**Work Paper WPSDGENRLG0081**

**Revision 3**

**San Diego Gas & Electric**

**Energy Efficiency Engineering**

**LED Display Case Retrofit**

### Core Measure Summary Table

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| General Measure Information | | | | | | | | PT | | 1st Baseline Period | | | | 2nd Baseline Period | | | | TOU |
| Measure Name | Measure RunID | Solution Code | CZ | Building Type | Load Shape | EUL | Unit Definition | Program Type (NEW, ROB, RET) | Applicable Code | Gross Unit Annual Electricity Savings (kWh/unit) | User Entered kW Savings per unit (kW/unit) | Gas Savings (Therms) | 1st Baseline Useful Life | kWh Saving per unit (kWh/unit) | kW Savings per unit (kW/unit) | Gas Savings (Therms) | 2nd Baseline Useful Life | % TOU |
| **Refer to workpaper WPSDGENRLG0999** | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |

Note: **For the complete list of Measures, refer to workpaper WPSDGENRLG0999**

### Costing and NTG Summary Table

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| General Measure Information | | | | PT | | NTG | | | IR | 1st Baseline Period | 2nd Baseline Period | IMC | DIM |
| Measure Name | Solution Code | CZ | Unit Definition | Program Type (NEW, ROB, RET) | Applicable Code | NTG Non-Res. | NTG Res. | NTG Multi Family | Installation Rate | Gross Measure Cost per unit | Gross Measure Cost per unit | Incremental Measure Cost per unit | Delivery & Incentive Method |
| **Refer to workpaper WPSDGENRLG0999** |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |

Note: **For the complete list of Costs and NTGs, refer to workpaper WPSDGENRLG0999**

# Document Revision History

|  |  |  |  |
| --- | --- | --- | --- |
| **Revision #** | **MM/DD/YY** | **Author/Affiliation** | **Summary of Changes** |
| 0 | 12/03/2007 | Emerging Technology / SDGE | Original Work paper |
| 1 | 07/17/2009 | Lucie Sidibe / SDGE | 1- General Review  2- Updated Format  3- NTG Updated to reflect 09/11 DEER  4- T8 and T12 were added as additional base case |
| 2 | 06/26/2012 | Peter Ford / SDGE | Revised NTG to 2011 DEER. Added references to WPSDGENRLG0999 and changed tables accordingly |
| 3 | 06/06/2014 | Judelson Enriquez / RMS | 1. Updated workpaper to new format. 2. Updated measure info, delivery method, measure requirements, DEER difference analysis, code analysis, EUL with DEER2014, NTG with DEER2011, Section 2 with new DEER2014 IE/operating hours methodology, measure wattage summary table, load shape section, and references list. 3. Added measure table, delivery and incentive mechanism section, DEER difference summary table, code summary table, EUL tables, NTG tables, GSIA language and tables, TOU section and tables, Section 2.3 gas savings and methodology. 4. Updated costs with average $/ft. based on online sources, and updated cost tables. |

# Section 1. General Measure & Baseline Data

## 1.1 Measure & Delivery Description

### 1.1a Measure Description

This work paper details the replacement of existing pin-based halogen or linear fluorescent lamps with new, more efficient linear LED strip lighting.

Table 1 below shows the measure description classifications with what the existing base case lamps can be replaced.

Table 1 Measure Names

|  |  |
| --- | --- |
| Product Code | Measure name |
| L-O11 | New Linear LED Strip (T8 base case) |
| L-O21 | New Linear LED Strip (T12 base case) |
| L-O31 | New Linear LED Strip (Bi-pin Halogen base case) |

### 1.1b Delivery and Incentive Mechanism

The delivery method for this measure is:

* Financial-Support Down-Stream Incentive Deemed

The measure install types are:

* Retrofit (RET)

### 1.1c Measure Requirements

Measure eligibility requirements for the measures addressed in this work paper are established in the San Diego Gas & Electric Energy Efficiency Business Rebates Product Catalog [[[1]](#endnote-1)]. Please refer to this document for the most updated eligibility requirements.

General requirements include:

* Only complete, new Linear LED lamps qualify
* Must replace an existing bi-pin halogen or linear fluorescent lamps
* A written warranty must be issued to the customer guaranteeing repair or replacement of defective electrical parts (including light source and power supplies) for a minimum of three (3) years from the date of purchase

Power Supply Requirements:

* An electronic power supply must be used in the new system
* Must have a power factor of greater than 0.9
* Must experience no more than 20% of total harmonic distortion

## 1.2 DEER Differences Analysis

The specific measures found in this workpaper are not included in the Database for Energy Efficient Resources (DEER) Version 2014. DEER contains interior lighting retrofit measures; however, none of the DEER measures match.

