**Work Paper PGECOLTG113**

**Interior Induction Fixtures**

**Revision 6**

**Pacific Gas & Electric Company**

**Customer Energy Solutions**

**Interior Induction Fixtures**

**Measure Codes L1023, L1024, L1025, L0270**

# At-a-Glance Summary

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Applicable Measure Codes:** | **L1023** | | **L1024** | | **L1025** | | **L0270** |
| **Measure Description:** | Interior Induction Fixtures | | | | | | |
| **Energy Impact Common Units:** | Per Fixture | | | | | | |
| **Base Case Description:** | Complete new fixture or retrofit of existing Mercury Vapor, High Pressure Sodium, Standard and Pulse-Start Metal Halide, or Incandescent fixture >60W in interior installations. | | | | | | |
| **Base Case Energy Consumption:** | Source: PG&E Calculations. Base case is assumed to be a metal halide fixture. | | | | | | |
| **Measure Energy Consumption:** | Source: PG&E Calculations. | | | | | | |
| **Energy Savings**  **(Base Case – Measure):** | Source: PG&E Calculations. | | | | | | |
| **Costs Common Units:** | $ per fixture | | | | | | |
| **Base Case Equipment Cost ($/unit):** | Varies | Varies | | Varies | | Varies | |
| **Measure Equipment Cost ($/unit):** | Varies | Varies | | Varies | | Varies | |
| **Full Measure Cost ($/unit)** | Varies | Varies | | Varies | | Varies | |
| **Measure Incremental Cost ($/unit):** | Varies | Varies | | Varies | | Varies | |
| **Effective Useful Life (years):** | 15 years, ILtg-MH  Source: DEER 2016 | | | | | | |
| **Measure Application Type:** | ROB | | | | | | |
| **Net-to-Gross Ratios:** | NTG = 0.60 Com-Default>2yrs  Source: DEER 2016 | | | | | | |
| **Important Comments:** |  | | | | | | |

# Document Revision History

|  |  |  |  |
| --- | --- | --- | --- |
| **Revision #** | **Revision Date** | **Section-by-Section Description of Revisions** | **Author (Company)** |
| Revision 0 draft | 03/27/2008 | Interior Induction Fixtures  PGECOLTG113R0.doc | Sabarish Vinod, Lincus Energy |
| Revision 1 | 5/18/2009 | Interior Induction Fixtures  PGECOLTG113R1.doc  Text edits, reformatting. | Judith Jennings, PG&E |
| Revision 2 | 2/5/2010 | Interior Induction Fixtures  PGECOLTG113 R2.doc  Added negative therm interactions to At-A-Glance Measure List.  Revised building hours of operation. Added measure code for 250W Induction fixture; expanded At-A-Glance Table by building type. Updated text and references. | Judith Jennings, PG&E |
| Revision 3 | 6/14/2012 | Interior Induction Fixtures  PGECOLTG113 R3.doc  Changed NTG and EUL. Recalculated all savings in new lighting work book by Zohrabian; updated cost figures with new distributor estimates, added base case cost for ROB measure. | Judith Jennings, PG&E |
| Revision 3 | 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 4 | 7/15/13 | Revised Savings values per ED Workpaper Disposition for Lighting Retrofit, issue March, 2013. For updated savings values, see file PGECOLTG113 R4-Calcs.xlsx  Base wattage adjustments. Measure L1025 changed from 297 to 295 watts. Measure L1024 changed from 224 to 215 watts. Measure L1023 changed from 130 to 128 watts | Alina Zohrabian (PG&E) |
| Revision 5 | 4/29/14 | Added DI values from (PGE3PLTG182) and applied the 2014 IE and Hours from DEER (posted 2/20/14). For updated savings values, see file PGECOLTG113 R5.xlsx.  Updated labor costs with 2014 RS Means Building Construction Cost Data. | Jia Huang (PG&E)  Tai Voong (PG&E) |
| Revision 6 | 1/1/2016 | Updated Section 1.4.2, EUL ID, base case ID, standard case ID per DEER 2016. Costs have also been updated. | Linda Wan (PG&E)/Alina Zohrabian (PG&E) |

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# Section 1. General Measure & Baseline Data

## 1.1 Product Measure Description & Background

***Catalog Description –*** Energy savings can be achieved by replacing existing Standard Metal Halide, Incandescent, Mercury Vapor, or High Pressure Sodium fixtures with appropriate induction fixtures. The base case for this measure is a Pulse Start/Standard Metal Halide fixture. Savings for each Wattage Range listed in the table below are based on the Induction fixture that will achieve similar light output as the base case fixture. Induction fixtures must have a maximum wattage as stipulated in Table-1 and less than the fixture being replaced and must be hardwired.

***Program Restrictions and Guidelines***

**Requirements:**

• Only complete, new induction fixtures or retrofit kits.

