Specialty Compact Fluorescent Screw in Bulb

Measure Number: IV-A-2 c
Portfolio: 13
Status: Active
Effective Date: 1/1/2015
End Date: 12/31/2019
Program: Efficient Products
End Use: Lighting

Referenced Documents

- Table HC7.10 Air Conditioning in Homes in South Region, Divisions, and States, 2009
- 2009 Residential Energy Consumption Survey
- Mid-Atlantic TRM 2013 V.3.0
- Historical Census of Housing Tables - House Heating Fuel

Applicable Markets

Applicable Markets
Commercial & Institutional
Multifamily
Efficient Products
Residential

Description

An ENERGY STAR qualified specialty compact fluorescent bulb installed in place of an incandescent specialty bulb. Specialty CFL bulbs are defined as lamps for general illumination that use fluorescent light emitting technology and an integrated electronic ballast with or without a standard Edison screw-base. They can be dimmable, designed for special applications, have special color enhancement properties or have screw-bases that are not standard Edison bases, and include A-lamps, candelabras, G-lamps (globe), reflectors, torpedoes, dimmables, and 3-way bulbs. Note specialty CFL bulbs are currently exempt from EISA regulations.

Note that assumptions are provided for Residential and Commercial customers. In addition separate freerider and spillover assumptions are provided for those customers that are typically unable to take advantage of the Retail EP program for economic, cultural or age-related reasons (Hard to Reach). Hard to reach products are distributed through Foodbanks and other locations serving disadvantaged populations.

Baseline Efficiencies

The baseline is a standard incandescent specialty light bulb.

Efficient Equipment

The efficient condition is an ENERGY STAR qualified specialty compact fluorescent bulb.

Algorithms

Electric Demand Savings

Market	Wattage Category Algorithm	ΔkW

	<= 15W	= (39.4 / 1000) * 0.95 * 1.252	0.0469
Commercial & Institutional Direct Install			
	> 15W	= (57.6 / 1000) * 0.95 * 1.252	0.0685
	<= 15W	= (39.4 / 1000) * 0.88 * 1.224	0.0424
Multifamily Direct Install In Unit			
	> 15W	= (57.6 / 1000) * 0.88 * 1.224	0.0620
	<= 15W	= (39.4 / 1000) * 0.88 * 1.224	0.0424
Residential Direct Install Interior			
	> 15W	= (57.6 / 1000) * 0.88 * 1.224	0.0620
	<= 15W	= (40.7 / 1000) * 0.92 * 1.224	0.0458
Efficient Products Residential - Retail & Hard to Reach			
	> 15W	= (69.8 / 1000) *0.92 * 1.224	0.0786
	<= 15W	= (40.7 / 1000) * 0.79 * 1.252	0.0403
Efficient Products Commercial - Retail			
	> 15W	= (69.8 / 1000) * 0.79 * 1.252	0.0690

ΔkW	= ((ΔWatts) / 1000) × ISR × WHF_d

Symbol Table

Electric Energy Savings

Market	Wattage Category	Algorithm	ΔkWh
	<= 15W	= (39.4 / 1000) * 3352 * 0.95 * 1.133	141.35
Commercial & Institutional Direct Install			
	> 15W	= (57.6 / 1000) * 3352 * 0.95 * 1.133	206.64
	<= 15W	= (39.4 / 1000) * 1150 * 0.88 * 1.122	44.74
Multifamily Direct Install In Unit			
	> 15W	= (57.6 / 1000) * 1150 * 0.88 * 1.122	65.40
	<= 15W	= (39.4 / 1000) * 1150 * 0.88 * 1.122	44.74
Residential Direct Install Interior			
	> 15W	= (57.6 / 1000) * 1150 * 0.88 * 1.122	65.40
	<= 15W	= (40.7 / 1000) * 1150 * 0.92 * 1.122	48.31
Efficient Products Residential - Retail & Hard to Reach			

	> 15W	= (69.8) / 1000) *1150 * 0.92 * 1.122	82.86
	<= 15W	= (40.7 / 1000) * 3333 * 0.79 * 1.133	121.42
Efficient Products Commercial - Retail			
	> 15W	= (69.8 / 1000) * 3333 * 0.79 * 1.133	208.23

*Note for Total DkWh savings see table Heating Penalty Algorithm below.

