**Work Paper PGECOLTG176**

**Dimmable Fluorescent Ballasts**

**Revision # 2**

**Pacific Gas & Electric Company**

**Customer Energy Solutions Department**

**Dimmable Fluorescent Ballasts**

**Measure Codes L0337, L0338**

# At-a-Glance Summary

|  |  |  |
| --- | --- | --- |
| **Applicable Measure Codes:** | L0337 | L0338 |
| **Measure Description:** | Dimmable ballast installed with 20% tuning | Dimmable ballast installed with 20% tuning and daylight harvesting |
| **Energy Impact Common Units:** | Fixture | |
| **Base Case Description:** | Single fixture containing a shipments weighted average of 1, 2, 3, and 4-lamp ballasts | |
| **Base Case Energy Consumption:** | 75 W  Source: Appendix B Standard Fixture Wattages, CEUS, US Census data, PG&E Calculations. | |
| **Measure Energy Consumption:** | Various. Refer to At-A-Glance Measure List.  Source: DEER, PG&E Calculations. | |
| **Energy Savings (Base Case – Measure)** | Various. Refer to At-A-Glance Measure List.  Source: DEER, PG&E Calculations. | |
| **Costs Common Units:** | $ per fixture | |
| **Base Case Equipment Cost ($/fixture):** | Various. Refer to At-A-Glance Measure List.  Source: PG&E Calculations. | |
| **Measure Equipment Cost ($/fixture):** | Various. Refer to At-A-Glance Measure List.  Source: PG&E Calculations. | |
| **Gross Measure Cost ($/fixture)** | Various. Refer to At-A-Glance Measure List.  Source: PG&E Calculations. | |
| **Measure Incremental Cost ($/fixture):** | Various. Refer to At-A-Glance Measure List.  Source: PG&E Calculations. | |
| **Effective Useful Life (years):** | 16, 8  Source: DEER 2011 | |
| **Program Type:** | ROB | |
| **Net-to-Gross Ratios:** | 0.7  Source: DEER 2011 | |
| **Important Comments:** |  | |

# Work Paper Approvals

The following Manager(s) approved this workpaper through the PG&E Electronic Data Routing System under Routing Requisition # \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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| --- |
|  |
| **Grant Brohard**  Manager, Technical Product Support |
| **Carolyn Weiner**  Manager, CES Products and Programs |

# Document Revision History

|  |  |  |  |
| --- | --- | --- | --- |
| Revision # | Date | Section by Section Description of Revisions | Author (Company) |
| Revision 0 | 02/21/2013 | Original Workpaper PGECOLTG176, Dimmable Fluorescent Ballasts | Daniel Young and Greg Barker (Energy Solutions) |
| Revision 0 | 03/01/2013 | PGECOLTG176, Dimmable Fluorescent Ballasts | Reviewed and modified by Alina Zohrabian (PG&E) |
| Revision 1 | 01/01/2013 | Updated the occupancy sensor savings based on the 2013-2014 occupancy sensor savings disposition-May31-2013 | Alina Zohrabian (PG&E) |
| Revision 2 | 6/17/2014 | Updated per Disposition for 2013 Title 24.  Removed occupancy sensor measures to accommodate code. Added DI option. | Mark Tiemens (PG&E) |

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# Section 1. General Measure & Baseline Data

## 1.1 Product Measure Description & Background

***Catalog Description***

**Requirements:**

* Equipment must be either
  + A new T8 or T5 linear fluorescent fixture replacing a fixture with fixed-output ballasts; or
  + A dimming ballast installed as a retrofit in a T8 or T5 linear fluorescent fixture replacing a fixed-output ballast.
* All ballasts included must be Consortium for Energy Efficiency (CEE)-listed dimming ballasts.[[1]](#endnote-1)
* Existing controls must be bi-level switching with no other controls.
* Dimming ballast must be installed with a maximum output equivalent to at least a 20% power reduction, or tuning. The tuning requirement depends on the ballast factors of the existing ballast and the new dimming ballast, as presented in the following table:

