004 negotiated delta watts from $Watts_{BASE} - Watts_{EE}$
 ΔkW = gross customer connected load kW savings for the measure
 $Watts_{BASE}$ = Baseline connected kW
 $Watts_{EE}$ = Energy efficient connected kW
 ΔkWh = gross customer annual kWh savings for the measure
 ISR = in service rate or the percentage of units rebated that actually get used³¹⁵
 WHF_d = Waste heat factor for demand to account for cooling savings from efficient lighting.
 For a cooled space, the value is 1.2 (calculated as $1 + (0.50 \times (0.85) / 2.5)$). Based on 2.5 COP cooling system efficiency and assuming 50% of spaces that are cooled and 85% of lighting heat that needs to be mechanically cooled at time of summer peak. (From 1993 ASHRAE Journal: Calculating Lighting and HVAC interactions which assumes that 80% of lighting heat offsets heating requirements, and 90% of lighting heat needs

³¹⁴ Assumed difference in wattage between installed CFL and the incandescent bulb it replaces. Based on EVT analysis of CFLs rebated through Efficient Products Program.

³¹⁵ ISR differs for residential and commercial applications. See table below for ISR in each application.

to be mechanically cooled.) For an uncooled space, the value is one. The Winter and Fall/Spring coincident factors in loadshape #63 have been decreased to offset the increase in the ΔkW due to the WHF_d . Therefore, the cooling savings are only added to the summer peak savings.

WHF_c = Waste heat factor for energy to account for cooling savings from efficient lighting. For a cooled space, the value is 1.06 (calculated as $1 + (0.50 \times (0.29) / 2.5)$). Based on 0.29 ASHRAE Lighting waste heat cooling factor for Vermont³¹⁶ and 50% of spaces that are cooled and 2.5 C.O.P. typical cooling system efficiency. For an uncooled space, the value is one.³¹⁷

HOURS = average hours of use per year³¹⁸

Waste Heat Adjustment

Cooling savings are incorporated into the electric savings algorithm with the waste heat factor (WHF). See above.

Heating Increased Usage

$\Delta MMBTU_{WH}$ = $(\Delta kWh / WHF_c) \times 0.003413 \times AR \times HF / 0.75$

$\Delta MMBTU_{WH}$ (Residential) = $(44.2 / 1) \times 0.003413 \times 1.00 \times 0.00 / 0.75 = 0.0$

$\Delta MMBTU_{WH}$ (Commercial) = $(162.6 / 1.06) \times 0.003413 \times 0.70 \times 0.39 / 0.75 = 0.191$

Where:

$\Delta MMBTU_{WH}$ = gross customer annual heating MMBTU fuel increased usage for the measure from the reduction in lighting heat.

0.003413 = conversion from kWh to MMBTU

AR = Typical aspect ratio factor. ASHRAE heating factor applies to perimeter zone heat, therefore it must be adjusted to account for lighting in core zones. It is assumed that 70% is the typical square footage of commercial buildings within 15 feet of exterior wall. The assumed aspect ratio for residential buildings is 100%.

HF = ASHRAE heating factor for lighting waste heat for Burlington, Vermont³¹⁹

0.75 = average heating system efficiency

Oil heating is assumed typical for commercial.

Baseline Efficiencies – New or Replacement

The baseline condition is an incandescent light bulb.

High Efficiency

High efficiency is an ENERGY STAR qualified compact fluorescent lamp.

Operating Hours

Residential: 1,241 hours / year

Commercial: 3,500 hours / year³²⁰

Loadshape

Residential: Loadshape #1: Residential Indoor Lighting

Commercial: Loadshape #63: Commercial Indoor Lighting with cooling bonus. This is a combined lighting and cooling loadshape

Source: Vermont State Cost-Effectiveness Screening Tool.

³¹⁶ From "Calculating lighting and HVAC interactions", Table 1, ASHRAE Journal November 1993

³¹⁷ Waste heat factor differs for residential and commercial applications. See table below for WHF_c in each application.

³¹⁸ Hours of usage differs for residential and commercial applications. See table below for HOURS at each application.

³¹⁹ From "Calculating lighting and HVAC interactions", Table 1, ASHRAE Journal November 1993. Heating factor differs for residential and commercial applications. See table below for HF in each application.

³²⁰ Commercial hours of use based on standard hours of use for commercial indoor lighting from Vermont State Cost Effectiveness Screening Tool.

Freeridership/Spillover Factors

Measure Category		Light Bulbs/Lamps	
Measure Code		LBLCFBLB	
Product Description		Compact Fluorescent screw-base bulbs	
Track Name	Track No.	Freerider	Spillover
Act250 NC	6014A250	n/a	n/a
Cust Equip Rpl	6013CUST	n/a	n/a
Farm NC	6014FARM	n/a	n/a
Farm Equip Rpl	6013FARM	n/a	n/a
Non Act 250 NC	6014NANC	n/a	n/a
Pres Equip Rpl	6013PRES	n/a	n/a
C&I Retro	6012CNIR	n/a	n/a
MF Mkt Retro	6012MFMR	n/a	n/a
Efficient Products	6032EPEP	0.94	1.25
LISF Retrofit	6034LISF	n/a	n/a
LIMF Retrofit	6017RETR	n/a	n/a
LIMF NC	6018LINC	n/a	n/a
LIMF Rehab	6018LIRH	n/a	n/a
RES Retrofit	6036RETR	n/a	n/a
RNC VESH	6038VESH	n/a	n/a
MF Mkt NC	6019MFNC	n/a	n/a

Persistence

The persistence factor is assumed to be one.

Lifetimes

Lifetime is a function of the average hours of use for the lamp. Most CFLs have a *rated* lifetime of 10,000 hours. However, units that are turned on and off more frequently have shorter lives and those that stay on for longer periods of time have longer lives. Thus, CFLs rebated through this program are assumed to have a life of 8,000 hours for residential applications (assumed average daily usage of 3.4 hours) and 12,000 hours for commercial applications (assumed daily usage of 9.6 hours). That translates to 6.4 years for residential applications and 3.4 years for commercial applications.

Analysis period is the same as the lifetime.

Measure Cost

The incremental cost for this measure is \$6

Incentive Level

The incentive level for this measure is \$2