Work Paper SCE17LG071

**Revision 0**

**Southern California Edison**

**Led Pool and Spa Lighting**

# At-a-Glance Summary

|  |  |
| --- | --- |
| **Measure Codes** | LT-97531, LT-60864, LT-18465, LT-79642, LT-19365, LT-28111, LT-34888, LT-42086, LT-47665, LT-59777, LT-69385, LT-50864, LT-78882, LT-88786, LT-95643, LT-80864, LT-18635, LT-18636, LT-18637, LT-18638, LT-18639, LT-18640, LT-18641, LT-19141, LT-18643, LT-18644, LT-18645, LT-18646, LT-18647, LT-18648, LT-18663, LT-18650 |
| **Measure Description** | LED Pool Luminaire, LED Spa Luminaire, LED Pool Lamp, or LED Spa Lamp |
| **Base Case Description** | Incandescent Pool Luminaire, Incandescent Pool Lamp, Incandescent Spa Luminaire, or Incandescent Spa Lamp |
| **Units** | per luminaire or per lamp |
| **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** | Residential: Varies (DEER EUL ID: OLtg-Res-LED-50000hr)  Non-residential: Varies (DEER EUL ID: OLtg-Com-LED-50000hr) |
| **Measure Installation Type** | Replace on Burnout (ROB)  Retrofit or Early Retirement (RET/ER) |
| **Net-to-Gross Ratio** | 0.6 (DEER NTGR ID: Com-Default>2yrs)  0.6 (DEER NTGR ID: Ind-Default>2yrs)  0.6 (DEER NTGR ID: Agr-Default>2yrs)  0.55 (DEER NTGR ID: Res-Default>2)  0.85 (DEER NTGR ID: Com-Default-HTR-di)  0.85 (DEER NTGR ID: Ind-Default-HTR-di)  0.85 (DEER NTGR ID: Agr-Default-HTR-di)  0.85 (DEER NTGR ID: Res-Default-HTR-di) |
| **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 | 10/14/16 | David Douglass-Jaimes (TRC) | * This work paper is an update of SCE13LG071.2 * New calculation template for 2017 program year * Updated DEER EUL and RUL values * Updated references to Title 20 to reflect current Standards * Updated cost information * Added new solution codes to differentiate lamp vs. fixture replacements * All (16) California Climate Zones added to calculation template |

# Commission Staff and Cal TF Comments

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Rev** | **Party** | **Submittal Date** | **Comment Date** | **Comments** | **WP Developer Response** |
| 0 | CS |  |  |  |  |
| 0 | Cal TF |  |  |  |  |

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 incandescent pool lamps or luminaires with LED pool lighting in commercial and residential swimming pools and spas. Individual measure codes refer to either full luminaire replacements, or just lamp replacements. The pool and spa lighting fixtures addressed in this work paper refers to the underwater pool lighting used to provide safety and aesthetics to the area.

The data used in this work paper are from SCE’s Emerging Technology study conducted in 2010, ET10SCE1130 [A] unless noted otherwise. The energy savings in this work paper include baseline incandescent wattages ranging from 100 to 500 Watts.

**Base, Standard, and Measure Cases**

|  |  |
| --- | --- |
| **Case** | **Description of Typical Scenario** |
| Measure | LED Pool Lighting or LED Spa Lighting |
| Existing Condition | Incandescent Pool Lighting or Incandescent Spa Lighting |
| Code/Standard | N/A |
| Industry Standard Practice | Incandescent Pool Lighting or Incandescent Spa Lighting |

