Work Paper SCE17LG105

**Revision 0**

**Southern California Edison**

**LED Exterior Landscape Lighting Fixture**

# At-a-Glance Summary

|  |  |
| --- | --- |
| **Measure Codes** | LT-27373, LT-54834, LT-28343, LT- 18927, LT-18928, and LT-18929 |
| **Measure Description** | LED Landscape Lighting Fixture |
| **Base Case Description** | Halogen Landscape Lighting Fixture |
| **Units** | Per Fixture |
| **Energy Savings** | Refer to Excel Calculation Attachment |
| **Full Measure Cost ($/unit)** | Refer to Excel Calculation Attachment |
| **Incremental Measure Cost ($/unit)** | Refer to Excel Calculation Attachment |
| **Effective Useful Life** | 50,000/HOU years (OLtg-Com-LED-50000hr) and OLtg-Res-LED-50000hr |
| **Measure Installation Type** | Replace on Burnout (ROB) |
| **Net-to-Gross Ratio** | 0.6 (DEER NTGR ID: Com-Default>2yrs)  0.55 (DEER NTGR ID: Res-Default>2) |
| **Important Comments** | This work paper has a complementary Ex Ante Database data set that will be provided in a separate submission to the California Public Utilities Commission (CPUC). |

# Revision History

|  |  |  |  |
| --- | --- | --- | --- |
| **Rev** | **Date** | **Author** | **Summary of Changes** |
| 0 | 11/18/16 | Chad Sisco (SCE) | * Updated to SCE17LG105.0 from WPSCE13LG105.3. * Updated Costs. * Added Solution Codes LT-18927, LT-18928, and LT-18929 for Residential Building Types. |

# Commission Staff and Cal TF Comments

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Rev** | **Party** | **Submittal Date** | **Comment Date** | **Comments** | **WP Developer Response** |
|  |  |  |  |  |  |

Cal TF website: <http://www.caltf.org/>

# Section 1. General Measure & Baseline Data

## 1.1 Measure Description & Background

This work paper details the replacement of a low voltage JC bi-pin lamp halogen landscape lighting fixtures ranging from 10-75 Watts typically with LED landscape lighting fixtures in Commercial and Residential sectors.

**Base, Standard, and Measure Cases**

|  |  |
| --- | --- |
| **Case** | **Description of Typical Scenario** |
| Measure | LED Landscape Lighting Fixture |
| Existing Condition | N/A |
| Code/Standard | Halogen Landscape Lighting Fixture |
| Industry Standard Practice | N/A |

The measure name indicates “MR16 Basecase” because the MR16 wattage reduction ratio is used for energy savings calculations. The actual base case fixture does not necessarily need to have MR16 lamps.

Measures and Codes

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Measure Codes** | | | | **Measure Name** |
| SCG | SDG&E | SCE | PG&E |
| N/A | N/A | LT-27373 | N/A | LED Landscape Lighting - 5 Watts or Less replacing MR16 Basecase, Total Watts = 4.24 x Msr Watts |
| N/A | N/A | LT-54834 | N/A | LED Landscape Lighting - Over 5 Watts to 15 Watts replacing MR16 Basecase, Total Watts = 4.24 x Msr Watts |
| N/A | N/A | LT-28343 | N/A | LED Landscape Lighting - Over 15 Watts to 30 Watts replacing MR16 Basecase, Total Watts = 4.24 x Msr Watts |
| N/A | N/A | LT-18927 | N/A | Residential LED Landscape Lighting - 5 Watts or Less replacing MR16 Basecase, Total Watts = 4.24 x Msr Watts |
| N/A | N/A | LT-18928 | N/A | Residential LED Landscape Lighting - Over 5 Watts to 15 Watts replacing MR16 Basecase, Total Watts = 4.24 x Msr Watts |
| N/A | N/A | LT-18929 | N/A | Residential LED Landscape Lighting - Over 15 Watts to 30 Watts replacing MR16 Basecase, Total Watts = 4.24 x Msr Watts |

The measures in this work paper are eligible in all building types (exterior) and climate zones. Fixtures must be listed on the DLC’s Qualified Products List (QPL) under the application “Landscape/Accent Floor and Spot Luminaires” to qualify for incentives. The base case must be a halogen based lamp.

