**Work Paper SCE13LG072**

**Revision 1**

**Southern California Edison Company**

**Upstream Interior 3-way and Dimmable CFLs**

# At-a-Glance Summary

|  |  |
| --- | --- |
| ****Applicable Measure Codes:**** | LT-18824, LT-60597, LT-29056, LT-10897, LT-69222, LT-71877, LT-28745, LT-36849, LT-32612, LT-29102, LT-36578, LT-48735, LT-68121, LT-59681, LT-46984, LT-92345, LT-47544, LT-50945, LT-67349, LT-28456, LT-78932, LT-67932, LT-69524, LT-72839, LT-72839, LT-90414, LT-89655 |
| **Measure Description:** | 3-way, dimming, or dimming with reflector Compact Fluorescent Lamps (CFLs) |
| **Base Case Description:** | Existing incandescent lamp |
| **Energy Impact Common Units:** | Lamp |
| **Energy Savings :** | Refer to Excel Calculation Attachment |
| **Gross Measure Cost ($/unit)** | Refer to Excel Calculation Attachment |
| **Measure Incremental Cost ($/unit):** | Refer to Excel Calculation Attachment |
| **Effective Useful Life (years):** | DEER14: 9.24 for Res and 3.3 for Non-Res measures. |
| **Measure Application Type:** | Replace on Burnout (ROB) |
| **Net-to-Gross Ratios:** | DEER14: 0.54 for Res and Non-Res measures. |
| **Important Comments:** | **This work paper document does not contain a data set in conformance with the 4/1/14 CPUC Ex Ante Database Specification; SCE will provide that data set separately.** |

# Document Revision History

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Workpaper and Revision # | Tech. Revision | MM/DD/YY | Author/Affiliation | Summary of Changes |
| SCE13LG072.0 | No | 4/12/12 | Nick Bengtson/PECI | Original work paper for 2013 PC |
| Yes | 4/12/12 | Brian V. O’Keefe/SCE | - Installation rate was removed from the gross calculations for kW. This factor will be kept separate from the gross savings values until reporting.  - Calculation Template was updated with the latest template for residential therm values. |
| SCE13LG072.1 | Yes | 5/29/2014 | Jason Wang/SCE | -Work paper updated for the reporting period, effective 7/1/14 – 12/31/14.  -Updated 3-way CFL savings methodology to align with PG&E approach. |

# Section 1. General Measure & Baseline Data

## 1.1 Measure Description & Background

The measure case is a 3-way, dimming, or dimming with reflector integral screw-in compact fluorescent lamp (CFL) ranging from 10 to 40 Watts. The base case is an incandescent lamp with wattage determined by multiplying the measure case wattage by a wattage ratio.

Table 1 Measure Names

|  |  |
| --- | --- |
| Solution Code | Measure name |
| LT-18824 | 10 Watt Dimming CFL replacing Incandescent |
| LT-60597 | 11 Watt Dimming CFL replacing Incandescent |
| LT-29056 | 13 Watt 3-Way CFL replacing Incandescent |
| LT-10897 | 14 Watt Dimming CFL replacing Incandescent |
| LT-69222 | 15 Watt 3-Way CFL replacing Incandescent |
| LT-71877 | 15 Watt Dimming CFL replacing Incandescent |
| LT-28745 | 15 Watt Dimming with Reflector CFL replacing Incandescent |
| LT-36849 | 16 Watt Dimming CFL replacing Incandescent |
| LT-32612 | 16 Watt Dimming with Reflector CFL replacing Incandescent |
| LT-29102 | 18 Watt 3-Way CFL replacing Incandescent |
| LT-36578 | 18 Watt Dimming CFL replacing Incandescent |
| LT-48735 | 19 Watt Dimming CFL replacing Incandescent |
| LT-68121 | 20 Watt Dimming CFL replacing Incandescent |
| LT-59681 | 20 Watt Dimming with Reflector CFL replacing Incandescent |
| LT-46984 | 23 Watt 3-Way CFL replacing Incandescent |
| LT-92345 | 23 Watt Dimming CFL replacing Incandescent |
| LT-47544 | 25 Watt 3-Way CFL replacing Incandescent |
| LT-50945 | 25 Watt Dimming CFL replacing Incandescent |
| LT-67349 | 26 Watt 3-Way CFL replacing Incandescent |
| LT-28456 | 26 Watt Dimming CFL replacing Incandescent |
| LT-78932 | 26 Watt Dimming with Reflector CFL replacing Incandescent |
| LT-67932 | 28 Watt 3-Way CFL replacing Incandescent |
| LT-69524 | 29 Watt 3-Way CFL replacing Incandescent |
| LT-72839 | 32 Watt 3-Way CFL replacing Incandescent |
| LT-90414 | 33 Watt 3-Way CFL replacing Incandescent |
| LT-89655 | 40 Watt 3-Way CFL replacing Incandescent |