Measures and Codes

| **Measure Codes** | | | | **Measure Name** |
| --- | --- | --- | --- | --- |
| SCG | SDG&E | SCE | PG&E |
|  |  | LT-97531 |  | 15.5 Watt Pool Light (Dusk to Close) LED replacing 100 Watt Incandescent |
|  |  | LT-60864 |  | 15.5 Watt Pool Light (Dusk to Dawn) LED replacing 100 Watt Incandescent |
|  |  | LT-18465 |  | 15.5 Watt Pool Light (Res) LED replacing 100 Watt Incandescent |
|  |  | LT-79642 |  | 15.5 Watt Spa Light (Res) LED replacing 100 Watt Incandescent |
|  |  | LT-19365 |  | 45.8 Watt Pool Light (Dusk to Close) LED replacing 300 Watt Incandescent |
|  |  | LT-28111 |  | 45.8 Watt Pool Light (Dusk to Dawn) LED replacing 300 Watt Incandescent |
|  |  | LT-34888 |  | 45.8 Watt Pool Light (Res) LED replacing 300 Watt Incandescent |
|  |  | LT-42086 |  | 45.8 Watt Spa Light (Res) LED replacing 300 Watt Incandescent |
|  |  | LT-47665 |  | 52.4 Watt Pool Light (Dusk to Close) LED replacing 400 Watt Incandescent |
|  |  | LT-59777 |  | 52.4 Watt Pool Light (Dusk to Dawn) LED replacing 400 Watt Incandescent |
|  |  | LT-69385 |  | 52.4 Watt Pool Light (Res) LED replacing 400 Watt Incandescent |
|  |  | LT-50864 |  | 52.4 Watt Spa Light (Res) LED replacing 400 Watt Incandescent |
|  |  | LT-78882 |  | 67.4 Watt Pool Light (Dusk to Close) LED replacing 500 Watt Incandescent |
|  |  | LT-88786 |  | 67.4 Watt Pool Light (Dusk to Dawn) LED replacing 500 Watt Incandescent |
|  |  | LT-95643 |  | 67.4 Watt Pool Light (Res) LED replacing 500 Watt Incandescent |
|  |  | LT-80864 |  | 67.4 Watt Spa Light (Res) LED replacing 500 Watt Incandescent |
|  |  | LT-18635 |  | 15.5 Watt Pool Lamp (Res) LED replacing 100 Watt Incandescent |
|  |  | LT-18643 |  | 15.5 Watt Pool Lamp (Dusk to Dawn) LED replacing 100 Watt Incandescent |
|  |  | LT-18646 |  | 15.5 Watt Spa Lamp (Res) LED replacing 100 Watt Incandescent |
|  |  | LT-18650 |  | 15.5 Watt Pool Lamp (Dusk to Close) LED replacing 100 Watt Incandescent |
|  |  | LT-18636 |  | 45.8 Watt Pool Lamp (Dusk to Close) LED replacing 300 Watt Incandescent |
|  |  | LT-18637 |  | 45.8 Watt Pool Lamp (Dusk to Dawn) LED replacing 300 Watt Incandescent |
|  |  | LT-18638 |  | 45.8 Watt Pool Lamp (Res) LED replacing 300 Watt Incandescent |
|  |  | LT-18639 |  | 45.8 Watt Spa Lamp (Res) LED replacing 300 Watt Incandescent |
|  |  | LT-18640 |  | 52.4 Watt Pool Lamp (Dusk to Close) LED replacing 400 Watt Incandescent |
|  |  | LT-18641 |  | 52.4 Watt Spa Lamp (Res) LED replacing 400 Watt Incandescent |
|  |  | LT-18644 |  | 52.4 Watt Pool Lamp (Res) LED replacing 400 Watt Incandescent |
|  |  | LT-19141 |  | 52.4 Watt Pool Lamp (Dusk to Dawn) LED replacing 400 Watt Incandescent |
|  |  | LT-18645 |  | 67.4 Watt Pool Lamp (Dusk to Close) LED replacing 500 Watt Incandescent |
|  |  | LT-18647 |  | 67.4 Watt Spa Lamp (Res) LED replacing 500 Watt Incandescent |
|  |  | LT-18648 |  | 67.4 Watt Pool Lamp (Dusk to Dawn) LED replacing 500 Watt Incandescent |
|  |  | LT-18663 |  | 67.4 Watt Pool Lamp (Res) LED replacing 500 Watt Incandescent |

Use of LED pool lighting does not preclude user’s responsibility for compliance with all code requirements and lighting performance recommendations where applicable to pool lighting applications. Illuminating Engineering Society Handbook 9th edition recommends luminance of the pool surface from underwater lights differentiated by 4 different classes of pools. The IES Handbook also states “As a general rule, unit power density (UPD) required for underwater lights varies between 5 to 30 watts per square meter (0.5 to 3 watts per square foot) of water surface depending on the class of facility and efficacy of light sources.” IES recommendations refer to incandescent lighting.

For LED pool lights that match the color temperature of the incandescent, it must meet the minimum light levels of the incandescent lamps as shown in the table below. This information can also be found in Table 5 of the ET report [A].

