**Work Paper PGE3PLTG173**

**Compact Fluorescent Direct Install**

**Revision 4**

**Pacific Gas & Electric Company**

**Customer Energy Efficiency Department**

**Compact Fluorescent Direct Install**

**Measure Codes 0L00-0L53, 0N01-0N13, L0234-L0235, L450, L856, LC70-LC107**

# At-a-Glance Summary

|  |  |
| --- | --- |
| **Applicable Measure Codes:** | **0L00-0L53, 0N01-0N13, L0234-L0235, L450, L856, LC70-LC107** |
| **Measure Description:** | The compact fluorescent lamps programs pay contractors (in Direct install programs) to replace customers’ existing incandescent lamps with more efficient compact fluorescent lighting. |
| **Energy Impact Common Units:** | Per lamp |
| **Base Case Description:** | Various Wattage Reduction Ratios  Refer to .xlsc attached  Source: DEER 2016 |
| **Base Case Energy Consumption:** | Various Refer to .xlsc attached  Source: DEER 2016 |
| **Measure Energy Consumption:** | Various Refer to .xlsc attached  Source: DEER 2016 |
| **Energy Savings (Base Case – Measure)** | Various Refer to .xlsc attached  Source: DEER 2016 |
| **Costs Common Units:** | $ per lamp |
| **Base Case Equipment Cost ($/unit):** | Various Refer to .xlsc attached  Source: 2016 DEER |
| **Measure Equipment Cost ($/unit):** | Various Refer to .xlsc attached  Source: 2016 DEER |
| **Measure Incremental Cost ($/unit):** | Various Refer to .xlsc attached  Source:  2016 DEER |
| **Effective Useful Life (years):** | Various Refer to .xlsc attached  Source: 2016 DEER. |
| **Program Type:** | Replace on Burnout (ROB) |
| **Net-to-Gross Ratios:** | |  |  |  |  | | --- | --- | --- | --- | | **NTGR ID** | **Description** | **Sector** | **NTGR** | | Res-Default>2 | All other EEM with no evaluated NTGR; existing EEM with same delivery mechanism for more than 2 years | Res | 0.55 | | NonRes-sAll-mCFL-All | Nonresidential CFLs: deemed; all delivery mechanisms | NonRes | 0.6 |   Source:  2016 DEER |
| **Important Comments:** | Savings and cost methodology follows PGECOLTG111, PGECOLTG110 & PGECOLTG107 |

# Document Revision History

|  |  |  |  |
| --- | --- | --- | --- |
| Revision # | Date | Description | Author (Company) |
| Revision 0 | 06/8/12 | Created Direct Install & Downstream Version of PGECOLTG111 R5 &  PGECOLTG107 R5  Modifications from the original include:   1. New DI & downstream NTG & ISR values 2. Adjustments to Cost Data to better align with ER transaction type | Breesa Collyer, PG&E |
| Revision 0 | 08/22/2012 | Updated nomenclature per ED direction for the following:  Building types-BCR to Any  Building vintage-AV to Any  Climate Zone-All to Any  Application Type-ER to ROB | Breesa Collyer, PG&E |
| Revision 0 | 1/7/2013 | Add Measures 0L23, 0L03, 0L14, 0L30, 0L34, 0L46, 0L49, L856 for Residential Building Types. | Sherry Hu, PG&E |
| Revision 1 | 10/18/2013 | Added Middle Income Direct Install (MIDI) codes | Mark Tiemens, PG&E |
| Revision 2 | 5/30/2014 | Revised savings values per ED workpaper Disposition for Lighting Retrofits.  Updated DI measures to vary by building type instead of Res/Com | Mark Tiemens, PG&E |
| Revision 3 | 10/27/2014 | Updated mis-categorization of measures LC101-LC103, LC73-LC74 and clarified measure descriptions for 0L15, 0L21, and 0L22. Fixed EUL ID use sub categories in Excel | Mark Tiemens, PG&E |
| Revision 4 | 1/1/2016 | Updated NTG, Annual Hours of Operation, GSIA, EUL, CDF, IE, and base case and measure costs per DEER 2016. Removed all downstream measures. | Linda Wan, PG&E / Alina Zohrabian, PG&E / Tai Voong, PG&E |