## 1.2 Technical Description

LED landscape lighting fixture is intended to illuminate but not limited to gardens and landscapes in exterior of the building. This enhances safety but is primarily used for aesthetics.

## 1.3 Installation Types and Delivery Mechanisms

The delivery method is:

**Financial Support – Downstream Incentive – Deemed and Mid-Stream for codes LT-27373, LT-54834, and LT-28343.**

**Financial Support – Downstream Incentive – Deemed for solution codes LT- 18927, LT-18928, and LT-18929.**

The install type is:

**Replace on Burnout (ROB)**

ROB measures replace existing equipment with more energy efficient equipment when the existing equipment has failed or passed its useful life.

**Installation Type Descriptions**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Installation Type** | **Savings** | | **Life** | |
| 1st Baseline (BL) | 2nd BL | 1st BL | 2nd BL |
| Replace on Burnout (ROB) | Above Code or Standard | N/A | EUL | N/A |

A delivery mechanism is a delivery method paired with an incentive method. Delivery mechanisms are used by programs to obtain program participation and energy savings.

**Delivery Method Descriptions**

|  |  |
| --- | --- |
| **Delivery Method** | **Description** |
| Financial Support | The program motivates customers, through financial incentives such as rebates or low interest loans, to implement energy efficient measures or projects. |
| Mid-Stream Programs | *See Mid-Stream Incentive in the Incentive Method Descriptions table.* |

**Incentive Method Descriptions**

|  |  |
| --- | --- |
| **Incentive Method** | **Description** |
| Down-Stream Incentive | The customer installs qualifying energy efficient equipment and submits an incentive application to the utility program. Upon application approval, the utility program pays an incentive to the customer. Such an incentive may be deemed or customized. |
| Mid-Stream Incentive  Mid-Stream Buy Down | The program gives a financial incentive to a midstream market actor (distributor, vendor, or retailer) to encourage the promotion of efficient measures. Buy Down means that the incentive is required to be passed down to the end-use customer. |

## 1.4 Measure Parameters

### 1.4.1 DEER Data

DEER Difference Summary

|  |  |
| --- | --- |
| **DEER Item** | **Used for Workpaper?** |
| Modified DEER methodology | No |
| Scaled DEER measure | No |
| DEER Base Case | No |
| DEER Measure Case | No |
| DEER Building Types | Yes |
| DEER Operating Hours | Yes |
| DEER eQUEST Prototypes | No |
| DEER Version | N/A |
| Reason for Deviation from DEER | DEER does not contain this type of measure. |
| DEER Measure IDs Used | N/A |

**Net-to-Gross Ratio**

The NTG values were obtained using the DEER READI tool. The relevant NTG values for the measures in this work paper are in the table below.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **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 |
| 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 | 0.6 |

**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.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **GSIA ID** | **Description** | **Sector** | **BldgType** | **ProgDelivID** | **GSIAValue** |
| Def-GSIA | Default GSIA values | Any | Any | Any | 1 |

**Effective and Remaining Useful Life**

The EUL and RUL values were obtained using the DEER READI tool. DEER defines the RUL as 1/3 of the EUL value. The RUL value is only applicable to the first baseline period for an RET measure with an applicable code baseline. The relevant EUL and RUL values for the measures in this work paper are in the table below.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **EUL ID** | **Description** | **Sector** | **UseCategory** | **EUL (Years)** | **RUL (Years)** |
| OLtg-Com-LED-50000hr | LED Fixture - Outdoor- Commercial | Com | Lighting | 50,000/HOU, max 12 years | N/A |
| OLtg-Res-LED-50000hr | LED Fixture - Outdoor- Residential | Res | Lighting | 50,000/HOU, max 16 years | N/A |

### 1.4.2 Codes and Standards Analysis

Title 24 2016 Building Energy Efficiency Standards [496] requires controls for the landscape lighting to automatically turn off when daylight is available. Exceptions 3 and 4 to Section 130.2(c)3 exempt non-pole mounted luminaires with a maximum rated wattage of 30 watts each and landscape lighting from the motion sensor and dimming control requirements outlined in Section 130.2(c)3. Measures in this work paper are 30 Watts and below.