Table-1. Minimum Required Power Reduction for Different Ballast Factors



**Ballast factor abbreviations:[[2]](#endnote-2)**

RLO = Reduced Light Output Ballast (<0.85 Ballast Factor)

NLO = Normal Light Output Ballast (0.85 to 0 .95 Ballast Factor)

HLO = High Light Output Ballast (0.96 to 1.1 Ballast Factor)

VHLO = Very High Light Output Ballast (> 1.1 Ballast Factor)

The calculations used to create Table 1 can be found on the worksheet tabs: “BF table 2-lamp” and “BF table 3-lamp.”[[3]](#endnote-3)

***Measure Descriptions:***

|  |  |
| --- | --- |
| **Product Code** | **Description** |
| L0337 | 20% Tuning |
| L0338 | 20% Tuning + Daylight Harvesting |

***Program Restrictions and Guidelines***

This work paper details the replacement of existing fixed output fluorescent ballasts in non-residential sites with dimmable fluorescent ballasts. This program will be delivered to non-residential customers through the midstream channel.

***Terms and Conditions:***

The customer must be a non-residential PG&E electric customer.

***Market Applicability:***

This measure applies to existing buildings in the non-residential market. Linear fluorescent fixtures are common in commercial buildings, where they can comprise a majority of lighting loads. Offices and education facilities of all levels are likely candidates, as occupants may also benefit from increased control capabilities.

***The Hard to Reach designation for NTG application must meet the following criteria from the Energy Efficiency Policy Manual.***

***Hard-to-Reach:*** Those customers who do not have easy access to program information or generally do not participate in energy efficiency programs due to a language, income, housing type, geographic, or home ownership (split incentives) barrier. These barriers are defined as:

Language – Primary language spoken is other than English, and/or

Income – Those customers who fall into the moderate income level (income levels less than 400% of the federal poverty guidelines and/or

Geographic – Businesses in areas other than the San Francisco Bay Area, San Diego area, Greater Los Angeles Area (Los Angeles, Orange, San Bernardino, Riverside and Ventura counties)or Sacramento, and/or

Other considerations of factors such as business size and lease (split incentive) barriers.

***Type of Transaction:***

This measure is applicable in replace on burnout (ROB) transactions, as a midstream, contractor-targeted incentive. The rebate incentivizes the replacement of fixed output ballasts with dimmable fluorescent ballasts by partially offsetting higher first costs for these products.

***1.2 Product Technical Description***

Fluorescent fixtures are commonly used to light commercial space. These fixtures generate light by exciting mercury vapor inside of fluorescent tubes. Fluorescent ballasts are necessary to provide the electric voltage needed to start the lamps and to sustain the discharge to keep the lamps lit. Dimmable fluorescent ballasts are capable of operating lamps at intermediate light levels below 100% full output. Some ballasts, known as “step-dimming” ballasts, are only able to dim lamps to one or more intermediate light levels, while other ballasts, known as “continuously-dimming” ballasts, are able to dim lamps gradually from 100% to any desired light output level.

Dimmable ballasts offer the potential to reduce energy consumption through smarter operation of fluorescent lamps to reduce wasted energy from over lighting spaces. There are three primary strategies for using dimmable ballasts to save energy:

**Tuning:** A reduction in light output to avoid over-illumination which can be achieved by:

* A factory preset reduction in light output level
* A field set permanent reduction in light output level
* Photo controls to adjust maximum light output to account for lumen maintenance

**Daylight Harvesting:** Use of photocells to sense natural sunlight in an area and to then dim or shut down lights if enough daylight is present.

Currently, sales and existing stock of dimming ballasts are low when compared to fixed output ballasts. However, in 2014, new Title 24 California state building codes will require dimming ballasts to be installed in many commercial buildings.

## 1.3 Transaction Types

The DEER Measure Cost Data Users Guide, version 2.01, defines the terms as follows:

* Replace on Burnout (ROB) – replacing a technology at the end of its useful life.