# Table of Contents

[At-a-Glance Summary ii](#_Toc437875400)

[Document Revision History iii](#_Toc437875401)

[Table of Contents iv](#_Toc437875402)

[List of Tables iv](#_Toc437875403)

[Section 1. General Measure & Baseline Data 1](#_Toc437875404)

[1.1 Work Paper Relationship to Core Work Paper 1](#_Toc437875405)

[1.2 Product Technical Description 1](#_Toc437875406)

[1.3 Measure Application Type 1](#_Toc437875407)

[1.4 Product Base Case and Measure Case Data 1](#_Toc437875408)

[1.4.1 DEER Base Case and Measure Case Information 1](#_Toc437875409)

[1.4.2 Codes & Standards Requirements Base Case and Measure Information 3](#_Toc437875410)

[1.4.3 EM&V, Market Potential, and Other Studies – Base Case and Measure Case Information 3](#_Toc437875411)

[Section 2. Calculation Methodology 4](#_Toc437875412)

[2.1 Electric Energy Savings Estimation Methodologies 4](#_Toc437875413)

[2.2. Demand Reduction Estimation Methodologies 4](#_Toc437875414)

[2.3. Gas Energy Savings Estimation Methodologies 4](#_Toc437875415)

[Section 3. Load Shapes 5](#_Toc437875416)

[3.1 Base Case Load Shapes 5](#_Toc437875417)

[3.2 Measure Load Shapes 5](#_Toc437875418)

[Section 4. Base Case & Measure Costs 6](#_Toc437875419)

[4.1 Base Case(s) Costs 6](#_Toc437875420)

[4.2 Measure Case Costs 6](#_Toc437875421)

[4.3 Incremental & Full Measure Costs 6](#_Toc437875422)

[References 7](#_Toc437875423)

# List of Tables

[Table 1 Measure Application Type 1](#_Toc437875424)

[Table 2 Installation Rates 2](#_Toc437875425)

[Table 3 Effective Useful Life 2](#_Toc437875426)

[Table 4 Building Types and Load Shapes 5](#_Toc437875427)

# Section 1. General Measure & Baseline Data

## 1.1 Work Paper Relationship to Core Work Paper

The measures in this work paper use the same DEER 2016 calculation methodology as PGECOLTG107, PGECOLTG110& PGECOLTG111[[1]](#endnote-1). The purpose of this short form work paper is to document the differences between these measures and their partner measures in the aforementioned work papers. The measures in this work paper are the direct install versions of measures in PGECOLTG107, PGECOLTG110& PGECOLTG111, which are upstream only. While the calculation methodology is the same as the upstream measures. The direct install measures differ in Net to Gross & Installation Service Rate values and the direct install measures differ in the Incremental Measure Cost calculation.

## 1.2 Product Technical Description

Refer to PGECOLTG107, PGECOLTG110 & PGECOLTG111 for technical description.

Several Middle Income Direct Install (MIDI) measures use hours for multi-family interior common areas, which are not included in above mentioned core work papers. These measures are consistent with DEER methodology.

## 1.3 Measure Application Type

The DEER Measure Cost Data Users Guide found on [www.deeresources.com](http://www.deeresources.com) under *DEER2011 Database Format* hyperlink, DEER2011 for 13-14, spreadsheet *SPTdata\_format-V0.97.xls*, defines the terms as follows:

Table 1 Measure Application Type[[2]](#endnote-2)

Identifies the measure application type in the Measure Implemenation table in DEER2011.

|  |  |  |
| --- | --- | --- |
| **Code** | **Description** | **Comment** |
| *ER* | *Early retirement* | *measure applied while existing equipment still viable, or retrofit of existing equipment* |
| *ROB* | *Replace on Burnout* | *measure applied when existing equipment fails or maintenance requires replacement* |
| *NC* | *New Construction* | *measure applied during construction design phase as an alternative to a code-compliant standard design* |

All the measures within this workpaper are ROB.