## 1.2 Technical Description

Eligible CFLs must be dimmable. These can be standard dimmable lamps that have a controller appropriately matched to its power. Compared to non-dimmable lamps, the circuitry in these lamps is configured to minimize flickering at lower operating power levels. Dimmable CFLs differ from incandescent lamps in that the color temperature stays the same regardless of lighting levels.

3-way lamps are composed of two filaments that enable three different power and light levels to simulate dimming. These require an appropriate socket and a 3-way 2-circuit switch. Like dimmable CFLs, the color temperature stays the same at each level.

The CFLs may also be combined with a reflector for improved lighting efficiency when dimmed.

## 1.3 Measure Application Type

Note: See Appendix A for a comparison of the application types used by and incorporated into SCE systems versus the application types available in the newest revision of DEER 2014. Appendix A will serve as a translation between the outputs of this workpaper and application types used by READi.

The delivery method is Upstream Programs – Up-Stream Buy Down.

The measure install type is ROB. ROB measures replace existing equipment with more energy efficient equipment on failure of the existing equipment.

## 1.4 Measure and Base Case Cost Effectiveness Data

### 1.4.1 DEER Measure and Base Case Analysis

The DEER 2014 READi tool does not have measures for 3-way or dimming CFLs.

Table 2 DEER Difference Summary

|  |  |
| --- | --- |
| DEER Difference Summary Table | |
| Modified DEER Methodology | No |
| Scaled DEER Measure | No |
| DEER Building Prototypes Used | No |
| Deviation from DEER | DEER does not include dimmable or 3-way CFL measures. |
| DEER Version | DEER14 |
| DEER Run ID and Measure Name (Sample) | N/A |

**Net to Gross**

The NTG value was obtained from the “DEER2011\_NTGR\_2012-05-16.xls” on the DEER website as required by Version 5 of the California Public Utilities Commission (CPUC) Energy Efficiency Policy Manual [351]. The relevant NTGR for this measure is shown in Table 3 below.

Table 3 Net-to-Gross Ratio

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| NTGR\_ID\* | Description\* | Sector\* | BldgType\* | ProgDelivID | NTG\* |
| NonRes-sAll-mCFL | CFL-screw in, All. | Com | Any | PreRebUp | 0.54 |
| Res-sAll-mCFL-up | CFL-screw in, All. | Res | Any | PreRebUp | 0.54 |

\*Denotes that the column is taken from the DEER NTG Table.

**Installation Rate**

The installation rate (IR) is from the 2006–08 Upstream Lighting Program Final Evaluation Report Volume 1, Table 17 [328]. The relevant IR values for this measure are shown in Table 4 below.

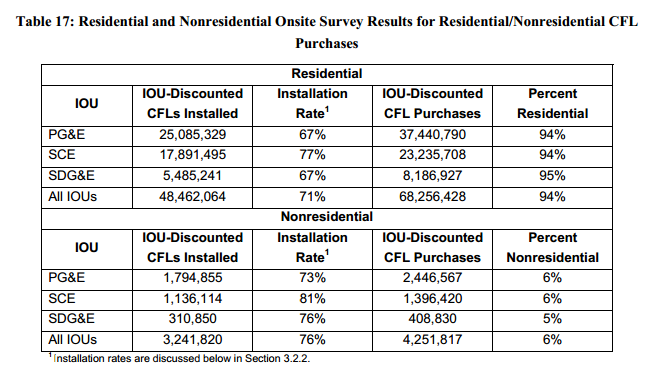


Figure 1 Installation Rates from Upstream Lighting Evaluation Report

Table 4 Installation Rate

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| GSIA\_ID | Description | Sector | BldgType | ProgDelivID | GSIAValue |
| N/A | SCE Non-residential Installation Rate | Non-residential | Any | Upstream | 0.81 |
| N/A | SCE Residential Installation Rate | Residential | Any | Upstream | 0.77 |

