**Work Paper PGECOLTG116**

**Low or Reduced Wattage T8 Systems**

**Revision 8**

**Pacific Gas & Electric Company**

**Customer Energy Efficiency Department**

**Low or Reduced Wattage T8 Systems (28 & 25 Watt)**

**Measure Codes L730, L863, LC21, LC22**

# At-a-Glance Summary

|  |  |
| --- | --- |
| **Applicable Measure Codes:** | L730, L863, LC21, LC22 |
| **Measure Description:** | Replace existing 32 watt T8 fluorescent lamp with low-wattage T8s |
| **Energy Impact Common Units:** | Per lamp. |
| **Base Case Description:** | 2nd generation 32W T8 lamps and electronic, normal light output ballasts  DEER Tech ID: LFLmpBlst-T8-48in-32w-2g+El-IS-NLO-2(30w)  Source: DEER 2016 |
| **Base Case Energy Consumption:** | Various: Refer to .xlsx file attached  Source: DEER 2016 |
| **Measure Energy Consumption:** | Various: Refer to .xlsx file attached  Source: DEER 2016 |
| **Energy Savings (Base Case – Measure)** | Various: Refer to .xlsx file attached  Source: DEER 2016 |
| **Costs Common Units:** | $ per lamp |
| **Base Case Equipment Cost ($/unit):** | Various: Refer to .xlsx file attached  Source: DEER 2016 |
| **Measure Equipment Cost ($/unit):** | Various: Refer to .xlsx file attached  Source: DEER 2016 |
| **Measure Incremental Cost ($/unit):** | Various: Refer to .xlsx file attached  Source: PG&E Calculations |
| **Effective Useful Life (years):** | Various: Refer to .xlsx file attached  Source: PG&E Calculations |
| **Program Type:** | Retrofit Add-On (REA) |
| **Net-to-Gross Ratios:** | 0.6, NonRes-sAll-mLFOth-Deemed  Source: 2016 DEER |
| **Important Comments:** |  |

# Document Revision History

|  |  |  |  |
| --- | --- | --- | --- |
| **Revision #** | **Date** | **Description** | **Author (Company)** |
| Superseded | 12/06/05 | 28 watt T8 replacing 32 watt T8 | Unknown |
| Superseded | 12/06/05 | T8 25W Instant Start Ballast Lamp Replacement of T8-32W Lamp 4’ | Unknown |
| Revision 1 | 05/05/09 | Reduced Wattage 4-Foot T8 (Lamp Replacement Only) | Lauren Casey (HDR)  Jim Wyatt (PG&E) |
| Revision 2 | 2/24/10 | Low or Reduced Wattage T8 Systems  (28 & (28 & 25 Watt) | Jim Wyatt (PG&E) |
| Revision 3 | 2/24/10 | Low or Reduced Wattage T8 Systems  (28 & (28 & 25 Watt)  Incorporated Attachment A recommendations | Alina Zohrabian(PG&E) |
| Revision 4 | 5/31/2012 | Low or Reduced Wattage T8 Systems  (28 & (28 & 25 Watt) Updated for DEER 2011 changes | Alina Zohrabian(PG&E) |
| Revision 4 | 8/28/12 | OTR explanation is added in the workpaper, For Vintage  AV is changed to EX and For Climate Zone All is  changed to IOU | Alina Zohrabian(PG&E) |
| Revision 5 | 7/16/13 | Revised Savings values per ED Workpaper Disposition  for Lighting Retrofit, issue March, 2013. For updated  savings values, see file PGECOLTG116 R5-Calcs.xlsx  For base wattage PG&E used 59/2=29.5 watt for both  Measures. These values got changed to 32 watt. For  Measure wattage for L730 PG&E used 50/2=25 watt, this  got changed to 28 watt. For measure wattage for L863  PG&E used 44/2=22 watts, this got changed to 25 watt.  ISR changed from 1 to 0.92. | Alina Zohrabian(PG&E) |
| Revision 6 | 5/19/2014 | Added DI values from (PGE3PLTG175) and Revised savings values per ED Workpaper Disposition for Lighting Retrofits, December 14, 2013. For updated savings values, see file PGECOLTG116 R6.xlsx | Mark Tiemens (PG&E) |
| Revision 7 | 1/1/2016 | Updated annual hours of operation, IE, CDF, EUL, base case costs, measure costs, NTG, and GSIA per DEER 2016. Changed ROB to REA for all measures. | Linda Wan (PG&E)/Alina Zohrabian (PG&E) |
| Revision 8 | 12/6/2016 | Retired MFM measures (LC17, LC18, LC19, and LC20) for 2017 | Mini Damodaran (PG&E)/Alina Zohrabian (PG&E) |
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# Section 1. General Measure & Baseline Data

## 1.1 Measure Description & Background

***Catalog Description***

***LOW OR REDUCED-WATTAGE T8 SYSTEMS (28 AND 25 WATT)***

Rebates are for the installation of 4-ft. low wattage T8 lamps that replace 32 watt T8 lamps. Low wattage lamp rebate can be combined with the T8 retrofit measure. These lamps can also be used in existing 32 watt T8 re-lamping projects.