LED Minimum Lumens at 3000K Color Temperature

|  |  |
| --- | --- |
| **Incandescent Lamp Replaced** | **LED Minimum Lumens** |
| 100W\* | 475 |
| 300W | 2,092 |
| 400W | 3,201 |
| 500W | 4,573 |

\*100W lumens was calculated based on 300-500W lamps [Attachment 2]

Study from ET10SCE1130 [A] has shown that LEDs with cooler color temperatures exhibit higher illumination levels from fewer lumens. This is due to the blue light traveling farther in water as it acts as a “blue filter”. The table below shows the minimum lumen output for LED pool lights above 6000K. This information can also be found in Table 5 of the ET report.

LED Minimum Lumens at >6000K Color Temperature

|  |  |
| --- | --- |
| Watts | Lumens |
| 100W Replacement\* | 475 |
| 300W Replacement | 2,000 |
| 400W Replacement | 2,732 |
| 500W Replacement | 3,039 |

\*100W replacement lumens was calculated

based on screw-in 300W replacement [Attachment 2]

A separate document was created to address the minimum qualifying criteria for LED pool/spa lights which is a recommended minimal requirement, but not currently required. Therefore, data from ET10SCE1130 study [A] is used for this work paper.

## 1.2 Technical Description

Per ET10SCE1130 study [A], “A Light Emitting Diode (LED) pool lamp is an underwater lighting luminaire used to illuminate swimming pools for safety, security, and aesthetics. The LED replaces the incandescent pool lamp traditionally screwed into an airtight fixture that submerges under water. It comes in two different variations: as a fixture replacement and as a screw-in replacement. The fixture replacement requires an entire fixture replacement along with the wiring that runs through an underground conduit, while the screw-in replacement only replaces the incandescent lamp with an LED lamp within the same/existing fixture.”

“Whether LED or incandescent, the LED pool lamp works by cooling itself with water. The fixture fits inside a niche that is typically three feet below the water level. Although screwed into the niche with one screw, the fixture has holes around the face to let water pass through.”

“A LED is a semiconductor completely covered in epoxy. It emits light when there is a proper amount of current in the LED. Often used as indicator lights, the small, low-output LED is a mature technology. However, advances in LED technology have made them brighter and more efficient, thereby expanding the application of LEDs to other markets. The operation of the LED pool lamp is the same as that of the incandescent pool lamp from the perspective of the end-user”.

## 1.3 Installation Types and Delivery Mechanisms

The delivery methods that are available for these measures are:

* Financial Support – Down-Stream Incentive - Deemed
* Financial Support – Direct Install

The program/install type for the above measures is:

* Replace on Burnout (ROB)
* Retrofit or Early Replacement (RET/ER) – No code baseline; 1st & 2nd baseline savings are same. Programs will take the following actions for RET measures (subject to change based on outcome of Draft Resolution E-4818, but may incorporate a survey similar to the HVAC example).
  + The MFEER program quality control ensures correct documentation of existing measure, base case, and specification of the energy efficient product installed.  SCE requires a detailed Product Location Form (PLF) for each project submitted for rebate or incentive.  The PLF is an Excel spreadsheet with a tab for measures installed in dwelling areas and another for measures installed in common area locations.  The PFL contains the following fields: Apartment Address, Measure Installed, Product Make/Model, Install Locations (detailed to Kitchen, Bathroom, Hallway, Living Room, Bedroom, Dining Room, Laundry Room, and Porch/Patio), as well as Common Area locations.  This information is entered and tracked in the program’s tracking database.  This level of data is provided in the Participation Data that is provided to the CPUC on a quarterly basis.
  + The Non Residential Direct Install program quality control ensures correct documentation of existing measure, base case, and specification of the energy efficient product installed.  SCE requires a detailed Product Location Form (PLF) for each project submitted for rebate or incentive.  The PLF is a form which information for measures installed in all building types related to the Non Residential Direct Install program.  The PLF contains the following fields: Service Account Address, Measures Proposed/Installed, Product Make/Model, Install Locations (detailed to define separate spaces/floors, as well as specific locations within the space including but not limited to:  Bathrooms, Hallways, Meeting Rooms, Offices, Warehouse, etc.).