The following excerpts were taken from the Title 24 2016 Building Energy Efficiency Standards [496].

***Section 130.2(c) states:***

**Controls for Outdoor Lighting.** Outdoor lighting controls shall be installed that meet the following requirements as applicable:

**EXCEPTION 1 to Section 130.2(c):** Outdoor lighting not permitted by a health or life safety statute, ordinance, or regulation to be turned OFF.

**EXCEPTION 2 to Section 130.2(c):** Lighting in tunnels required to be illuminated 24 hours per day and 365 days per year.

1. All installed outdoor lighting shall be controlled by a photo control or outdoor astronomical time-switch control that automatically turns OFF the outdoor lighting when daylight is available.
2. All installed outdoor lighting shall be independently controlled from other electrical loads by an automatic scheduling control.
3. All installed outdoor lighting, where the bottom of the luminaire is mounted 24 feet or less above the ground, shall be controlled with automatic lighting controls that meet all of the following requirements:
   1. Shall be motion sensors or other lighting control systems that automatically controls lighting in accordance with item B in response to the area being vacated of occupants; and
   2. Shall be capable of automatically reducing the lighting power of each luminaire by at least 40 percent but not exceeding 90 percent, or provide continuous dimming through a range that includes 40 percent through 90 percent, and
   3. Shall employ auto-ON functionality when the area becomes occupied; and
   4. No more than 1,500 watts of lighting power shall be controlled together.

**EXCEPTION 1 to Section 130.2(c)3:** Lighting for Outdoor Sales Frontage complying with Section 130.2(c)4.

**EXCEPTION 2 to Section 130.2(c)3:** Lighting for Building Facades, Ornamental Hardscape and Outdoor Dining complying with Section 130.2(c)5.

**EXCEPTION 3 to Section 130.2(c)3**: Outdoor lighting, where luminaire rated wattage is determined in accordance with Section 130.0(c), and which meet one of the following conditions:

1. Pole-mounted luminaires each with a maximum rated wattage of 75 watts; or
2. **Non-pole mounted luminaires with a maximum rated wattage of 30 watts each; or**
3. Linear lighting with a maximum wattage of 4 watts per linear foot of luminaire.

**EXCEPTION 4 to Section 130.2(c)3: Applications listed as Exceptions to Section 140.7(a) shall not be required to meet the requirements of Section 130.2(c)3.**

**Section 140.7(a) states:**

(a) An outdoor lighting installation complies with this section if it meets the requirements in Subsections (b) and (c), and the actual outdoor lighting power installed is no greater than the allowed outdoor lighting power calculated under Subsection (d). The allowed outdoor lighting shall be calculated according to Outdoor Lighting Zone in Title 24, Part 1, Section 10-114.

**EXCEPTIONS to Section 140.7(a):** When more than 50 percent of the light from a luminaire falls within one or more of the following applications, the lighting power for that luminaire shall be exempt from Section 140.7:

1. Temporary outdoor lighting.
2. Lighting required and regulated by the Federal Aviation Administration, and the Coast Guard.
3. Lighting for public streets, roadways, highways, and traffic signage lighting, including lighting for driveway entrances occurring in the public right-of-way.
4. Lighting for sports and athletic fields, and children’s playgrounds.
5. Lighting for industrial sites, including but not limited to, rail yards, maritime shipyards and docks, piers and marinas, chemical and petroleum processing plants, and aviation facilities.
6. Lighting of public monuments.
7. Lighting of signs complying with the requirements of Sections 130.3 and 140.8.
8. Lighting of stairs, wheelchair elevator lifts for American with Disabilities Act (ADA) compliance, and ramps that are other than parking garage ramps.
9. **Landscape lighting.**
10. In theme parks: outdoor lighting only for themes and special effects.
11. Lighting for outdoor theatrical and other outdoor live performances, provided that these lighting systems are additions to area lighting systems and are controlled by a multiscene or theatrical cross-fade control station accessible only to authorized operators.
12. Outdoor lighting systems for qualified historic buildings, as defined in the California Historic Building Code (Title 24, Part 8), if they consist solely of historic lighting components or replicas of historic lighting components. If lighting systems for qualified historic buildings contain some historic lighting components or replicas of historic components, combined with other lighting components, only those historic or historic replica components are exempt. All other outdoor lighting systems for qualified historic buildings shall comply with Section 140.7.