Table Product Codes and Descriptions

|  |  |
| --- | --- |
| **Product Code** | **Description** |
| L730 | Replace an existing 4' 32W T8 fluorescent lamp with a 4’ 28W T8 fluorescent lamp. |
| L863 | Replace an existing 4' 32W T8 fluorescent lamp with a 4’ 25W T8 fluorescent lamp. |
| LC21 | Replace an existing 4' 32W T8 fluorescent lamp with a 4’ 25W T8 fluorescent lamp, EXTERIOR |
| LC22 | Replace an existing 4' 32W T8 fluorescent lamp with a 4’ 28W T8 fluorescent lamp, EXTERIOR |

***Exclusions:***

**•** Replacement lamps rebated in this category are not eligible for additional rebates through the "Interior Linear Fluorescent Fixtures" category.

***Additional Details:***

**•** Low wattage T8 lamps are best used to replace Second Generation 700 series 32 watt T8 lamps in existing lighting systems. Care should be taken to read manufacturer recommendations for ballast requirement and use in low temperature.

***Program Restrictions and Guidelines***

***Terms and Conditions:*** Rebates are for the installation of 4-ft Low wattage T8 lamps that replace 32 watt T8 lamps. Low wattage lamp rebate can be combined with the T8 retrofit measure. These lamps can also be used in existing 32 watt T8 re-lamping projects. Care should be taken to read Manufacturer recommendations for ballast requirements and use in Low Temperature applications.

***Market Applicability:*** Fluorescent lamps are used in all non-residential sectors.

Please refer to the table below for the applicable delivery types, building types, and application types.

Table Delivery Method and Applicable Building Types

|  |  |  |
| --- | --- | --- |
| **Delivery Type** | **Applicable Building Types** | **Application Type** |
| Downstream | DEER Building Types | REA |
| Direct Install | DEER Building Types | REA |

## 1.2 Product Technical Description

Replace an existing 32WT8 lamp with a low-wattage T8 lamp. This replacement is recommended in situations where relamping of the lighting system is occurring without the replacement of the existing instant start generic electronic ballast. This lamp is not recommended for use with occupancy or motion sensors, short cycle lamp installations or in applications where new or existing energy efficient electronic ballasts are installed.

## 1.3 Measure Application Type

The installation type definitions follow the latest Ex Ante Review guidance document, Early Retirement Using Preponderance of Evidence[[1]](#endnote-1). It defines the terms as follows:

Table 3 Measure Application Type

|  |  |  |
| --- | --- | --- |
| **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* |
| *REA* | *Add-on Retrofit* | *new equipment that has been installed onto an existing system as either an integral additional component or a substitution of a pre-existing add-on component whose primary purpose is to improve overall efficiency of the system* |

All the measures within this workpaper are REA.

## 1.4 Product Base Case and Measure Case Data

The base case wattages follow the DEER methodology. The measure case is the associated linear fluorescent fixture wattage.

### 1.4.1 DEER Base Case and Measure Case Information

The Database for Energy Efficient Resources (DEER) 2016 contains measures for linear fluorescent lamp replacements using the Delta Wattage methodology. The base case is a second generation T8 lamp.

**Hours of Operation**:

The DEER 2016 hours of operation and interactive effects are used for savings calculations.

**Net-to-Gross Assumption:**

The NTG values are from DEER 2016. The table below summarizes all applicable Net-to-Gross ratios for programs that may be used by these measures.

Table Net-to-Gross Ratios

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **NTGR ID** | **Description** | **Sector** | **BldgType** | **Delivery Method** | **NTGR** |
| NonRes-sAll-mLFOth-Deemed | Nonresidential Linear Fluorescent: measures not listed elsewhere; deemed; all delivery mechanisms | NonRes | Any | Any | 0.6 |

**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. The relevant IR values for the measures in this work paper are in the table below.

Table Installation Rates

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **GSIA ID** | **Description** | **Sector** | **BldgType** | **ProgDelivID** | **GSIAValue** |
| Com-LF-PGE | Non-Res Linear Fluorescent fixture; Annual Installation Rate | Com | Any | NonUpStrm | 0.92 |

**Effective Useful Life / Remaining Useful Life**

The effective useful life (EUL) is based on the electronic ballast rated hours or 70,000 hours, whichever is less. Since the effective useful life (EUL) is depended on hours of operation, the EUL varies by building type. The EUL is calculated using the following equation:

EUL = (Electronic ballast rated hours (or 70,000 hours)) / (Average Operating Hours for Building Type)

**Table 6 Effective and Remaining Useful Life**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **EUL ID** | **Description** | **Sector** | **UseCategory** | **EUL (Years)** | **RUL (Years)** |
| ILtg-Lfluor-Elec | Linear Fluorescent with Electronic Ballast | Com | Lighting | Varies (max 15) | Varies (max 5) |

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

***Title 20[2015]:*** Lamps manufactured before July 15, 2012 follow standards listed in Table K-1 (page 155). Lamps manufactured on or after July 15, 2012 follow standards listed in Table K-2 (page 155).