Table 2 DEER Difference Summary

|  |  |
| --- | --- |
| DEER Difference Summary Table | |
| Modified DEER Methodology | No |
| Scaled DEER Measure | No |
| DEER Building Prototypes Used | No |
| Deviation from DEER | DEER does not contain this type of measure. |
| DEER Version | DEER 2014 |
| DEER Run ID and Measure Name (Sample) | N/A |

## 1.3 Code Analysis

The 2013 California Title 24 Building Energy Efficiency Standards [[[2]](#endnote-2)] focus on key areas to improve the energy efficiency of newly constructed buildings and additions and alterations to existing buildings.

* Section 140.6(c)3I and J outlines the calculation of allowed indoor lighting power density for wall and floor display lighting, but this only applies to new, proposed space types and does not govern the measures in this workpaper.

The 2014 California Title 20 Appliance Efficiency Regulations [[[3]](#endnote-3)] include standards for both federally regulated appliances and nonfederally-regulated appliances that are sold or offered for sale in California, but it does not govern the lighting measures in this workpaper.

The measures in this workpaper do not fall under the Federal DOE or EPA Energy Regulations.

Table 3 Code Summary

| Code | Applicable Code Reference | Effective Dates |
| --- | --- | --- |
| Title 24 (2013) | 2013 Non-Residential Compliance Manual, Section 140.6 | July 1, 2014 |
| Title 20 (2014) | N/A | N/A |
| Federal Standards | N/A | N/A |

## 1.4 Measure Effective Useful Life

## DEER and the CPUC ED Workpaper Disposition for Lighting Retrofits documentation provide EUL and RUL information on [www.deeresources.com](http://www.deeresources.com).

To obtain the EUL value, the updated CPUC ED EUL table documentation issued on February 5, 2014, “DEER2014-EUL-table-update\_2014-02-05.xlsx”, was consulted. However, the workbook does not specifically include EUL/RUL values for unrefrigerated linear LED strip for display case lighting. It does include the EUL ID of “LED-Cooler” but the values are for walk-in coolers and freezers.

Without valid commercial EUL/RUL values for unrefrigerated linear LED strip for display case lighting, this workpaper will assume the EUL/RUL values of EUL ID “GrocDisp-FixtLtg-LED”.

Table 4 below identifies the value/methodology used for the measures in this workpaper. Please consult workpaper WPSDGENRLG0999 Master Lighting Look-up Table workpaper [[[4]](#endnote-4)] for the actual EUL values used for all of the building types in this work paper.

Table 4 DEER EUL Value/Methodology

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Market | Enduse | Measure | EUL (Years) | RUL (Years) |
| Non-Residential | Indoor Lighting | Display Case Lighting LED Lighting | SEE EUL ID | (1/3) of EUL |

Table 5 identifies the EUL IDs used in this workpaper.

Table 5 EUL ID Summary

|  |  |  |
| --- | --- | --- |
| EUL\_ID | Description | Sector |
| GrocDisp-FixtLtg-LED | Display Case Lighting LED Lighting | Com |

## 1.5 Net-to-Gross Ratios for Different Program Strategies

Net-to-Gross (NTG) Ratios are used to estimate free-ridership occurring in energy efficiency programs. Free riders are program participants who would have undertaken an activity whether or not there was an energy efficiency program promoting that activity. An NTG Ratio is a factor that represents the net program load impact divided by the gross program load impact. This factor is applied to gross program savings to determine the program's net impact.

The NTG value was obtained from the “DEER2011\_NTGR\_2012-05-16.xls” on the DEER website as required by Version 4 of the California Public Utilities Commission (CPUC) Energy Efficiency Policy Manual [132].

The relevant NTGR for this measure is shown in Table 6 below. Refer to workpaper WPSDGENRLG0999 for specific NTG values used.

Table 6 Net-to-Gross Ratio

| NTGR\_ID\* | Description\* | Sector\* | BldgType\* | ProgDelivID |
| --- | --- | --- | --- | --- |
| ET-Default | Emerging Technologies approved by ED through work paper review | All | Any | All |

\*Denotes that the column is taken from the DEER NTG Table.

## 1.6 Time-of-Use Adjustment Factor

As directed by the CPUC in decision 06-06-063 dated June 29, 2006, time-of-use (TOU) adjustment factors are to be applied for 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. Additionally, if a measure is assigned a DEER08 load shape, i.e. the load shape starts with “DEER:” the TOU assigned to that measure should also be zero.

Table 7 TOU Summary Table

|  |  |
| --- | --- |
| Measure | % |
| Linear LED Strip | 0 |

Note: Check Section 3 if a measure appears to require a non-zero percentage but is assigned zero. If the load shape is a DEER08 load shape, a TOU of 0 is correct.