## 1.4 Product Base Case and Measure Case Data

## 1.4.1 DEER Base Case and Measure Case Information

This workpaper follows the same DEER methodology as PGECOLTG107, PGECOLTG110& PGECOLTG111.

**Net-to-Gross Assumption:**

Table 1 below summarizes all applicable DEER based Net-to-Gross ratios for programs that use these measures.

Table 1. Net-to-Gross Ratios

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **NTGR ID** | **Description** | **Sector** | **BldgType** | **Measure Delivery** | **NTGR** |
| Res-Default>2 | All other EEM with no evaluated NTGR; existing EEM with same delivery mechanism for more than 2 years | Res | Any | Any | 0.55 |
| NonRes-sAll-mCFL-All | Nonresidential CFLs: deemed; all delivery mechanisms | NonRes | Any | NonUpStrm | 0.6 |

**Hours of Operation**

As described in the 2015 Uncertain Measures Update[[3]](#endnote-3) and the Lighting Disposition from December 2014[[4]](#endnote-4), the annual hours of operation for CFLs and CDF depend on the building type and area. Please refer to the Excel calculation workbook for more information[[5]](#endnote-5).

**Spillage Rate**

Spillage rates are not tracked in work papers; they are tracked in an external document, which will be supplied to the Commission Staff.

**Installation Rate**

The IR values were obtained using the DEER READI tool and the 2006-2008 Lighting Evaluation. The relevant IR values for the measures in this work paper are in the table below:

Table 2 Installation Rates

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **GSIA ID** | **Description** | **Sector** | **BldgType** | **ProgDelivID** | **GSIAValue** |
| MFm-IntCFL-PGE | Interior CFL; Annual Installation Rate; Multi-family | Res | MFm | NonUpStrm | 0.89 |
| MFm-IntCF-PGE | Interior Compact Fluorescent fixture; Annual Installation Rate; Multi-family | Res | MFm | NonUpStrm | 0.87 |
| Mfm-ExtCF-PGE | Exterior Compact Fluorescent fixture; Annual Installation Rate; Multi-family | Res | MFm | NonUpStrm | 0.89 |
| PGE\_Prop\_CFL\_0.89 | 2006-2008 lighting evaluation - DI RES | Res | Any | Direct Install | 0.89 |
| Com-CFL-PGE | Non-Res CFL; Non-Upstream Program; Annual Installation Rate | Com | Any | NonUpStrm | 0.77 |

**Effective Useful Life**

The effective useful life values were taken from 2016 DEER. The EUL varies according to lamp annual hours for CFL lamps.

Table 3 Effective Useful Life

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **EUL ID** | **Description** | **Sector** | **EUL (Years)** | **Version**  **VersionSource** |
| ILtg-CFL-Com | CFL Lamps - Indoor- Commercial - 10,000 Rated Hours | Com | Varies | DEER2016  2015 Uncertain Measures Update |
| ILtg-CFL-Res | CFL Lamps - Indoor- Residential - 10,000 Rated Hours | Res | 3.5 | DEER2016  2015 Uncertain Measures Update |
| ILtg-CFLfix-Res | CFL Fixtures - Indoor - Residential | Res | 16 | DEER2014  D08 v2.05 |
| ILtg-CFL-ResCmn | CFL Lamps - Indoor- Residential Common Area- 10,000 Rated Hours | Res | Varies | DEER2014  Lighting Disposition |
| ILtg-CFLfix-ResCmnArea | CFL Fixtures - Indoor - Residential Common Area | Res | 15 | DEER2014  Lighting Disposition |
| OLtg-CFL | CFL Lamps - Outdoor- Residential - 10,000 Rated Hours | Res | 3.5 | DEER2016  2015 Uncertain Measures Update |
| OLtg-CFL | Outdoor CFL Lamps - 10,000 Hour | Com | 2.44 | DEER2014  D08 v2.05 |
| OLtg-CFLfix | CFL Fixtures - Outdoor - Residential | Res | 16 | DEER2014  D08 v2.05 |