Most dimmable ballasts in the non-residential market are installed in either “replace on burnout” or “new construction” transactions. New construction (as well as major renovation) must meet existing Title 24 building codes that already require the use of daylight harvesting sensors where these controls are most appropriate. Minimal savings would be expected from new construction transactions.

## 1.4 Product Base Case and Measure Case Data

### 1.4.1 DEER Base Case and Measure Case Information

The DEER 2011 data include: Lighting coincident demand, demand, electric, gas energy interactive effects , and hours of operation for non-CFL lighting, which was used to develop measure savings, daylight harvesting and dimming ballast measures.

**Delta Wattage Assumption (ΔW):**

Electric Savings **(ΔW): D11 v4.01**

* The electric savings were downloaded from DEER 2011, however they differ from the measures in the following ways:
  + - DEER savings provided as “per kW of lighting under sensor control”. DEER savings were multiplied by 0.075kW to determine the savings on a “per fixture” basis. These savings were reduced 20% to account for the wattage reduction due to tuning. These calculations are described in detail in Section 2.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Building type** | **Bldg Vintage** | **Climate Zone** | **Electric Savings Watts** | **Deer units** | **DEER Version** | **Impact IDs** |
| Wtd-Com | Existing | IOU | Varies | kW/kW Controlled | D11 v4.01 | N/A |

**Therms Savings Assumption (ΔTh) DEER Version and Impact IDs**

Gas Savings **(ΔTh): Interactive Effect only D11 v4.01**

* The gas savings were downloaded from DEER, however they differ from the measures by:
  + - DEER savings are provided as “per kW of lighting under sensor control”. DEER savings was multiplied by 0.075kW to determine the savings on a per fixture basis. This savings was reduced 20% to account for the wattage reduction from tuning. These calculations are described in detail in Section 2.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Building type** | **Bldg Vintage** | **Climate Zone** | **Interactive Only?**  **Yes / No** | **Gas Savings Therms** | **Deer units** | **DEER Version** | **Impact IDs** |
| Wtd-Com | Existing | IOU | Yes | Varies | Therms/kW controlled | D11 v4.01 | N/A |

**Hours of Operation**:

**Hours of Operation:**

* The hours of operation were taken from DEER 2011 Energy Division’s Non-CFL Energy Impacts. They apply to all climate zones and building vintages, and are weighted for all non-residential building types.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Building type** | **Bldg Vintage** | **Climate Zone** | **Hours of Operation hrs/yr** | **DEER Version** | **Impact IDs** |
| Wtd-Com | Existing | IOU | 3,180 | D11 v4.01 | N/A |

**Net-to-Gross Assumption:**

**Net to Gross Value: D11 v4.01**

Table 2 below summarizes all applicable DEER based Net-to-Gross ratios for programs that may be used by this measure.

Table 2 Net-to-Gross Ratios

|  |  |  |
| --- | --- | --- |
| DEER ID | Program Approach | NTG |
| All-Default<=2yrs | All other EEM with no evaluated NTGR; new technology in program for 2 or fewer years | 0.7 |
| Com-Default-HTR-di | All other EEM with no evaluated NTGR; direct install to hard-to-reach only. | 0.85 |

The NTG Ratios in Table 2 are appropriate for the measure(s) because:

* This will be a new program measure for the 2013-14 cycle.
* There is no evaluated NTGR for this measure.