• New fixtures must not exceed the maximum “New Lamp Wattage” listed in Table 1 for each lamp being replaced. New lamp wattage is the total lamp only wattage.

• Rebates are based on a one-for-one replacement of incandescent or high intensity discharge (HID) lamps including, mercury vapor, high pressure sodium, and standard metal halide or pulse start metal halide. Existing lamp wattage is used rather than total fixture wattage (i.e. a 250 Watt high pressure sodium fixture is a 250 Watt base case and qualifies under the L1025 rebate code).

• Any wattage incandescent lamp ≥ 60 Watts may be replaced by complete new interior induction fixtures.

– To calculate the base case wattage for incandescent fixtures with more than one lamp, multiply number of lamps by nominal lamp wattage as listed on lamp label.

• In all cases, the wattage of the replacement fixture must be less than the wattage of the existing lamp.

• May qualify for an additional control(s) rebate through the “Occupancy Sensors” category, provided all requirements are met and are not mandatory per Title 24.

– Example: Interior induction fixture plus integrated sensor

**Exclusions:**

• Exterior installations and applications are typically operating during non-peak hours and therefore do not qualify under this interior fixture category.

• Other fixture configurations may be considered under our Customized Retrofit Incentive Program.

Table 1 Ranges of maximum Lamp Wattage identified for replacement

|  |  |
| --- | --- |
| **Measure Code[[1]](#footnote-1)** | **Description** |
| L0270 | FIXTURE INT INDUCTION - 400 WATTS BASE CASE - UP TO 250W (TIER 1) |
| L1025 (formerly L959) | FIXTURE INT INDUCTION: 176-399 W LAMP BASECASE; UP TO 180 W LAMP |
| L1024 (formerly L958) | FIXTURE INT INDUCTION: 101-175 W LAMP BASECASE; UP TO 120 WATT LAMP |
| L1023 (formerly L957) | FIXTURE INT INDUCTION: <=100 W LAMP BASECASE; UP TO 70 WATT LAMP |

***Terms and Conditions:*** The customer must be a commercial PG&E electric customer.

***Market Applicability:*** The measures discussed in this work paper are applicable to nonresidential market sectors. This program is applied as a downstream rebate program as well as Direct Install for Hard to Reach customers in SMB sector.

Table 2 Delivery Method and Applicable Building Types

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

***1.2 Product Technical Description***

Induction fixtures generally offer higher efficiency than mercury vapor lamps and better light quality than either mercury vapor or sodium lamps. An Induction Lamp offers longer life and more stable operation due to the elimination of the starter probe and bimetal strip which often cause standard metal halide lamps to fail.[[2]](#endnote-1)

To calculate the savings, a Pulse-Start Metal Halide fixture of appropriate light output for each product code is used as the base case, because this is the most commonly used replacement technology for the qualifying existing fixture types (Incandescent, Mercury Vapor, Standard Metal Halide, or High Pressure Sodium Fixtures). Savings for each wattage range listed in this work paper are based on the most applicable induction fixture to achieve similar output as the assumed existing standard fixture. The purpose of the incentive is to encourage customers to choose a fixture that is more efficient than the most common alternative.

## 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 3 Measure Application Type[[3]](#endnote-2)

*Identifies the measure application type in the Measure Implementation 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* |

These measures are identified as ROB, or replace on burnout.

## 

## 1.4 Product Base Case and Measure Case Data

The base case is metal halide, and the standard case is pulse start metal halide. DEER 2016 was used to determine the base, standard, and measure cases.

## 1.4.1 DEER Base Case and Measure Case Information

The Database for Energy Efficient Resources (DEER) 2016 contains interior induction lamp and ballast replacement measures. The base case is metal halide, and the standard case is pulse start metal halide.

Table 4 DEER 2016 Base Case for Induction Lighting

|  |  |  |  |
| --- | --- | --- | --- |
| **Measure Code** | **Base Case Technology** | **Lamp Wattage** | **Base Case Fixture Wattage** |
| L1023 | Metal Halide | 100 | 128 |
| L1024 | Pulse Start Metal Halide | 175 | 208 |
| L1025 | Pulse Start Metal Halide | 250 | 288 |
| L0270 | Pulse Start Metal Halide | 350 | 400 |

**Hours of Operation**

The hours of operation depend on the building type. The hours of operation and interactive effects are based on DEER 2016.

**Net-to-Gross Assumption**

Table 3 below summarizes all applicable DEER based Net-to-Gross ratios for programs that may be used by this measure.