**Spillage Rate**

Spillage rate will also be applied to measures however the values will not be tracked in the workpapers. The spillage rate will be tracked in an external table to be supplied to the Energy Division.

**READi Technology Fields**

To support the development of the ED ex ante tables, select fields from the ex ante database will be identified in the workpaper. For a full set of values associated with the measures in the workpaper refer the Excel calculation template.

Table 5 READi Tech IDs

|  |  |
| --- | --- |
| READi Field Name | Values included in this workpaper |
| Measue Case UseCategory | Lighting |
| Measure Case UseSubCats | Indoor Lighting |
| Measure Case TechGroups | Lighting - Screw-in Lamps |
| Measure Case TechTypes | Integral CFL (with ballast) |
| Base Case TechGroups | Lighting - Screw-in Lamps |
| Base Case TechTypes | Incandescent Lamp |

### 1.4.2 Codes and Standards Analysis

Table 6 Code Summary

|  |  |  |
| --- | --- | --- |
| Code | Applicable Code Reference | Effective Dates |
| Title 20 (2014) | Table K-5 Standards for Medium Base Compact Fluorescent Lamps | July 1, 2014 |

Title 24 2013 [355] does not impact the measures in this work paper.

Title 20 2014 [422] includes standards for the lamp electrical power input of state-regulated general service incandescent lamps. However, instead of using Title 20 standards to determine maximum base case wattages, wattage ratios provided by the Energy Division (ED) are used. Title 20 also includes standards for medium base compact fluorescent lamps and dimmable systems. Eligible CFLs will comply with these requirements.

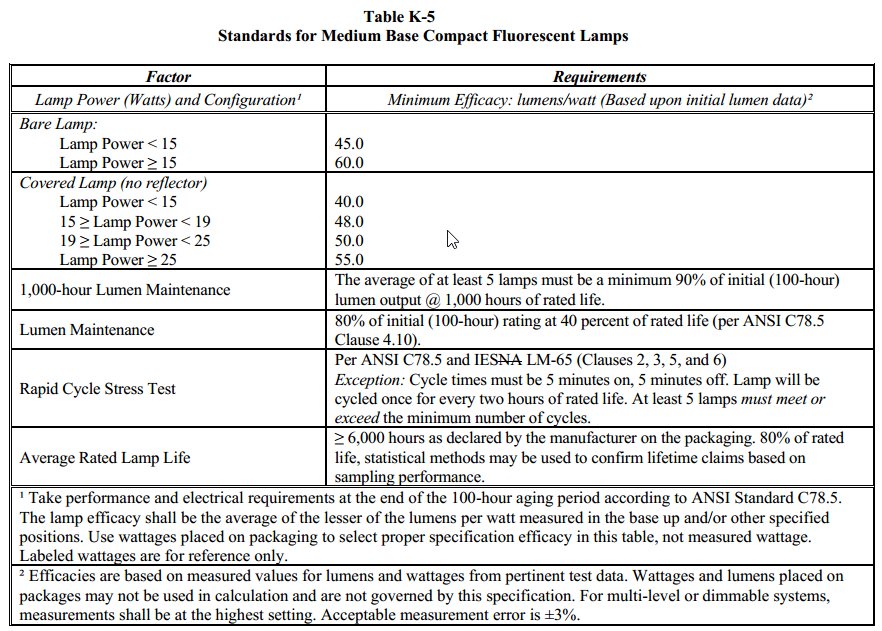


Figure 2 Title 20 CFL Standards

### 1.4.3 Non-DEER Study Review

The California Baseline Lighting Efficiency Technology (CBLET) Report Volume I [29] and the 2006–08 Upstream Lighting Program (ULP) Final Evaluation Report Volumes 1 and 2 [328, 432] are referenced in this work paper’s assumptions.