## 1.4.2 Codes & Standards Requirements Base Case and Measure Information

**Title 24:** These measures do not fall under Title 24 [2013] Non-Residential Building Energy Efficiency Standards.

**Title 20:** California Title 20 [2015] lists the federal standards for incandescent reflector lamps.

**Federal Standards:** Federally-regulated incandescent reflector lamps must meet a minimum average lamp efficacy level as shown in the table below. Because the measures in this workpaper and the corresponding base case incandescent reflector wattages are governed by DEER methodology, the Title 20 efficacy requirements were not used to dictate the base and measure cases for this workpaper.

## 1.4.3 EM&V, Market Potential, and Other Studies – Base Case and Measure Case Information

Refer to PGECOLTG107, PGECOLTG110 & PGECOLTG111 for applicable study information.

# Section 2. Calculation Methodology

## 2.1 Electric Energy Savings Estimation Methodologies

Energy and demand savings vary by market sector (building type) because of differences in operating hours and interactive effect multipliers. The operating hours and interactive effects for each segment were taken from DEER 2016 or DEER 2014 data.

The following formula was used to determine annual energy savings:

Annual Electric Savings = ∆watts × annual hours of operation × kWh interactive effects factor

1000

An example calculation is presented below for measure code LC106 (CFL 7 Watt Int) for ASM building type.



## 2.2. Demand Reduction Estimation Methodologies

Demand reduction varies by market sector (building type) due to different HVAC interactive effects and coincident peak demand multipliers for each type of building type. The operating hours, interactive effects, and coincident diversity factors (CDF) for each segment were taken from DEER 2016 data.

The following formula was used to determine annual demand savings:

Demand Savings = ∆watts × kW interactive effects factor × CDF

1000

An example calculation is presented below for measure code LC106 (CFL 7 Watt Int) for ASM building type.



## 2.3. Gas Energy Savings Estimation Methodologies

DEER 2016 included an analysis of the thermal interactive effects of lighting measures. The energy savings achieved via a reduction in lighting demand is partially offset by an increase in thermal energy needed for heating.

The following formula was used to determine annual gas savings:

Gas Savings = (∆Watts/unit) × (annual hours of use) × Interactive Effects Factor (Therms/kWh)

1,000

An example calculation is presented below for measure code LC106 (CFL 7 Watt Int) for ASM building type.

Gas Savings [-0.2070Therm/Unit-year] = (0.007\*2.53-0.007 KWatts/unit) x (1160) x -0.010

# Section 3. Load Shapes

Load Shapes are an important part of the life-cycle cost analysis of any energy efficiency program portfolio. The net benefits associated with a measure are based on the amount of energy saved and the avoided cost per unit of energy saved. For electricity, the avoided cost varies hourly over an entire year. Thus, the net benefits calculation for a measure requires both the total annual energy savings (kWh) of the measure and the distribution of that savings over the year. The distribution of savings over the year is represented by the measure’s load shape. The measure’s load shape indicates what fraction of annual energy savings occurs in each time period of the year. An hourly load shape indicates what fraction of annual savings occurs for each hour of the year. A Time-of-Use (TOU) load shape indicates what fraction occurs within five or six broad time-of-use periods, typically defined by a specific utility rate tariff. Formally, a load shape is a set of fractions summing to unity, one fraction for each hour or for each TOU period. Multiplying the measure load shape with the hourly avoided cost stream determines the average avoided cost per kWh for use in the life cycle cost analysis that determines a measure’s Total Resource Cost (TRC) benefit.