ΔkWh	= ((ΔWatts) / 1000) × HOURS × ISR × WHF_e
ΔWatts	= $Watts_{BASE}$ – $Watts_{EE}$

Symbol Table

Water Savings
Fossil Fuel Savings

Default values:

Market	Wattage Category	Algorithm	ΔMMBtu
	<= 15W	= (-157.49/ 1.133) * 0.003413 * (1-0.25) * 0.7 * 0.23 * 0.95 / 0.75	-0.073
Commercial & Institutional Direct Install			
	> 15W	= (-224.58/1.133) * 0.003413 * (1-0.25) * 0.7 * 0.23 * 0.95 / 0.75	-0.103
	<= 15W	= -(((39.4/ 1000) * 0.88 * 1150 * 0.5 * 0.003412) / 0.78) * 0.76	-0.066
Multifamily Direct Install In Unit			
	> 15W	= - (((57.6/ 1000) * 0.88 * 1150 * 0.5 * 0.003412) / 0.78) * 0.76	-0.097
	<= 15W	= -(((39.4/ 1000) * 0.88 * 1150 * 0.5 * 0.003412) / 0.78) * 0.76	-0.066
Residential Direct Install Interior			
	> 15W	= - (((57.6/ 1000) * 0.88 * 1150 * 0.5 * 0.003412) / 0.78) * 0.76	-0.097
	<= 15W	= - (((40.7/ 1000) * 0.92 * 1150* 0.5 * 0.003412) / 0.78) * 0.76	-0.072
Efficient Products Residential - Retail & Hard to Reach			
	> 15W	= - (((69.8/ 1000) * 0.92 * 1150 * 0.5 * 0.003412) / 0.78) * 0.76	-0.123
	<= 15W	= ((-115.51 /1.133) * 0.003413 * 0.75 * 0.7 * 0.23 * 0.95) / 0.75	-0.053
Efficient Products Commercial - Retail			
	> 15W	= ((-193.8 /1.133) * 0.003413 * 0.75 * 0.7 * 0.23 * 0.95) / 0.75	-0.089

$\Delta MMBtu_{residential}$	= - ((((ΔWatts) / 1000) × ISR × HOURS × HF × 0.003412) / ηHeat) × %GasHeat
$\Delta MMBTU_{Commercial}$	= ((- ΔkWh / WHF_e) x 0.003413 x (1 - OA) x AR x HF x DFH) / 0.75

Symbol Table

Midlife Adjustment
Electric Heating Penalty

Market	Wattage Category	Algorithm	Heating Penalty ΔkWh	
Commercial & Institutional Direct Install	<= 15W	Natural Gas heating is assumed typical for commercial buildings.	N/A	**141.4**
	> 15W			**206.6**
Multifamily Direct Install In Unit	<= 15W	= - (((39.4 / 1000) * 0.88 * 1150 * 0.5) / 1.67) *0.24	-2.87	**41.9**
	> 15W	= - (((57.6/ 1000) * 0.88 * 1150 * 0.5) / 1.67) *0.24	-4.19	**61.2**
Residential Direct Install Interior	<= 15W	= - (((39.4 / 1000) * 0.88 * 1150 * 0.5) / 1.67) *0.24	-2.87	**41.9**
	> 15W	= - (((57.6/ 1000) * 0.88 * 1150 * 0.5) / 1.67) *0.24	-4.19	**61.2**
Efficient Products Residential - Retail & Hard to Reach	<= 15W	= - (((40.7/ 1000) * 0.92 * 1150 * 0.5) / 1.67) *0.24	-3.09	**45.2**
	> 15W	= - (((69.8/ 1000) * 0.92 * 1150 * 0.5) / 1.67) *0.24	-5.31	**77.6**
Efficient Products Commercial - Retail	<= 15W	Natural Gas heating is assumed typical for commercial buildings.	N/A	**121.4**
	> 15W			**208.2**