### 1.4.4 Measure and Base Case Effective Useful Life

DEER14 update documentation provides EUL and RUL information to be used for the 2013-14 program cycle on [www.deeresources.com](http://www.deeresources.com). The DEER documentation “Summary of EUL-RUL Analysis for the April 2008 Update to DEER” provides the RUL value as a flat 1/3 of the EUL value. The RUL value will only be applied to the first baseline period for retrofit measures that have applicable code that will affect the energy savings. In all other installation types and retrofit with no applicable code that affects the energy savings, the RUL is not applicable to either the first or second baseline period.

To obtain the EUL value the DEER14 update documentation, EUL\_Summary\_10-1-08.xls [213], was consulted. The EUL for CFL lamps is obtained by dividing the DEER CFL lamp life of 10,000 hours by the DEER building operating hours. Residential EULs are further multiplied by a switching degradation factor. The EUL varies by building type and climate zone. Table 7 below shows an example of the EUL value/methodology used for the measures in this work paper.

Table 7 DEER14 EUL Value/Methodology

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| READi EUL ID | Market | Enduse | Measure | EUL (Years) | RUL (Years) |
| ILtg-CFL-Com | Commercial | Lighting | CFL Lamps – Indoor – Commercial – 10,000 Hours | 3.3 | N/A |
| ILtg-CFL-Res | Residential | Lighting | CFL Lamps – Indoor – Residential – 10,000 Hours | 9.24 | N/A |

# Section 2. Energy Savings & Demand Reduction Calculations

The measure case wattages are indicated in the measure names. The base case wattages are calculated by multiplying the measure case wattage by the ED-provided ratios in Table 8.

Table 8 CFL Wattage Ratios

|  |  |  |
| --- | --- | --- |
| **Technology Type** | **Building Type** | **Wattage Ratio** |
| Screw-in CFLs | Commercial | 3.57 |
| Screw-in CFLs, non-reflector lamps | Residential | 3.47 |
| Screw in CFLs, reflector lamps | Residential | 4.09 |

*[Equation 1] Delta kW Calculation for a 23 W Non-reflector Residential CFL*

*Base Case Watts = 23 W \* 3.47 = 79.81 W*

*∆Watts/unit = Base Case Watts - Measure Case Watts*

*= 79.81 – 23*

*= 56.81 W*

*= .05681 kW*

**Watts and Hours Correction Factors**

The California Baseline Lighting Efficiency Technology (CBLET) report, Volume 1, page 83 [29], provides Watts and hours correction factors for dimmer and 3-way controls. The lighting savings calculated through DEER methodology are further multiplied by these 2 factors to determine final savings:



Figure 3 CBLET Energy Correction Factors

For 3-way Residential CFL measures, the Low and High hour factors (refer to Figure 3) are weighted averaged using data from the ULP report, Volume 2, Table 6 [432]. Figure 2 below is a table from the ULP report showing the location of lighting fixtures in a study of California’s residential lighting inventory:



Figure 4 California Lighting Fixture Locations

From the 2011 PG&E Work Paper Review (Attachment 3), the recommended hours factors are:

*3-way Residential = 0.67 \* 0.57 + 0.33 \* 1.25 = 0.79*

*3-way Non-residential = 0.5 \* 0.57 + 0.5 \* 1.25 = 0.91*

The final correction factors are:

Table 9 Correction Factors

|  |  |  |
| --- | --- | --- |
| Measure Type | Watts factor | Hours factor |
| Residential Dimmer | 0.8 | 0.92 |
| Residential 3-way | 0.8 | 0.79 |
| Non-residential Dimmer | 0.8 | 0.92 |
| Non-residential 3-way | 0.8 | 0.91 |

**Energy Savings and Demand Reduction**

Examples of savings calculations for a 23W 3-way CFL measure are provided below:

*[Equation 2] Residential 3-way CFL kWh Savings, Single Family Home, Climate Zone 06*

*[Equation 3] Non-residential 3-way CFL kWh Savings, Misc – Commercial, Climate Zone 06*

*[Equation 4] Residential 3-way CFL Demand Reduction, Single Family Home, Climate Zone 06*

*[Equation 5] Non-residential 3-way CFL Demand Reduction, Misc – Commercial, Climate Zone 06*

See the calculation template (Attachment 1) for all savings calculations.