Customers are solicited to participate primarily through field visits.  Contractors conduct energy consultation and provide recommendation that can help eligible customers use less energy.  If the customer agrees, the Direct Install contractor will help them complete an authorization form and schedule an installation appointment.

SCE can also provide photos to show measure functionality and a sample close up photos to substantiate the measure base case where applicable.  These photos would be part of the required project package.  The project package is identified with the Service Account Number and attached to SCE’s SMART database (SCE Project Tracking System) at each specific project level. The above described information is entered and tracked in the program’s tracking database.  This level of data is provided in the Participation Data that is provided to the CPUC on a quarterly basis.

**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 |
| Retrofit or Early Replacement (RET/ER) | Above Customer Existing | Above Code or Standard | RUL | EUL-RUL |

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. |

**Incentive Method Descriptions**

|  |  |
| --- | --- |
| **Incentive Method** | **Description** |
| Direct Install | The program implements energy efficiency measures for qualifying customers, at no cost to the customer. |
| 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. |

## 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 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** |
| --- | --- | --- | --- | --- | --- |
| 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 |
| Ind-Default>2yrs | All other EEMs with no evaluated NTGR; existing EEM in programs with same delivery mechanism for more than 2 years | Ind | Any | Any | 0.60 |
| Agric-Default>2yrs | All other EEMs with no evaluated NTGR; existing EEM in programs with same delivery mechanism for more than 2 years | Ag | Any | Any | 0.60 |
| Com-Default-HTR-di | All other EEM with no evaluated NTGR; direct install to hard-to-reach only. | Com | Any | DirInstall | 0.85 |
| Ind-Default-HTR-di | All other EEM with no evaluated NTGR; direct install to hard-to-reach only. | Ind | Any | DirInstall | 0.85 |
| Agricult-Default-HTR-di | All other EEM with no evaluated NTGR; direct install to hard-to-reach only. | Ag | Any | DirInstall | 0.85 |
| Res-Default>2yrs | All other EEM with no evaluated NTGR; existing EEM with same delivery mechanism for more than 2 years | Res | Any | Any | 0.55 |
| Res-Default-HTR-di | All other EEM with no evaluated NTGR; direct install to hard-to-reach only. | Res | Any | DirInstall | 0.85 |

Note: Direct install measures that are not hard-to-reach will use the default NTG value.

This work paper includes measures that are offered via direct install activities into hard-to-reach (HTR) customer homes. “Final Resolution E-4700”, dated December 18, 2014, defines specific criteria to classify customer homes as HTR. The “Required Corrections to Measure Level Input Parameters Identified by Commission Staff per D.14-10-046 Order Paragraph 16”, dated November 3, 2014, includes additional clarification for the geographic criteria.

SCE’s Multi-Family Energy Efficiency Rebate (MFEER) program addresses the ongoing concern with “split incentives”, where the residents are not the owners of the property, so they lack incentive to improve their energy usage. Similarly, the property owners do not live on-site and pay higher utility expenses due to inefficient appliances, thus lack any incentive to upgrade. The MFEER is designed to drive this customer segment toward participation by offering property owners a variety of energy efficiency measures and services. The MFEER program will offer and track measure installations in both common and dwelling areas of multifamily complexes and common areas of mobile home parks and condominiums. Measures offered via direct install activities in both common and dwelling areas of multifamily complexes and common areas of mobile home parks and condominiums will receive the HTR NTG. Other measures in the MFEER program will receive default NTG (NTGR\_ID: Res-Default>2), unless otherwise specified in DEER.

**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 | 12 | 4 |
| OLtg-Com-LED-20000hr | LED lamp – Outdoor- Commercial | Com | Lighting | 4.88 | 1.63 |
| OLtg-Res-LED-50000hr | LED Fixture - Outdoor- Residential | Res | Lighting | 16 | 5.33 |
| OLtg-Res-LED-20000hr | LED lamp – Outdoor- Residential | Res | Lighting | 16 | 5.33 |
| OLtg-Res-LED-50000hr-Cmn | LED lamp - Outdoor- Residential Common Area | Res | Lighting | 14.75 | 4.92 |

### 1.4.2 Codes and Standards Analysis

There are no applicable codes in Title 24 Building Energy Efficiency Standards [496]. Title 20 [422] contains an applicable code that requires a minimum average lamp efficacy of incandescent reflector lamps. California Electrical Code [461] Article 680 contains restrictive installation and equipment requirements necessary to prevent severe shock to human bodies around swimming pools, spas, hot tubs, and fountains.