ΔkWh	= - (((ΔWatts/ 1000) × ISR × HOURS × HF) / ηHeat) × %ElecHeat

Where:

%ElecHeat	=	Percentage of home with electric heat = 0 if gas heated home, 1 if electric heated home, if unknown use 0.24[24]
%GasHeat	=	Percentage of home with gas heat = 1.0 if gas heated home, 0 if electric heated home, if unknown use 0.76[12]
ΔkW	=	Gross customer connected load kW savings for the measure.
ΔkWh	=	Gross customer annual kWh savings for the measure. Negative value denotes that this is an increase in heating consumption due to efficient lighting and interactive effects.
$\Delta MMBTU_{Commercial}$	=	-ΔkWh x 0.000462
$\Delta MMBtu_{residential}$	=	Negative value because this is an increase in heating consumption due to the efficient lighting.
ΔWatts	=	Average delta watts between specialty CFL and incandescent $Watts_{BASE}$ – $Watts_{EE}$

Market	Wattage Category	ΔWatts

All Direct Install[1]	<= 15W	39.4
	> 15W	57.6
All Efficient Products[2]	<= 15W	40.7
	> 15W	69.8

ηHeat	=	Efficiency in COP of Heating equipment = actual. If not available use defaults below[17]:

System Type	*Age of Equipment*	*HSPF Estimate*	*ηHeat (COP Estimate)*
Heat Pump	Before 2006	6.8	2.00
	After 2006	7.7	2.26
Resistance	N/A	N/A	1.00
Unknown[18]	N/A	N/A	1.67

$Watts_{BASE}$	=	Baseline connected kW.
0.003412	=	Converts kWh to MMBtu.
0.003413	=	Constant to convert kWh to MMBTU.
0.75	=	Assumed heating system efficiency[19].
AR	=	Typical aspect ratio factor. The ASHRAE heating factor applies to perimeter zone heat, therefore it must be adjusted to account for lighting in core zones. = 0.7[20]
DFH	=	*Percent of lighting in heated spaces, assumed to be 95%*
HF	=	Heating Factor or percentage of light savings that must be heated. = 50%[21]for interior or unknown location. = 0% for exterior or unheated location. = ASHRAE heating factor – fraction of lighting heat that contributes to space heating = 0.23[22]
HOURS	=	Average hours of use per year Dependent on **Market.**

Market	**Hours**
Commercial & Institutional Direct Install[10]	**3352**
Multifamily Direct Install In-Unit[11]	**1150**
Residential Direct Install Interior[12]	**1150**
Efficient Products Residential - Retail & Hard to Reach[13]	**1150**
Efficient Products Commercial - Retail[14]	**3333**

ISR	=	In service rate or the percentage of units rebated that actually get used Dependent on **Market**.

Market	**ISR**
Commercial & Institutional Direct Install[3]	0.95
Multifamily Direct Install Interior[4]	0.88
Residential Direct Install Interior[5]	0.88
Efficient Products Residential - Retail & Hard to Reach[6]	0.92
Efficient Products Commercial - Retail[7]	0.79

OA	=	Outside Air - the average percent of the supply air that is Outside Air, assumed to be 25%[23].
$Watts_{EE}$	=	Energy efficient connected kW.
WHF_d	=	Waste Heat Factor for Demand to account for cooling savings from efficient lighting

Market	WHF_d
Commercial & Institutional – Direct Install[8]	**1.252**
Residential and Multifamily – Direct Install[9]	**1.224**
All Exterior	**1.0**

WHF_e	=	Waste Heat Factor for Energy to account for cooling savings from efficient lighting.