# Section 3. Load Shapes

The difference between the base case load shape and the measure load shape would be the most appropriate load shape; however, only end-use profiles are available. Therefore, the closest load shape chosen for this measure is the DEER:Indoor\_CFL\_Ltg load shape. See Table 10 for a list of all Building Types and Load Shapes. See the KEMA report [31] for a more thorough discussion regarding the load shapes for this measure.

Table 10 Building Types and Load Shapes

|  |  |  |
| --- | --- | --- |
| Building Type | E3 Alt. Building Type | Load Shape |
| Residential Single Family | RES | DEER:Indoor\_CFL\_Ltg |
| Misc - Commercial | NON\_RES | DEER:Indoor\_CFL\_Ltg |
| Office - Small | NON\_RES | DEER:Indoor\_CFL\_Ltg |
| Restaurant - Sit-Down | NON\_RES | DEER:Indoor\_CFL\_Ltg |
| Retail - Small | NON\_RES | DEER:Indoor\_CFL\_Ltg |

# Section 4. Base Case & Measure Costs

## 4.1 Base Case Cost

Base case costs are from DEER 2008, which includes costs for 3-way but not dimming incandescent lamps. Therefore, costs for standard incandescent lamps are used as a substitute for dimming incandescent lamp costs. Since the majority of the dimming lamp base case wattages are under 100 Watts, and since the costs for 60, 75, and 100W standard incandescent lamps are the same ($0.68), the base case cost for all dimming measures is $0.68. The base case cost for the 3-way measures is the cost of a 100W 3-way incandescent lamp, $2.34.

Table 11 Base Case Costs

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Measure** | **Cost Case Description** | **DEER 2008 ID** | **Program Delivery Strategies** | **Base Case Cost** | **Labor Cost** |
| Dimming | Incandescent, medium base, 60W, 75W, 100W | D08-NE-ILtg-Inc-60W, D08-NE-ILtg-Inc-75W, D08-NE-ILtg-Inc-100W | All Program Delivery Strategies | $0.68 | $5.89 |
| 3-way | Incandescent, medium base, 3-way, 100W maximum | D08-NE-ILtg-Inc-3wy-100W | All Program Delivery Strategies | $2.34 | $5.89 |

## 4.2 Measure Case Cost

Measure costs are derived from DEER 2008, which includes costs for 13W, 23W, and 26W continuously dimmable and 3-way CFLs. The costs for 3-way CFLs greater than 26W are scaled based on costs in DEER. The costs for dimmable with reflector CFLs are equal to the DEER costs for dimmable CFLs, plus the added material cost for a reflector. Although some of these costs are for downstream, they are used since no equivalent upstream costs are available from DEER.

Table 12 shows a sample of the measure costs and sources. See Attachment 2 for full cost calculations.

Table 12 Measure Case Costs

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Measure | Cost Case Description | DEER 2008 ID | Measure Cost | Labor Cost |
| 10 Watt Dimming CFL replacing Incandescent | CFL, (1) 13W screw-in lamp, continously dimmable, Spiral, W/fixt=13 | D08-NE-ILtg-CFL-Int-13wCFLsdSMg13w-Rpl | $14.68 | $5.89 |
| 26 Watt Dimming CFL replacing Incandescent | CFL, (1) 26W screw-in lamp, continously dimmable, Spiral, W/fixt=26 | D08-NE-ILtg-CFL-Int-26wCFLsdSMg26w-Rpl | $14.68 | $5.89 |
| 15 Watt Dimming with Reflector CFL replacing Incandescent | N/A | Non-DEER | $19.47 | $5.89 |
| 13 Watt 3-Way CFL replacing Incandescent | CFL, (1) 13W screw-in lamp, 3-way dimmable, Spiral, W/fixt=13 | D08-NE-ILtg-CFL-Int-13wCFLs3wSMg13w-Rpl | $12.13 | $5.89 |
| 26 Watt 3-Way CFL replacing Incandescent | CFL, (1) 26W screw-in lamp, 3-way dimmable, Spiral, W/fixt=26 | D08-NE-ILtg-CFL-Int-26wCFLs3wSMg26w-Rpl | $12.13 | $5.89 |
| 28 Watt 3-Way CFL replacing Incandescent | N/A | Non-DEER | $13.00 | $5.89 |