Code Summary

|  |  |  |
| --- | --- | --- |
| **Code** | **Reference** | **Effective Dates** |
| Title 20 (2015) | Section 1605.3(k)1 Table K-9 | July 1, 2015 |
| T24 California Electrical Code | Article 680 | January 1, 2014 |

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

### ET10SCE1130 – Commercial LED Pool Lamps study [A] was used to qualify the measure in this work paper. ET11SCE4050 – Residential Pool Light Hours Survey study [B] was used to estimate the measure’s operating hours in this work paper.

### 1.5.1 ET10SCE1130 – Commercial LED Pool Lamps

## Southern California Edison (SCE) conducted the Commercial Light Emitting Diode (LED) Pool Lamps Emerging Technologies (ET) Assessment Project in December 2010 to determine the energy savings, performance, and merits of LED pool lighting. The project assessed LED lighting to replace the incumbent incandescent lighting used in commercial pools for recreational swimming, amateur athletics, and Jacuzzi spas. Surveys of multiple spa and pool locations determined the specifications of existing lighting and general characteristics.

### 1.5.2 ET11SCE4050 – Residential Pool Light Hours Survey

This Emerging Technology (ET) project focuses on gathering operating hour data for underwater pool lighting usage in the residential sector. The objective of this study was to determine how long Southern California Edison (SCE) residential customers use their underwater pool lights in a year. To gather the pool light operating data, a 10-minute survey was conducted over the internet. One hundred and ninety-eight interviews were conducted where 105 participants answered questions about spa lights. In addition, 189 responded to questions about swimming pool lights.

## 1.6 Data Quality and Future Data Needs

No additional data needs are required.

# Section 2. Calculation Methodology

The LED pool lamps or luminaires replace incandescent lamps or luminaires ranging from 100-500 Watts for pools and spas. The wattages, listed in the table below, were determined by tests conducted in the field with various wattages for the ET10SCE1130 study [A, Table 5]. The wattage of the 300W equivalent LED was determined from an average of 2 different LED pool lights. Spa lights use the same wattages as the pool lights. Base case and measures wattages are the same for both lamps and luminaires.

Base and Measure Wattages

|  |  |  |
| --- | --- | --- |
| **Measures** | **Basecase – Incandescent Watts (W)** | **Measure - LED Watts (W)** |
| LED Pool Lights Replacing 100W\* | 100 | 15.5 |
| LED Pool Lights Replacing 300W | 300 | 45.8 |
| LED Pool Lights Replacing 400W | 400 | 52.4 |
| LED Pool Lights Replacing 500W | 500 | 67.4 |

\*Information from pool light manufacturers

For non-residential applications, the pool lights either operate 4 hours/day for dusk to close operation (1460 hrs/year) or 4380 hours/year for dusk to dawn operation. The dusk to close and dusk to dawn operation data was logged from the ET10SCE1130 study [A]. Although dusk to dawn was logged at 13 hours, DEER-defined 4380 hours was used for energy savings calculations.

Equation 1 illustrates the methodology used to calculate annual energy savings. Equation 2 shows a 45.8W LED pool light replacing a 300W incandescent operating 12 hours/day (dusk to dawn).

Equation 1



Equation 2



For residential applications, the pool lights are used 48 hours/year and spa lights are used 66 hours/year based on the Emerging Technology - Market Behavior Study (ET11SCE4050) that surveyed 189 customers on how long they operate their pools/spas at home [B]. Therefore, pool and spa savings for residential applications will have different operating hours. Equation 3 shows a 45.8W LED pool light replacing a 300W incandescent in a residential pool.

Equation 3



The demand reduction for exterior installations is zero as they have a Peak Coincidence Factor of 0.

The table below lists the energy savings and demand reduction for LED Pool lights.