**Effective Useful Life / Remaining Useful Life:**  **D11 v4.01**

* The Effective Useful Life (EUL) estimates were downloaded from the READI tool directly, they match the intended measures for climate zones and building types and vintages.
* The EUL for tuning is the EUL of a linear fluorescent fixture; therefore, EUL of 16 years is used.
* The daylight harvesting sensors EUL is 8 years.
* To be conservative the measures with the controls are assumed to have the EUL of the controls, which is 8yrs.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Building type** | **Bldg Vintage** | **Climate Zone** | **EUL (yrs)** | **DEER Version** | **Impact IDs** |
| Wtd-Com | Existing | IOU | 16, 8 | D11 v4.01 | N/A |

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

***Title 20:*** These measures do not fall under Title 20 of the California Energy Regulations.

***Title 24:*** 2013 Title 24 – occupancy sensor measures removed to accommodate new code requirements.

***Federal Standards:*** These measures do not fall under Federal DOE or EPA Energy Regulations.

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

***1.4.3.1 LBNL:*** ***A Meta-Analysis of Energy Savings from Lighting Controls in Commercial Buildings.[[4]](#endnote-4)***

The Lawrence Berkeley National Laboratory, in September 2011, published a research report on energy savings achievable through lighting controls in commercial buildings. This meta-study compiled the results from a total of 240 lighting controls projects and scenarios from 88 unique papers and case studies to estimate expected energy savings resulting from the implementation of various lighting controls strategies. The lighting controls strategies considered include tuning (referred to in the study as institutional tuning) and daylight harvesting.

LBNL found average savings from institutional tuning to be 36% on average. This value is used to justify the conservative selection of a 20% energy savings assumption for the tuning measure. A 20% power reduction is commonly cited by lighting specifiers and designers as a typical target for energy savings from tuning, and was selected as the energy savings assumption for tuning. The Advanced Lighting Guidelines, developed and adopted by the California Energy Commission, state that differences in light output of 25% or less (which generally corresponds to an actual power draw reduction of less than 25%) have little to no impact on visual performance.[[5]](#endnote-5)

**Energy Savings Assumption for Tuning (ΔW, ΔTherms):**

* The requirements for this measure are designed to ensure that the dimmable ballast is tuned upon installation to capture at least a 20% power reduction over the assumed base case fixture. Table 1 in Section 1.1 provides the tuning guidance that results in an average energy savings of 20% or greater for each installed fixture. Calculations for this tuning guidance are shown in the worksheet tabs: “BF table 2-lamp” and “BF table 3-lamp.”3
* PG&E Appendix B: Table of Standard Fixture Wattages was consulted for the base case power draw for the existing ballast.[[6]](#endnote-6)

### 1.4.4 Assumptions and Calculations from other sources—Base and Measure Cases

Equipment cost for daylight harvesting sensors was obtained through RSMeans data, which present the typical cost per sensor of $131.00 for materials and $79.00 for labor.[[7]](#endnote-7) The 2013-2014 Title 24 Codes and Standards Enhancement (CASE) Study[[8]](#endnote-8) was consulted to estimate the number of fixtures a daylight harvesting sensor typically controls. The study presents assumptions for the typical number of fixtures served by a daylight harvesting sensor in three types of office lighting applications. For an office, the study assumes that five sensors are required for five fixtures (one sensor per fixture). For an open office, the study assumes that two sensors are required for sixteen fixtures. For a reception area, the study assumes that one sensor is required for four fixtures. The Gross Measure Cost (GMC) for daylighting controls assumes that as in reception areas, one sensor is required for every four fixtures on average. This is roughly the average sensor density required by the three common applications presented in the Title 24 CASE Study. Therefore, the GMC per fixture for each daylight harvesting sensor is $52.50. Table 13 shows the measure case cost per measure. The cost varies for each measure depending on the included equipment.

**Base Case Costs and Measure Case Costs for daylight harvesting sensors only (ballast costs not included):**

* Base Case and Measure Case fixture costs are not included in the following table.
* Base Case cost is assumed to be $0, since the existing fixture is assumed not to be under daylight harvesting sensor control.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  |  |  | **Costs ($) daylight harvesting sensors** | | |  |
| **Building type** | **Bldg Vintage** | **Climate Zone** | **Base Case** | **Measure Case** | **IMC** | **Reference** |
| Wtd-Com | Existing | IOU | $0.00 | $52.50 | ($131+$79)/4=$52.50 | RSMeans |

**In-service factor/first year installation rate**:

* The in service rates are assumed to be 1.

|  |  |  |  |
| --- | --- | --- | --- |
| **Building type** | **Bldg Vintage** | **Climate Zone** | **In service rate** |
| Wtd-Com | Existing | IOU | 1 |

***1.4.5 Time-of-Use Adjustment Factor***

We are required by CPUC decision 06-06-063 dated June 29, 2006 to apply time-of-use (TOU) adjustment factors on residential A/C and commercial A/C (packaged and split-system direct-expansion cooling) measures only. Since this is not an A/C measure, the TOU adjustment factor is 0.