Market	WHF_e
Commercial & Institutional – Direct Install[15]	**1.133**
Residential and Multifamily – Direct Install[16]	**1.122**

WHF_e	=	Waste Heat Factor for Energy to account for cooling savings from efficient lighting.

Market	WHF_e
Commercial & Institutional – Direct Install[15]	**1.133**
Residential and Multifamily – Direct Install[16]	**1.122**
All Exterior	**1.0**

Load Shapes

1a Residential Indoor Lighting
3a Commercial Indoor Lighting - Blended
24a Residential A/C
25a Commercial A/C

Number	Name	Status	Assigned To	Portfolio	Winter On kWh	Winter Off kWh	Summer On kWh	Summer Off kWh	Winter kW	Summer kW	Effective Date	Expiration Date
1	Residential Indoor Lighting	Active			35.7 %	36.2 %	12.9 %	15.2 %	0.0 %	11.0 %	1/1/2012	
3	Commercial Indoor Lighting - Blended	Active			46.0 %	23.0 %	21.0 %	11.0 %			1/1/2012	
24	Residential A/C	Active			0.8 %	2.7 %	51.8 %	44.7 %	0.0 %	66.0 %	1/1/2012	
25	Commercial A/C	Active			15.4 %	3.9 %	58.9 %	21.8 %	0.0 %	67.7 %	1/1/2012	

Net Savings Factors

Measures

LBLCFBLB	Compact Fluorescent screw-base bulbs

Tracks

7101PVMR	7101PVMR

Track Name	Track Nr.	Measure Code	Free Rider	Spillover
7101PVMR	7101PVMR	LBLCFBLB	1.00	1.00

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 lifetimes, and those that stay on continuously for longer periods of time have longer lifetimes. CFLs rebated through this program for commercial applications are assumed to have a life of 12,000 hours (assumed annual use of 3333). That translates to 3.6 years for commercial applications. Nexus Market Research recently analyzed and report measure life for residential applications in the Residential Lighting Measure Life Study dated June 4, 2008. Measure life for residential markdown specialty CFL's is 6.8[25] yr. Analysis period is the same as the lifetime.

Measure Cost

The incremental cost for specialty bulbs in the Northeast Residential Lighting Strategy (RLS) report, 2011 was $5. The ratio of incremental cost difference between the two size classifications as was found based on a review of available product to give separate incremental costs assumptions. See 2012_DeltaWatts_MeasureCost for more information.

Market	Wattage Category	Unit Cost[26] (Incremental or Full)	Labor Cost	Total Measure Cost
Commercial & Institutional – Direct Install	<= 15W	$8.16 (Full)	$3.59	$11.75
	> 15W	$8.84 (Full)	$3.59	$12.43
Multifamily – Direct Install	<= 15W	$8.16 (Full)	$3.59	$11.75
	> 15W	$8.84 (Full)	$3.59	$12.43
Residential – Direct Install	<= 15W	$8.16 (Full)	$3.59	$11.75
	> 15W	$8.84 (Full)	$3.59	$12.43
All Efficient Products	<= 15W	$5.45 (Incremental)	n/a	$5.45
	> 15W	$4.55 (Incremental)	n/a	$4.55

O&M Cost Adjustments

O& M cost adjustments are based on component costs provided in the reference table below.

Market	Wattage Category	Baseline 1 Replacement Time[27]	Baseline 1 Cost[28]
Commercial & Institutional – Direct Install	<= 15W	0.30	$2.71
	> 15W		$4.29
Multifamily – Direct Install	<= 15W	0.87	$2.71
	> 15W		$4.29
Residential – Direct Install	<= 15W	0.87	$2.71
	> 15W		$4.29
Efficient Products – Residential Retail & Hard to Reach	<= 15W	0.87	$2.71