Table 10 Energy Savings and Demand Reduction

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Measures** | **Base Case (kW)** | **Measure (kW)** | **Delta Watts (kW)** | **Energy Savings (kWh)** | **Peak Demand Reduction (kW)** |
| 45.8 Watt Pool Light (Dusk to Close) LED replacing 300 Watt Incandescent | 0.300 | 0.046 | 0.254 | 371.13 | 0 |
| 52.4 Watt Pool Light (Dusk to Close) LED replacing 400 Watt Incandescent | 0.400 | 0.052 | 0.348 | 507.50 | 0 |
| 67.4 Watt Pool Light (Dusk to Close) LED replacing 500 Watt Incandescent | 0.500 | 0.067 | 0.433 | 631.60 | 0 |
| 15.5 Watt Pool Light (Dusk to Close) LED replacing 100 Watt Incandescent | 0.100 | 0.0155 | 0.085 | 123.37 | 0 |

# 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

|  |  |  |
| --- | --- | --- |
| **Building Type** | **Load Shape** | **E3 Alternate Building Type** |
| Lodging - Hotel | Outdoor Lt | Misc.\_Commercial |
| Lodging - Motel | Outdoor Lt | Misc.\_Commercial |
| Residential Multi-family | Outdoor Lt | Misc.\_Commercial |
| Residential Mobile Home - Double-Wide | Outdoor Lt | Misc.\_Commercial |
| Residential Single Family | Outdoor Lt | Misc.\_Commercial |

# Section 4. Costs

## The costs of the base and measure technologies were taken from various online pool lighting supply sources in December 2016, as shown in Attachment 2. Labor costs were taken from the ET report [A].

## 4.1 Base Case Cost

The base case cost is shown in the table below.

Base Case Cost

|  |  |  |  |
| --- | --- | --- | --- |
| **Measure** | **Fixture w/ Lamp** | **Labor** | **Total** |
| 100W Incandescent Pool Luminaire | $199.49 | $130.00 | $329.49 |
| 300, 400, 500W Incandescent Pool Luminaire | $213.78 | $130.00 | $343.78 |
| 100W Incandescent Pool Lamp | $17.38 | $65.00 | $82.38 |
| 300, 400, 500W Incandescent Pool Lamp | $23.47 | $65.00 | $88.47 |

## 4.2 Measure Case Cost

The measure case cost is shown in the table below.

Measure Cost

|  |  |  |  |
| --- | --- | --- | --- |
| **Measure** | **Measure Cost** | **Labor** | **Gross Measure Cost** |
| 15.5 Watt LED Pool Luminaire | $342.15 | $130.00 | $472.15 |
| 45.8 Watt LED Pool Luminaire | $386.75 | $130.00 | $516.75 |
| 52.4 Watt LED Pool Luminaire | $430.35 | $130.00 | $560.35 |
| 67.4 Watt LED Pool Luminaire | $392.73 | $130.00 | $522.73 |
| 15.5 Watt LED Pool Lamp | $131.63 | $65.00 | $193.63 |
| 45.8 Watt LED Pool Lamp | $274.49 | $65.00 | $339.49 |
| 52.4 Watt LED Pool Lamp | $285.39 | $65.00 | $350.39 |
| 67.4 Watt LED Pool Lamp | $381.99 | $65.00 | $446.99 |

## 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 |
| RET/ER | (MEC + MLC) – (BEC + BLC) | MEC + MLC | (MEC + MLC) – (BEC + BLC) |