***1.5 Summary of Inputs for Savings Calculations***

The following sections provide the inputs for calculation:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Input Variable** | **Variations** | **Base Case Average Value** | **Measure Case Average Value** | **Reference Section** |
| **Electric Savings** | All climate zones, Existing, Wtd-Com, | Varies | Varies | *Section 1.4.1,*  *Section 1.4.4* |
| **Gas Savings** | All climate zones, Existing, Wtd-Com, | Varies | Varies | *Section 1.4.1* |
| **Hours of operation** | All climate zones, Existing, Wtd-Com, | 3,180 | 3,180 | *Section 1.4.1* |
| **Full Cost** | ROB | Varies | Varies | *Section 1.4.1,*  *Section 1.4.4* |
| **Incremental Cost** | ROB | Varies | Varies | *Section 1.4.1,*  *Section 1.4.4* |
| **EUL /RUL** | ROB | Varies | Varies | *Section 1.4.1* |
| **NTG** | N/A | 0.7 | 0.7 | *Section 1.4.1* |
| **ISR** | Applies | 1 | 1 | *Section 1.4.4* |
| **TOU Factor** | A/C projects only | N/A | N/A | *Section 1.4.5* |

***Section 2. Calculation Methods***

|  |  |  |  |
| --- | --- | --- | --- |
| **Install / Program Type** | **Measure Life Basis** | **First Baseline Period -- Energy Savings Baseline** | **Second Baseline Period -- Energy Savings Baseline** |
| ROB | EUL | Code Baseline | N/A |

We determined an average linear fluorescent fixture type based on fixture data from US Census and California Commercial End-Use Survey (CEUS). Data on fixture shipments and existing fixture types were used to weight the average power draw of 1-, 2-, 3-, and 4-lamp fixtures at 75 Watts. We have based energy consumption and savings calculations on this blended average power draw of fluorescent fixtures, assuming a Normal Light Output Ballast Factor (0.85 to 0.95 Ballast Factor) because industry input from manufacturers, distributors and contractors all indicate that these ballast factors are predominant in the market.

As described in Section 1.4.1, energy savings, demand reduction, and gas savings for daylight harvesting measures were taken directly from READI tool. Table 3 below presents the DEER 2011 savings estimates used to calculate measure savings for daylight harvesting.

Table 3. DEER savings per 1 kW controlled lighting for daylighting

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Measure** | **Building type** | **Bldg Vintage** | **Climate Zone** | **Electric Savings (kWh per 1 kW controlled lighting)** | **Demand Reduction (kW per 1 kW controlled lighting)** | **Gas Savings (Therms per 1 kW controlled lighting)** | **DEER Version** |
| Side-lighting (daylighting) | Wtd-Com | Existing | IOU | 883 | 0.352 | -15.4 | D11 v4.01 |

The DEER savings was given in terms of kWh, kW, and Therms per 1 kW of connected load under sensor control. These values were multiplied by 0.075kW to determine the savings on a per fixture basis (shown in Table 4).

**Example: For daylight harvesting measures**

Electric Energy Savings per fixture = 883kWh \* 0.075 kW per fixture / 1 kW controlled lighting = 65.82 kWh savings per fixture

Table 4 presents the calculated savings per fixture for daylight harvesting controls.