	> 15W		$4.29
Efficient Products - Commercial	<= 15W	0.30	$2.71
	> 15W		$4.29

Footnotes

[1] The delta watts is calculated by finding the weighted average wattage of specialty bulbs installed in Efficiency Vermont's Existing Homes, Low Income and RNC programs from 01/2011-10/2014. The equivalent incandescent wattage was used to calculate delta watts. See: 2011-2014 Specialty DI.xlsx

[2] Assumed difference in wattage between installed CFL and the incandescent bulb it replaces. Based on EVT analysis of bulbs purchased through the Efficient Product program between 2012 and 2014 YTD and using an equivalent baseline based on the ENERGY STAR consumer guide. See SpecCFL_EVT_2011-14.xlsx for more information.

[3] EmPOWER Maryland DRAFT 2010 Interim Evaluation Report, Chapter 2: Commercial and Industrial Prescriptive, Navigant Consulting, 2010.

[4] Assumption is based on the EmPOWER Maryland 2011 Evaluation Report used in Mid Atlantic TRM Version 3.0.

[5] Assumption is based on the EmPOWER Maryland 2011 Evaluation Report used in Mid Atlantic TRM Version 3.0.

[6] Starting with a first year ISR of 0.88 (based on EmPOWER Maryland 2011 Evaluation Report; Chapter 5: Lighting and Appliances) and a lifetime ISR of 0.97 (from Nexus Market Research, RLW Analytics and GDS Associates study; "New England Residential Lighting Markdown Impact Evaluation, January 20, 2009"), and assuming 43% of the remaining 9% not installed in the first year replace incandescents (24 out of 56 respondents not purchased as spares; Nexus Market Research, RLW Analytics, October 2004; "Impact Evaluation of the Massachusetts, Rhode Island, and Vermont 2003 Residential Lighting Programs", table 6-7). ISR is therefore calculated as 0.88 + (0.43*0.09) = 0.92. See MidAtlantic CFL Adjustments.xls for calculation.

[7] Based on Mid Atlantic TRM 2013, data from EmPOWER Maryland 2011 Evaluation Report Chapter 2: Commercial and Industrial; and Chapter 5 Residential Lighting and Appliances Prescriptive, Navigant, 2012.

[8] Waste heat factor to account for cooling demand savings from efficient lighting. The value is estimated at 1.25 (calculated as 1 + (0.74*(0.85) / 2.5)). Based on 2.5 COP cooling system efficiency, estimate that 74% of commercial floorspace in the Mid-Atlantic region is cooled (Delmarva Commercial Baseline Research Project, Final Report, SAIC, 1995), and 85% of lighting heat that needs to be mechanically cooled at time of summer peak (methodology adopted from ASHRAE Journal, Calculating Lighting and HVAC Interactions, 1993).

[9] Waste heat factor for demand to account for cooling savings from efficient lighting. The value is estimated at 1.22 (calculated as 1 + (0.68 * 0.66) / 2.0)). Based on 2.0 COP cooling system efficiency during peak hours, and 68% of homes have central cooling, based on 2009 EIA data for DC. (http://www.eia.gov/consumption/residential/data/2009/xls/HC7.10%20Air%20Conditioning%20in%20South%20Region.xls). The 66% factor represents the average Residential cooling coincidence factor calculated by dividing average load during the peak hours divided by the maximum cooling load.

[10] Based on report findings Interior Lighting Hours of Use and Coincidence Factor Values for EmPOWER Maryland Commercial Lighting Program Evaluations, Itron, 2010 and weighted average of 2010 U.S. Census data of District of Columbia's percentage of commercial and institutional space. See reference file Lighting hours of use weighted average 2013_Final.xlsx for details.

[11] Based on EmPOWER Maryland 2011Evaluation Report; Chapter 5: Residential Lighting and Appliances.

[12] Ibid.

[13] Based on EmPOWER Maryland 2011 Evaluation Report; Chapter 5: Residential Lighting and Appliances.