MEC = Measure Equipment Cost; MLC = Measure Labor Cost

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

**Full and Incremental Costs**

| **Measure** | **Installation Type** | **Incremental Measure Cost** | **Full Measure Cost** | |
| --- | --- | --- | --- | --- |
| **1st Baseline** | **2nd Baseline** |
| LT-97531 | ROB | $142.66 | $142.66 | N/A |
| LT-60864 | ROB | $142.66 | $142.66 | N/A |
| LT-18465 | ROB | $142.66 | $142.66 | N/A |
| LT-79642 | ROB | $142.66 | $142.66 | N/A |
| LT-19365 | ROB | $172.97 | $172.97 | N/A |
| LT-28111 | ROB | $172.97 | $172.97 | N/A |
| LT-34888 | ROB | $172.97 | $172.97 | N/A |
| LT-42086 | ROB | $172.97 | $172.97 | N/A |
| LT-47665 | ROB | $216.57 | $216.57 | N/A |
| LT-59777 | ROB | $216.57 | $216.57 | N/A |
| LT-69385 | ROB | $216.57 | $216.57 | N/A |
| LT-50864 | ROB | $216.57 | $216.57 | N/A |
| LT-78882 | ROB | $178.95 | $178.95 | N/A |
| LT-88786 | ROB | $178.95 | $178.95 | N/A |
| LT-95643 | ROB | $178.95 | $178.95 | N/A |
| LT-80864 | ROB | $178.95 | $178.95 | N/A |
| LT-97531 | RET | $142.66 | $472.15 | $142.66 |
| LT-60864 | RET | $142.66 | $472.15 | $142.66 |
| LT-18465 | RET | $142.66 | $472.15 | $142.66 |
| LT-79642 | RET | $142.66 | $472.15 | $142.66 |
| LT-19365 | RET | $172.97 | $516.75 | $172.97 |
| LT-28111 | RET | $172.97 | $516.75 | $172.97 |
| LT-34888 | RET | $172.97 | $516.75 | $172.97 |
| LT-42086 | RET | $172.97 | $516.75 | $172.97 |
| LT-47665 | RET | $216.57 | $560.35 | $216.57 |
| LT-59777 | RET | $216.57 | $560.35 | $216.57 |
| LT-69385 | RET | $216.57 | $560.35 | $216.57 |
| LT-50864 | RET | $216.57 | $560.35 | $216.57 |
| LT-78882 | RET | $178.95 | $522.73 | $178.95 |
| LT-88786 | RET | $178.95 | $522.73 | $178.95 |
| LT-95643 | RET | $178.95 | $522.73 | $178.95 |
| LT-80864 | RET | $178.95 | $522.73 | $178.95 |
| LT-18635 | ROB | $114.25 | $114.25 | N/A |
| LT-18643 | ROB | $114.25 | $114.25 | N/A |
| LT-18646 | ROB | $114.25 | $114.25 | N/A |
| LT-18650 | ROB | $114.25 | $114.25 | N/A |
| LT-18636 | ROB | $251.02 | $251.02 | N/A |
| LT-18637 | ROB | $251.02 | $251.02 | N/A |
| LT-18638 | ROB | $251.02 | $251.02 | N/A |
| LT-18639 | ROB | $251.02 | $251.02 | N/A |
| LT-18640 | ROB | $261.92 | $261.92 | N/A |
| LT-18641 | ROB | $261.92 | $261.92 | N/A |
| LT-18644 | ROB | $261.92 | $261.92 | N/A |
| LT-19141 | ROB | $261.92 | $261.92 | N/A |
| LT-18645 | ROB | $358.52 | $358.52 | N/A |
| LT-18647 | ROB | $358.52 | $358.52 | N/A |
| LT-18648 | ROB | $358.52 | $358.52 | N/A |
| LT-18663 | ROB | $358.52 | $358.52 | N/A |
| LT-18635 | RET | $114.25 | $196.63 | $114.25 |
| LT-18643 | RET | $114.25 | $196.63 | $114.25 |
| LT-18646 | RET | $114.25 | $196.63 | $114.25 |
| LT-18650 | RET | $114.25 | $196.63 | $114.25 |
| LT-18636 | RET | $251.02 | $339.49 | $251.02 |
| LT-18637 | RET | $251.02 | $339.49 | $251.02 |
| LT-18638 | RET | $251.02 | $339.49 | $251.02 |
| LT-18639 | RET | $251.02 | $339.49 | $251.02 |
| LT-18640 | RET | $261.92 | $350.39 | $261.92 |
| LT-18641 | RET | $261.92 | $350.39 | $261.92 |
| LT-18644 | RET | $261.92 | $350.39 | $261.92 |
| LT-19141 | RET | $261.92 | $350.39 | $261.92 |
| LT-18645 | RET | $358.52 | $446.99 | $358.52 |
| LT-18647 | RET | $358.52 | $446.99 | $358.52 |
| LT-18648 | RET | $358.52 | $446.99 | $358.52 |
| LT-18663 | RET | $358.52 | $446.99 | $358.52 |

# Attachments

1. SCE17LG071.0 A1 – Calculation Template\_Final.zip

2. SCE17LG071.0 A2 – Updated Cost Calculator.xlsx

# References

1. References\_09222016\_11072016.xlsx

[422]

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[A] *Commercial LED Pool Lamps*. Tech. no. ET10SCE1130 Report. N.p.: Southern California Edison, 2010. Print.

[B] *Residential Pool Light Hours Survey*. Tech. no. ET11SCE4050 Report. N.p.: Southern California Edison, 2011. Print.