Table 4. DEER savings adjusted to represent savings per fixture.

|  |  |  |  |
| --- | --- | --- | --- |
| **Measure** | **kWh** | **kW** | **Therms** |
| Side-lighting (daylighting) | 65.82 | 0.03 | -1.15 |

Savings for daylight harvesting were then reduced by 20% to account for the savings already captured from tuning, as presented in Table 5.

**Example: For daylight harvesting measures**

Electric Energy Savings per fixture = 65.82 kWh savings per fixture \* 80% = 52.65 kWh savings per fixture

Table 5. DEER savings adjusted to represent savings per fixture after 20% reduction for tuning.

|  |  |  |  |
| --- | --- | --- | --- |
| **Measure** | **kWh** | **kW** | **Therms** |
| Side-lighting (daylighting) | 52.65 | 0.02 | -0.92 |

## 2.1 Electric Energy Savings Estimation Methodologies

* This measure includes HVAC interactive effects savings.
* This measure is not an Early Retirement measure.

**∆Watts/fixture:** The demand difference (watts per fixture) is simply the difference between the electric demand of the base unit and the electric demand of the energy efficient unit. The base unit is a generic electronic fixed-output ballast with a Normal Light Output Ballast Factor in a fixture representing a weighted-average of 1-, 2-, 3-, and 4-lamp fixtures, with a connected load of 75 W.

**∆Watts/fixture = Base Watts/fixture - Energy Efficient Watts/fixture**

**Example: For 20% tuning**

∆Watts/fixture = 75 W – 60 W = 15 ∆Watts/fixture

**Annual Electric Savings:**

**Energy Savings [kWh/fixture] = (∆Watts/fixture) x (Annual Hours of Operation) x (Energy Interactive Effects) / 1,000 Watts / kW**

**Example:**

Annual Energy Savings = 15 ∆Watts/fixture 3,180 hours x 1.061 kWh/kWh / 1,000 Watts/kW   
= 50 kWh

## 2.2. Demand Reduction Estimation Methodologies

* This measure includes HVAC interactive effects savings.
* This measure is not an Early Retirement measure.

**∆Watts/fixture:** The demand difference (watts per unit) is simply the difference between the electric demand of the base unit and the electric demand of the energy efficient unit. The base unit is a generic electronic fixed-output ballast with a Normal Light Output Ballast Factor in a fixture representing a weighted-average of 1-, 2-, 3-, and 4-lamp fixtures, with a connected load of 75 W.

**∆Watts/fixture = Base Watts/fixture - Energy Efficient Watts/fixture**

**Example: For 20% tuning**

∆Watts/fixture = 75 W – 60 W = 15 ∆Watts/fixture

**Demand Reduction:**

**Demand Reduction [kW/fixture] = (∆Watts/fixture) x (DEER Peak Hour Load Share) (Energy Interactive Effects) / 1,000 Watts / kW**

**Example:**

Demand Reduction = 15 ∆Watts/fixture x 0.64 x 1.20 kW/kW / 1,000 Watts/kW   
= 0.011 kW

## 2.3. Gas Energy Savings Estimation Methodologies

* Gas estimates are entirely those estimated increased gas use through calculated interactive effects.
* This measure is not an Early Retirement measure.

**∆Watts/fixture:** The demand difference (watts per fixture) is simply the difference between the electric demand of the base unit and the electric demand of the energy efficient unit. The base unit is a generic electronic fixed-output ballast with a Normal Light Output Ballast Factor in a fixture representing a weighted-average of 1-, 2-, 3-, and 4-lamp fixtures, with a connected load of 75 W.

**∆Watts/fixture = Base Watts/fixture - Energy Efficient Watts/fixture**

**Example: For 20% tuning**

∆Watts/fixture = 75 W – 60 W = 15 ∆Watts/fixture

**Annual Gas Savings:**

**Annual Gas Savings [∆Therms/fixture] = (∆Watts/ fixture) x (Annual Hours of Operation) x (Gas Interactive Effects) / 1,000 Watts/kW**

**Example: For 20% tuning**

Annual Gas Savings = 15 ∆Watts/fixture x 3,180 hours x -0.0061 Therms/kWh / 1,000 Watts/kW   
= -0.289 Therms

# 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 closest load shape chosen for this measure is the DEER:Indoor\_Non-CFL\_Ltg load shape.