***Section 141.0(b)2L states:***

L. Alterations to existing outdoor lighting systems in a lighting application listed in TABLE 140.7-A or 140.7-B shall meet the applicable requirements of Sections 130.0, 130.2(a), 130.2(b), and 130.4, and:

1. In alterations that increase the connected lighting load, the added or altered luminaires shall meet the applicable requirements of Section 130.2(c) and the requirements of Section 140.7 for general hardscape lighting or for the specific lighting applications containing the alterations; and
2. In alterations that do not increase the connected lighting load, where the greater of 5 luminaires or 10 percent of the existing luminaires are replaced in a general hardscape or a specific lighting application, the alterations shall meet the following requirements:
   1. In parking lots and outdoor sales lots where the bottom of the luminaire is mounted 24 feet or less above the ground, the replacement luminaires shall comply with Section 130.2(c)1 AND Section 130.2(c)3;
   2. For all other lighting applications and where the bottom of the luminaire is mounted greater than 24 feet above the ground, the replacement luminaires shall comply with Section 130.2(c)1 AND EITHER comply with Section 130.2(c)2 or be controlled by lighting control systems, including motion sensors, that automatically reduces lighting power by at least 40 percent in response to the area being vacated of occupants; and
3. In alterations that do not increase the connected lighting load, where the greater of 5 luminaires or 50 percent of the existing luminaires are replaced in general hardscape or a specific application, the replacement luminaires shall meet the requirements of subsection ii above and the requirements of Section 140.7 for general hardscape lighting or specific lighting applications containing the alterations.

**EXCEPTION to Section 141.0(b)2Liii.** Alterations where the replacement luminaires have at least 40 percent lower power consumption compared to the original luminaires are not required to comply with the lighting power allowances of Section 140.7.

**EXCEPTION to Section 141.0(b)2L.** Acceptance testing requirements of Section 130.4 are not required for alterations where controls are added to 20 or fewer luminaires.

Code Summary

|  |  |  |
| --- | --- | --- |
| **Code** | **Reference** | **Effective Dates** |
| Title 24 (2016) | Section 130.2 Controls for Outdoor Lighting  Section 140.7 Requirements for Outdoor Lighting  Section 141.0 Lighting Alterations  Section 150.0 Mandatory Features and Devices | January 1, 2017 |

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

N/A

## 1.6 Data Quality and Future Data Needs

N/A

# Section 2. Calculation Methodology

In accordance with the July 22, 2016 disposition (LED-WRR-WorkpaperDisposition\_22Jul2016-Final) a WRR of 4.24 for MR16 lamps was used to calculate the base case wattage; see the following table:

|  |  |  |
| --- | --- | --- |
| **Measure Name** | **LED Lamp Watts (Measure Case)** | **Halogen Lamp Watts (Base Case)** |
| LED Landscape Lighting - 5 Watts or Less replacing MR16 Basecase, Total Watts = 4.24 x Msr Watts | 3 | (3\*4.24)=12.72 |
| LED Landscape Lighting - Over 5 Watts to 15 Watts replacing MR16 Basecase, Total Watts = 4.24 x Msr Watts | 6 | (6\*4.24)=25.44 |
| LED Landscape Lighting - Over 15 Watts to 30 Watts replacing MR16 Basecase, Total Watts = 4.24 x Msr Watts | 16 | (16\*4.24)=67.84 |

The annual energy savings are based on dusk-to-dawn Operating Hours and Energy Interactive Effects by Building Type for Non-CFL Lighting for each market sector. Energy interactive effects (EIE) are the additional savings resulting from the reduced air conditioning load because of the reduction in internal heat gains from the more efficient lighting system. Since LED landscape lighting is used outdoors, EIE will be 1. For residential building type HOU of 935 was used to calculate energy savings.

The energy savings estimates are calculated as follows:



The following is a sample energy savings calculation for LED Landscape Lighting – Over 5 Watts to 15 Watts in an Assembly building type, Climate Zone 6.