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

***Federal Standards:*** This measure is affected by the new Federal standard for General Service Fluorescent Lamps (GSFLs), effective July 14, 2012. Refer to the Federal Register, volume 74, No. 133, July 14, 2009; p.34082.

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

The most pertinent study for linear fluorescent lamp market characteristics is the *Commercial Lighting Systems Initiative* by The Consortium for Energy Efficiency 2008. This initiative is attempting to provide clear definitions in the market for energy efficient T8 lamps.

Other EM&V and Market Potential Studies used in this analysis include the 2011 DEER, 2008 DEER database, the 2005 update to the DEER database prepared by Itron and JJ Hirsch and Associates, and the Southern California Edison *Standard Performance Contract Program Manual*.

# Section 2. Calculation Methods

## 2.1 Electric Energy Savings Estimation Methodologies

Energy savings vary by market sector and building type because of differences in operating hours and interactive effect multipliers. The operating hours and interactive effects for Commercial were taken from DEER 2016 data. Refer to the equation below for the energy savings calculation:



The following example calculation demonstrates the annual energy savings, kWh per year, for the “ASM” building type, for “Replace an existing 4' 32W T8 fluorescent lamp with a 4’ 28W T8 fluorescent lamp”:



## 2.2. Demand Reduction Estimation Methodologies

Demand reduction varies by market sector and 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. Below is the equation to calculate demand savings:



The following example calculation demonstrates the annual energy demand savings, kW per year, for the “ASM” building type, for “Replace an existing 4' 32W T8 fluorescent lamp with a 4’ 28W T8 fluorescent lamp”:



## 2.3. Gas Energy Savings Estimation Methodologies

Gas estimates are entirely based on the estimated increased gas use through calculated interactive effects. This measure includes HVAC interactive effects savings. The equation below calculates the gas savings:



The following example calculation demonstrates the annual gas savings; therms per year, for the “ASM” building type, for “Replace an existing 4' 32W T8 fluorescent lamp with a 4’ 28W T8 fluorescent lamp”:



# 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 non-residential 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 shapes for these measures are determined by the E3 calculator based on the applicable residential or non-residential market sector and the lighting end-use.

Table Building Types and Load Shapes

|  |  |  |
| --- | --- | --- |
| **Building Type** | **Load Shape** | **E3 Alternate Building Type** |
| All Commercial | PGE:DEER:Com:Indoor\_Non-CFL\_Ltg | NON\_RES |
| “Com” – Exterior | PGE:COMMERCIAL:2 = Commercial Outdoor Lighting | COMMERCIAL |

# Section 4. Base Case & Measure Costs

## 4.1 Base Case Costs

DEER 2016 base case costs are not used since these are REA measures.

## 4.2 Measure Costs

DEER 2016 measure costs from the READI tool, v2.3.0 were used. Please refer to the cost spreadsheet for more information. The labor cost used is $5.75, which is the cost to replace a screw-in lamp, per WO017[[2]](#endnote-2).

## 4.3 Incremental & Full Measure Costs

Table Full and Incremental Measure Cost Equations

|  |  |  |  |
| --- | --- | --- | --- |
| **Installation Type** | **Incremental Measure Cost** | **Full Measure Cost** | |
| **1st Baseline** | **2nd Baseline** |
| ROB | (MEC + MLC) – (BEC + BLC) | (MEC + MLC) – (BEC + BLC) | N/A |
| NEW/NC |
| RET/ER | (MEC + MLC) – (BEC + BLC) | MEC + MLC | (MEC + MLC) – (BEC + BLC) |
| REF | (MEC + MLC) – (BEC + BLC) | MEC + MLC | N/A |
| REA | MEC + MLC | MEC + MLC | N/A |

MEC = Measure Equipment Cost; MLC = Measure Labor Cost

BEC = Base Case Equipment Cost; BLC = Base Case Labor Cost

### 4.3.1 Full Measure Cost

Full Measure Cost is the cost to install an energy efficient measure per the CPUC calculators. This definition implies a different meaning depending on the Measure Application type. For full measure costs please refer to the cost spreadsheet.

# References

1. Early Retirement Using Preponderance of Evidence. SCE/CPUC. Version 1.0. July 16, 2014. Page 7-9. http://www.cpuc.ca.gov/PUC/energy/Energy+Efficiency/Ex+Ante+Review+Custom+Process+Guidance+Documents.htm [↑](#endnote-ref-1)
2. 2010-2012 WO017 Ex Ante Measure Cost Study Final Report. Submitted by: Itron, Inc. May 27, 2014. [↑](#endnote-ref-2)