Table 6 Building Types and Load Shapes

|  |  |  |
| --- | --- | --- |
| **Building Type** | **E3 Alt. Building Type** | **Load Shape** |
| Commercial weighted | NON\_RES | DEER:Indoor\_Non-CFL\_Ltg |

## 3.2 Measure Load Shapes

The measure load shape for this measure is determined based on the commercial market sector and the lighting end-use. This load shape is different from the base case due to the savings impact of the measures and is shown by the load shapes listed below.

The closest load shape chosen for this measure is the DEER:Indoor\_Non-CFL\_Ltg load shape.

Table 7 Building Types and Load Shapes

|  |  |  |
| --- | --- | --- |
| **Building Type** | **E3 Alt. Building Type** | **Load Shape** |
| Commercial weighted | NON\_RES | DEER:Indoor\_Non-CFL\_Ltg |

# Section 4. Base Case & Measure Costs

|  |  |  |  |
| --- | --- | --- | --- |
| **Install/Program Type** | **Measure Life Basis** | **First Baseline Period Gross Measure Cost (RUL)** | **Second Baseline Period Gross Measure Cost (EUL – RUL)** |
| ***ROB*** | EUL | Calculated as Incremental Measure Cost | N/A |

## 4.1 Base Case(s) Costs

The following Transaction type is appropriate to these measures, based on a generic electronic fixed-output ballast with a Normal Light Output Ballast Factor in a fixture representing a weighted-average of 1- 2- 3- and 4-lamp fixtures. The Base Case Costs are:

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| ***Measure Code*** | **Transaction** | **Baseline** | **Equipment Cost** | **Labor / Installation Cost** | **Maintenance / Other Cost** | **Total Base Case Cost** |
| L0337 | ROB | Existing | $20.87 | $0 | $0 | $20.87 |
| L0338 | ROB | Existing | $20.87 | $0 | $0 | $20.87 |

*All costs are noted as $ per measure unit*

## 4.2 Measure Case Costs

The following Transaction type is appropriate to these measures. The Measure Case Costs are:

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| ***Measure Code*** | **Transaction** | **Baseline** | **Equipment Cost** | **Labor / Installation Cost** | **Maintenance / Other Cost** | **Total Measure Case Cost** |
| L0337 | ROB | Existing | $56.16 | $0 | $0 | $56.16 |
| L0338 | ROB | Existing | $88.91 | $19.75 | $0 | $108.66 |

*All costs are noted as $ per measure unit*

Base case cost of fluorescent ballasts and measure case cost of dimming ballasts were estimated by examining product costs from 1000bulbs.com, a large national distributor of lighting products. As 2-lamp ballasts are the most common ballast types in commercial installations, average prices for 2-lamp fixed output and 2-lamp dimming ballasts were chosen as representative costs for this measure. Off-brand products and dimming ballasts with special added functionality (for example, DALI communications) were filtered out from the final averages, resulting in an average incremental measure cost of $37.74.3 This is consistent with an Energy Design Resources’ claim that the cost of a dimming ballast is typically on the order of three times greater than that of a fixed output ballast.[[9]](#endnote-9)

This adjustment is detailed in Section 1.4.1. Equipment and labor cost for daylight harvesting sensors was obtained from RSMeans data. These costs were adjusted to represent per fixture costs by relying on data from the T24 Controllable Lighting CASE report. This adjustment is detailed in Section 1.4.4.

All installation costs are incremental to the cost of installing the ballast itself. Ballast installation cost is assumed to be equal for fixed output and dimming ballasts, and therefore has been removed both base and incremental costs. Therefore, for 20% tuning, the installation costs in the base and measure case are assumed to be $0. The installation costs are only the added cost of installing daylighting sensors. Since the existing ballast is not assumed to have a daylighting sensor installed, the base case installation cost is $0 for these measures.