## 4.3 Gross and Incremental Measure Cost

### 4.3.1 Gross Measure Cost

For ROB, Gross Measure Cost (GMC) is represented by the equation below:

*GMC = Measure Equipment Cost – Base Case Equipment Cost*

In the case of ROB, the equipment being replaced/installed is assumed to have failed in place or is past its useful life. In this scenario the customer is in the situation of having to purchase new equipment. The customer is faced with either purchasing standard efficiency or code baseline equipment versus energy efficient equipment. Because the customer will be spending money to replace their equipment anyway, the gross cost for the energy efficient measure is the premium paid above the non-efficient or code baseline equipment.

Table 13 shows a sample of the measure costs and sources. See Attachment 2 for full cost calculations.

Table 13 Gross Measure Cost

|  |  |  |  |
| --- | --- | --- | --- |
| Cost Case Description | Base Cost | Measure Cost | GMC and IMC |
| 10 Watt Dimming CFL replacing Incandescent | $0.68 | $14.68 | $14.00 |
| 26 Watt Dimming CFL replacing Incandescent | $0.68 | $14.68 | $14.00 |
| 15 Watt Dimming with Reflector CFL replacing Incandescent | $0.68 | $19.47 | $18.79 |
| 13 Watt 3-Way CFL replacing Incandescent | $2.34 | $12.13 | $9.79 |
| 26 Watt 3-Way CFL replacing Incandescent | $2.34 | $12.13 | $9.79 |
| 28 Watt 3-Way CFL replacing Incandescent | $2.34 | $13.00 | $10.66 |

### 4.3.2 Incremental Measure Cost

The Upstream Lighting Program offers different rebate amounts for the same CFL technology due to multiple vendors with different pricing. As a result, this work paper does not document the different incremental measure costs found in the E3 Calculator since it has been established that the incremental measure costs will change based on the different rebate amounts.

For ROB measures, the IMC and GMC are the same.

# Attachments

1. 

2. 

3. 

# References



|  |  |
| --- | --- |
| [29] | Lighting Efficiency Technology Report - Volume I California Baseline - Heschong Mahone Group (For CEC) - September 1999 |
| [31] | Load Shape Update Initiative - KEMA / JJ Hirsch and Assoc. / Itron Inc. - November 17, 2006 |
| [213] | EUL/RUL Values Provided through Excel Spreadsheet |
| [328] | Final Evaluation Report: Upstream Lighting Program - Volume 1 |
| [351] | Energy Efficiency Policy Manual-Version 5 |
| [355] | 2013 Building Energy Efficiency Standards for Residential and Nonresidential Buildings (Title 24) |
| [422] | 2014 Appliance Efficiency Regulations (Title 20) |
| [432] | Final Evaluation Report: Upstream Lighting Program - Volume 2 |

# Appendix A – SCE/ED Application Types

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| SCE Program Type | ED Application Type | 1st Baseline Savings | 2nd Baseline Savings | 1st Baseline Cost | 2nd Baseline Cost | 1st Baseline Life | 2nd Baseline Life |
| New | New Construction (Nc) | Above Code/Standard | N/A | Incremental Cost | N/A | EUL | 0 |
| Replace on Burnout (ROB) | Replace on Burnout (Rob)/Normal Replacement (NR) | Above Code/Standard | N/A | Incremental Cost | N/A | EUL | 0 |
| Retrofit (RET) | Early Replacement (ER) | Above Cust. Existing | Above Code/Standard | Full Cost | Incremental Cost | RUL | EUL-RUL |
| Retrofit – First Baseline Only (REF) | Early Replacement RUL (ErRul) | Above Cust. Existing | N/A | Full Cost | N/A | EUL | 0 |
| Retrofit Add-on (REA) | N/A | Above Cust. Existing | N/A | Full Cost | N/A | EUL | 0 |