Table 5 DEER Net-to-Gross Ratios

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **NTGR ID** | **Description** | **Sector** | **BldgType** | **Delivery Method** | **NTGR** |
| Com-Default>2yrs | All other EEMs with no evaluated NTGR; existing EEM in programs with same delivery mechanism for more than 2 years | Com | Any | Any | 0.60 |

**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 6 Installation Rate

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **GSIA ID** | **Description** | **Sector** | **BldgType** | **ProgDelivID** | **GSIAValue** |
| Com-HiBay-PGE | Non-Res High-Bay; Annual Installation Rate | Com | Any | NonUpStrm | 0.92 |

**Effective Useful Life / Remaining Useful Life**

Induction fixture lifetime is limited based on the ballast (generator) lifetime. Some induction generators claim a lifetime of 100000 hours, but the more common value claimed is 70,000 hours. The more conservative hours of 70,000 hours is used to calculate the effective useful life of these fixtures for each building type. DEER 2016 does not provide EUL for this specific lighting measure, but for all HID and other large wattage fixtures the EUL is listed as 15 years max.

The EUL is calculated using the following equation:

EUL = (Rated Life of Lamp (70,000 hours)) / (Average Operating Hours for Building Type)

Table 7 Effective and Remaining Useful Life

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **EUL ID** | **Description** | **Sector** | **UseCategory** | **EUL (Years)** | **RUL (Years)** |
| ILtg-MH | HID Lighting - Metal Halide | Com | Lighting | Varies (max 15) | Varies (max 5) |

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

***Title 20:*** Induction fixtures do not fall under Title 20 [2015] of the California Energy Regulations. Metal halide fixtures with lamps rated between 150W and 500W must meet minimum ballast efficiencies listed under 1605.1(n)(2). Additional requirements for metal halide luminaires sold or offered for sale in California are listed under 1605.3(n)(1).

***Title 24:*** Title 24 [2013] is triggered when more than 10% of fixtures or 40 fixtures are replaced or modified. Multi-level lighting controls and uniformity requirements are listed in Table 130.1-A for induction fixtures greater than 25W.

***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 Induction Lighting Systems[[4]](#endnote-3)***

An evaluation study of induction lighting systems, entitled “Induction Lighting Systems,” was performed by Sacramento Municipal Utility District (SMUD) in 2003. The study discusses induction technology, including different manufacturers’ products, and compares the performance of induction lighting against other lighting technologies. The study also presents case studies for installation of the technology. The conclusions of the study indicate that the installed cost of induction lighting is higher than comparable lighting technologies, but that induction lights provide an energy-efficient alternative for indoor luminaries for which access is difficult.

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

There are no further data or calculations provided for the support of the measures in this work paper.

# 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 each segment were taken from DEER 2016 data. Refer to the equation below for the energy savings calculation:



For measure L0270, building type ASM, the calculations are as follows:

*Energy Savings =* (0.400– 0.275) (*kW/Fixture) × 1620 (hrs/yr) \* 1.04 (kWh/kWh)*

*= 211 kWh/(Fixture\*yr)*

## 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:



For Measure L0270, building type ASM, the calculations are as follows:

Demand Savings = (0.400– 0.275) (kW/Fixture) × 0.48 (CDF) × 1.17 (kW/kW) = 0.0702 kW

## 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:



Example of Gas Savings Calculation for ASM –measure code L0270:

Gas Savings = (0.400– 0.275)(kW/fixture) × (1620 (hrs/yr) × -0.0104 (Therms/kWh)

= -2.11 Therms/Fixture-yr

# 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* *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 *non-residential* market sector and *the industrial indoor lighting* end-use.

Table 8 Building Types and Load Shapes

|  |  |  |
| --- | --- | --- |
| **Building Type** | **Load Shape** | **E3 Alternate Building Type** |
| All Commercial | PGE:DEER:Com:Indoor\_Non-CFL\_Ltg | NON\_RES |

# Section 4. Base Case & Measure Costs

## 4.1 Base Case(s) Costs

WO017 was used for current base case costs. Please refer to the cost spreadsheet for detailed information and cost calculations.

## 4.2 Measure Case Costs

Measure costs vary depending on the fixture wattage. PG&E and SCE are using the same measure costs. Measure costs are from various online retailers and averaged.

The labor cost is $187.14 from the WO017 report. [[5]](#endnote-4)

## 4.3 Incremental & Full Measure Costs

Table 9 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

The labor required to replace a baseline light fixture is equivalent to the labor cost associated with installing a proposed case fixture, leaving only the incremental equipment costs.

Refer to the cost spreadsheet for more detailed cost information.

# References

1. [↑](#footnote-ref-1)
2. # Houghton, D., “Metal Halide – Advances and Improvements.” *Architectural Lighting Magazine*. 2002.

   [↑](#endnote-ref-1)
3. 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.* [↑](#endnote-ref-2)
4. Bisbee, David, “Induction Lighting Systems,” Sacramento Municipal Utilities District (SMUD) Customer Advanced Technologies Program, March 26, 2003. [↑](#endnote-ref-3)
5. 2010-2012 WO017 Ex Ante Measure Cost Study Final Report. Submitted by: Itron, Inc. May 27, 2014. Page 4-12. [↑](#endnote-ref-4)