## 3.1 Base Case Load Shapes

The base case load shape would be expected to follow a typical residential or nonresidential lighting end-use load shape.

## 3.2 Measure Load Shapes

For purposes of the net benefits estimates in the E3 calculator, what is required is the load shape that ideally represents the *difference* between the base equipment and the installed energy efficiency measure. This *difference* load profile is what is called the Measure Load Shape and would be the preferred load shape for use in the net benefits calculations.

The measure load shape for this measure is determined by the E3 calculator based on the applicable residential or nonresidentialmarket sector and the lighting end-use.

Table 4 Building Types and Load Shapes

|  |  |  |
| --- | --- | --- |
| **Building Type** | **Load Shape** | **E3 Alternate Building Type** |
| Commercial | PGE:2 = Commercial Outdoor Lighting | COMMERCIAL |
| Commercial | PGE:DEER:Com:Indoor\_CFL\_Ltg | NON\_RES |
| Residential | PGE:DEER:Indoor\_CFL\_Ltg | RES |

# Section 4. Base Case & Measure Costs

The Direct Install Incremental Measure Cost (IMC) is different from the values in PGECOLTG107, PGECOLTG110 & PGECOLTG111 because the base case cost for direct install measures is $0.00. We assign this value because, for direct install programs, the customers would not have changed out the equipment if it were not for the program.

All CFL base case and measure case costs were taken from the DEER cost table found from the READI tool v 2.3.0. Costs for measures that are not explicitly in DEER were calculated using a variety of methods. Please reference PGECOLTG107, PGECOLTG110 & PGECOLTG111 for specific cost information.

## 4.1 Base Case(s) Costs

For Direct install measures the base case assumes the customer would not have done anything without the program. Therefore base case costs are $0 for all measure codes.

## 4.2 Measure Case Costs

Direct Install measure case costs vary slightly per DEER. See measure list for CFL measure case costs.

## 4.3 Incremental & Full Measure Costs

All CFL incremental & full measure costs were calculated using values from the DEER cost table. Descriptions of how incremental & full measure costs were calculated are shown below.

Incremental Measure Cost is the premium cost to install an energy efficient measure over a standard efficiency measure or code baseline measure. While IMC has a straight forward definition depending on the install type, the equation does vary.

The Incremental Measure Cost (IMC) is represented by the equation below:

IMC = (Measure Equipment Cost + Measure Labor Cost) –

(Base Case Equipment Cost + Base Case Labor Cost)

The Direct Install measure transaction type is **ROB.**  Please refer to the calculation spreadsheet5 for full and incremental costs.

# **References**

1. PG&E Work Paper PGECOLTG107 R8, PGECOLTG110 R6, & PGECOLTG111 R8 [↑](#endnote-ref-1)
2. The DEER Measure Cost Data Users Guide found on www.deeresources.com under DEER2011 Database Format hyperlink, DEER2011 for 13-14, spreadsheet SPTdata\_format-V0.97.xls. [↑](#endnote-ref-2)
3. 2015 Uncertain Measures Update – Database for Energy-Efficient Resources – DEER2015 Updates for Measures Removed from the ESPI Uncertain Measure List found on http://www.deeresources.com/index.php/deer-versions/2015-uncertain-measures-update [↑](#endnote-ref-3)
4. CPUC Energy Division -- CPUC Energy Division – Lighting Disposition 2013-2014\_LightingRetrofit\_Disposition-14December2013.Docx

   DEER 2012 Lighting 13-14 dispositions 2013-2014\_LightingRetrofit\_Disposition-14December2013.xlsx {from Dec. 2013] [from December 2013] [↑](#endnote-ref-4)
5. Excel calculation workbook [↑](#endnote-ref-5)