[14] Based on report findings Interior Lighting Hours of Use and Coincidence Factor Values for EmPOWER Maryland Commercial Lighting Program Evaluations, Itron, 2011 and weighted average of 2010 U.S. Census data of District of Columbia's percentage of commercial and institutional space. See reference file Lighting hours of use weighted average 2013_Final.xlsx for details.

[15] Waste heat factor to account for cooling energy savings from efficient lighting. The value is estimated at 1.13 (calculated as 1 + (0.74*(0.45) / 2.5)). Based on 0.45 ASHRAE Lighting waste heat cooling factor for Washington DC and estimate that 74% of commercial floorspace in the Mid-Atlantic region is cooled (Commercial Baseline Research Project, Final Report, SAIC, 1995) with 2.5 C.O.P. typical cooling system efficiency (methodology adopted from ASHRAE Journal, Calculating Lighting and HVAC Interactions, 1993).

[16] Waste heat factor for energy to account for cooling savings from efficient lighting. The value is estimated at 1.122 (calculated as 1 + (0.68*(0.45) / 2.5)). Based on 0.45 ASHRAE Lighting waste heat cooling factor for Washington DC (http://lighting.bki.com/pubs/b6_tab1.htm) and assuming typical cooling system operating efficiency of 2.5 COP (accounting for distribution losses, inadequate airflow etc.) Assuming 68% of homes have central cooling, based on 2009 EIA data for DC.

(http://www.eia.gov/consumption/residential/data/2009/xls/HC7.10%20Air%20Conditioning%20in%20South%20Region.xls)

[17] These default system efficiencies are based on the applicable minimum Federal Standards. In 2006 the Federal Standard for Heat Pumps was adjusted. While one would expect the average system efficiency to be higher than this minimum, the likely degradation of efficiencies over time mean that using the minimum standard is appropriate.

[18] Calculation assumes 59% Heat Pump and 41% Resistance which is based upon data from Energy Information Administration, 2009 Residential Energy Consumption Survey: see HC6.10 Space Heating in South Region.xls. Average efficiency assumption assumes 50% HP before 2006 and 50% after.

[19] Typical heating system efficiency of 75%, consistent with current federal standards for fossil fuel-fired systems.

[20] HVAC-Lighting interaction impacts adapted from 1993 ASHRAE Journal: Calculating Lighting and HVAC Interactions. Typical aspect ratio for perimeter zones. Heating factor applies to perimeter zoneheat, therefore it must be adjusted to account for lighting in core zones. It is assumed that 70% of C&I buildings is within 15 feet of perimeter wall.

[21] This means that heating loads increase by 50% of the lighting savings. This is based on the average result from REMRate modeling of several different configurations of homes in DC.

[22] Fraction of lighting heat that contributes to space heating. Based on 0.23 factor for Washington DC (from 1993 ASHRAE Journal: Calculating Lighting and HVAC Interactions).

[23] 2009 ASHRAE Handbook Fundamentals (p. 16.2): "Conventional all-air air-handling systems for commercial and institutional buildings have approximately 10 to 40% outside air."

[24] Based on data from United States Census Bureau Historical Data of House Heating Fuel Tables: http://www.census.gov/hhes/www/housing/census/historic/fuels.html

[25] Residential Lighting Measure Life Study, Nexus Market Research, June 4, 2008

[26] Based on Northeast Regional Residential Lighting Strategy (RLS) report, prepared by EFG, D&R International, Ecova and Optimal Energy, applying sales weighting and phase-in of EISA regulations. Assumption is $2.50 for CFL over three years and $0.6 for baseline in 2012, $0.70 in 2013 and $1.00 in 2014 as more expensive EISA qualified bulbs become baseline.

[27] Based on standard assumption of 1000 hours lamp life for baseline bulb.

[28] Baseline cost is consistent with the assumptions from the NEEP Residential Lighting Survey, 2011. This evaluation did not provide the <=15W and >15W categories and so the costs from VEIC's analysis of baseline costs are adjusted such that the average matches the values from the NEEP study.