Since this is dusk to dawn operation, the demand savings are zero.

A complete list of savings for other measures in this work paper can be found in the attachment [Attachment 1].

# Section 3. Load Shapes

The ideal load shape for net benefits estimates would represent the difference between the base case and measure case. The closest load shapes that are applicable to the measures in this work paper are listed in the table below.

Building Types and Load Shapes

|  |  |  |  |
| --- | --- | --- | --- |
| **Solution Code Map** | **Building Type** | **Load Shape** | **E3 Alternate Building Type** |
| LT-27373, LT-54834, and LT-28343 | Assembly | Outdoor Lt | Misc.\_Commercial |
| Education - Primary School | Outdoor Lt | Misc.\_Commercial |
| Education - Secondary School | Outdoor Lt | Misc.\_Commercial |
| Education - Relocatable Classroom | Outdoor Lt | Misc.\_Commercial |
| Education - Community College | Outdoor Lt | Misc.\_Commercial |
| Education - University | Outdoor Lt | Misc.\_Commercial |
| Grocery | Outdoor Lt | Misc.\_Commercial |
| Health/Medical - Hospital | Outdoor Lt | Misc.\_Commercial |
| Health/Medical - Nursing Home | Outdoor Lt | Misc.\_Commercial |
| Lodging - Hotel | Outdoor Lt | Misc.\_Commercial |
| Lodging - Guest Rooms | Outdoor Lt | Misc.\_Commercial |
| Lodging - Motel | Outdoor Lt | Misc.\_Commercial |
| Manufacturing - Bio/Tech | Outdoor Lt | Misc.\_Commercial |
| Manufacturing - Light Industrial | Outdoor Lt | Misc.\_Commercial |
| Office - Large | Outdoor Lt | Misc.\_Commercial |
| Office - Small | Outdoor Lt | Misc.\_Commercial |
| Restaurant - Fast-Food | Outdoor Lt | Misc.\_Commercial |
| Restaurant - Sit-Down | Outdoor Lt | Misc.\_Commercial |
| Retail - Multistory Large | Outdoor Lt | Misc.\_Commercial |
| Retail - Single-Story Large | Outdoor Lt | Misc.\_Commercial |
| Retail - Small | Outdoor Lt | Misc.\_Commercial |
| Storage - Conditioned | Outdoor Lt | Misc.\_Commercial |
| Storage - Unconditioned | Outdoor Lt | Misc.\_Commercial |
| Warehouse - Refrigerated | Outdoor Lt | Misc.\_Commercial |
| LT- 18927, LT-18928, and LT-18929 | Residential Single Family | Outdoor Lt | Misc.\_Commercial |
| Residential Multi-family | Outdoor Lt | Misc.\_Commercial |
| Residential Mobile Home - Double-Wide | Outdoor Lt | Misc.\_Commercial |

# Section 4. Costs

## 4.1 Base Case Cost

Bi-pin halogen lighting fixture cost is an average of fixture costs found online [Attachment 2]. The costs are similar regardless of the wattage of the base case, hence, are grouped into a single cost. The cost varies most by the finish of the fixture. The web scraping to find the new costs was done in fourth quarter of 2016. The labor cost is taken from RS Means 2016 Electrical Cost Data [503]. For a complete breakdown of measure case costs, please refer to Attachment 1.

## 4.2 Measure Case Cost

Measure costs are also taken from online retailers [Attachment 2]. Same base case labor cost is used for the measure case cost. For a complete breakdown of measure case costs, please refer to Attachment 1.

## 4.3 Full and Incremental Measure Cost

**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

For a complete breakdown of full and incremental measure costs, please refer to Attachment 1.

# Attachments

1. SCE17LG105.0 A1 – Calculation Template\_Final.zip

2. SCE17LG105.0 A2 – Cost.xlsx

# References

1. References\_12122016\_100741.xlsx

|  |  |
| --- | --- |
| [433] | Workpaper Disposition for Lighting Retrofits - May 30, 2014 |
| [496] | 2016 Building Energy Efficiency Standards for Residential and Nonresidential Buildings (Title 24) |
| [503] | 2016 RS Means Electrical Cost Data |
|  |  |
|  |  |