## 4.3 Incremental & Full Measure Costs

|  |  |  |  |
| --- | --- | --- | --- |
| **Install/Program Type** | **Gross Measure Cost**  **(RUL Period/First Baseline)** | **Gross Measure Cost**  **(EUL-RUL Period / Second Baseline)** | **Incremental Measure Cost** |
| ROB | Measure Equipment Cost – Base Case Equipment Cost | N/A | Measure Equipment Cost – Base Case Equipment Cost |

Labor costs for installing a fixed output ballast and dimmable ballast are assumed to be roughly equivalent. Therefore, labor costs for ballast installation cancel out, and are not included in measure cost calculations. However, labor costs for daylight harvesting sensors are included in measure cost calculations.

### 4.3.1 Gross Measure Cost

Gross Measure Cost is the cost to install an energy efficient measure per the CPUC calculators.

This measure transaction type is: **ROB**, so the Gross Measure Cost (GMC) is represented by the equation below:

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

(Base Case Equipment Cost + Base Case Labor Cost)

*For20% tuning (base and measure labor costs are assumed to be equal, so are both set to zero):*

*GMC = $56.16 per fixture - $20.87 per fixture = $35.29 per fixture*

### 4.3.2 Incremental Measure Costs

Incremental Measure Cost is the premium cost to install an energy efficient measure over a standard efficiency measure or code baseline measure.

This measure transaction type is: **ROB** so 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)

*For 20% tuning:*

*IMC = $56.16 per fixture - $20.87 per fixture = $35.29 per fixture*

**Summary Table for Section 4**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Measure ID** | **Transaction Type** | **Base Case Total Cost** | **Gross Measure Case Cost** | **Incremental Measure Cost** |
| L0337 | ROB | $20.87 | $56.16 | $35.29 |
| L0338 | ROB | $20.87 | $108.66 | $87.79 |

# References:

1. Consortium for Energy Efficiency High Performance T8 Qualifying Products List. <http://library.cee1.org/content/commercial-lighting-qualifying-products-lists> [↑](#endnote-ref-1)
2. PG&E Lighting Rebate Catalog. <http://www.pge.com/includes/docs/pdfs/mybusiness/energysavingsrebates/incentivesbyindustry/lighting_catalog_final.pdf> [↑](#endnote-ref-2)
3. Excel worksheet provided, PGECOLTG176 R0calc, includes cost research and calculations, UES calculations, CEE list. [↑](#endnote-ref-3)
4. Williams, A., Atkinson, B., Garbesi, K., & Rubinstein, F. (2011) A Meta-Analysis of Energy Savings from Lighting Controls in Commercial Buildings. Lawrence Berkeley National Laboratory. [↑](#endnote-ref-4)
5. Benya, J., Heschong, L., McGowan, T., Miller, N., Rubinstein, F. (2003) Advanced Lighting Guidelines. New Buildings Institute, Inc. [↑](#endnote-ref-5)
6. PG&E Appendix B: Table of Standard Fixture Wattages. <http://www.pge.com/en/mybusiness/energysavingsrebates/rebatesincentives/index.page>

   In the link above, go to Customized Retrofit Incentives, then click on “learn more”, then go to Appendices section and locate Appendix B. [↑](#endnote-ref-6)
7. 2012 RSMeans Electrical Cost Data. 35th Annual Edition. [↑](#endnote-ref-7)
8. 2011 California Building Energy Efficiency Standards: Requirements for Controllable Lighting. <http://www.energy.ca.gov/title24/2013standards/prerulemaking/documents/2011-04-04_workshop/review/Nonres_Controllable_Lighting.pdf> [↑](#endnote-ref-8)
9. Energy Design Resources. Design Brief: Lighting Controls. <http://www.energydesignresources.com/media/1765/EDR_DesignBriefs_lightingcontrols.pdf?tracked=true> [↑](#endnote-ref-9)