# Section 2. Energy Savings & Demand Reduction Calculations

**2.1 Energy Savings Calculations**

The energy savings (ΔWatts) is the difference in wattage from the base case to the measure case as shown below.

ΔWatts = Base Case Wattage – Measure Case Wattage

The assumed base case lighting systems are taken to be a 31W T8 linear fluorescent fixture, a 43W T12 linear fluorescent fixture, and a 108W pin-based halogen lamp fixture for the L-O11, L-O21, and L-O31 product code measures, respectively. The replacement system is taken to be a 4’-5’ LED system, at an average rating of 29W [[[5]](#endnote-5)]. Table 8 provides a sample summary of the measure, base case, and delta wattages used in the energy calculation methodology.

Table 8 Measure Wattage Summary

| Product Code | TechType | Base Case Technology | Measure Technology | Base Case  Watts | Meas. Watts | Δ Watts | CstAve  Δ Watts/ft. |
| --- | --- | --- | --- | --- | --- | --- | --- |
| L-O11 | New Linear LED Strip (T8 base case) | Linear Fluorescent | Linear LED Strip | 31 | 29 | 2 | 0.5 |
| L-O21 | New Linear LED Strip (T12 base case) | Linear Fluorescent | Linear LED Strip | 43 | 29 | 14 | 3.5 |
| L-O31 | New Linear LED Strip (Bi-pin Halogen base case) | Halogen | Linear LED Strip | 108 | 29 | 79 | 19.75 |

**Hours of Operation**

For the purpose of this work paper, Annual hours of operation were obtained from the Energy Efficient Resources (DEER) 2008 A summary table with applicable values per market sector is provided below. This table applies to measure codes L-O31 and L-O21 only. For Measure Code L-O11, please refer to WPSDGENRLG0999.

**Table3: Hours of Operation Summary**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| DEER 2008 |  | Equivalent Full Load Hours | | |
| Lighting Hours of Use |  | Indoor | Indoor | Outdoor |
| Building Type | Bldg Code | CFL | Other | All |
| Retail - 3-Story Large | Rt3 | 3702.759278 | 3371.751181 | 4100 |
| Retail - Single-Story Large | RtL | 3813.273788 | 3430.294072 | 4100 |
| Retail - Small | RtS | 3720.635294 | 3252.859412 | 4100 |

 [**Equation 2**]

**\*Interactive effect was not utilized for this measure saving calculations.**

Refer to workpaper WPSDGENRLG0999 for the detailed lighting calculations.

**2.2 Demand Reduction Estimation Methodologies**

The demand reduction estimates are based upon the DEER methodology for Express Efficiency type programs. The methodology for demand reduction is shown in Equation3 below:

**Formula:**

Demand Reduction =  [**Equation 3**]

Refer to workpaper WPSDGENRLG0999 for the detailed lighting calculations.

**2.3 Gas Energy Saving Estimation**

There are no gas savings associated with the measures in this workpaper.

For all the savings discussed above, there is an installation rate applied to values associated with the installation GSIA ID in Table 9. The GSIA ID is identified in the ex-ante implementation tables for all programs and measures. The installation rate (IR) is applied to the gross savings calculations using the values associated with the IDs below.

Table 9 Gross Savings Installation Adjustment (GSIA) IDs

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| GSIA\_ID | Description | Sector | BldgType | UseCategory | TechType |
| Def-GSIA | Default GSIA | Any | Any | Any | Any |

# Section 3. Load Shapes

The difference between the base case load shape and the measure load shape would be the most appropriate load shape; however, only end-use profiles are available. Therefore, the closest load shape chosen for this measure is the NON\_res:DEER:Indoor\_Non-CFL\_Ltg load shape. See Table 10 for a list of all Building Types and Load Shapes. See the KEMA report [31] for a more thorough discussion regarding the load shapes for this measure.

Table 10 Building Types and Load Shapes

| Building Type | Load Shape |
| --- | --- |
| Retail - Multistory Large | NON\_res:DEER:Indoor\_Non-CFL\_Ltg |
| Retail - Single-Story Large | NON\_res:DEER:Indoor\_Non-CFL\_Ltg |
| Retail - Small | NON\_res:DEER:Indoor\_Non-CFL\_Ltg |

# Section 4. Base Case & Measure Costs

## 4.1 Base Case Cost

DEER 2008 data does not provide information on costs for linear LED strip for display case lighting. The installation type for the measures in this workpaper is “Retrofit” so it is assumed that the base case costs are zero because the linear LED strip display case lighting would not have been normally installed, as the existing lighting is assumed to be functioning properly and does not need to be replaced.

## 4.2 Gross Measure Cost

Per the E3, the gross measure cost (GMC) is the cost to install an energy efficient measure.

There are no existing DEER measure costs relevant to the installation of LED refrigerated case lighting. The measure costs were obtained from online retailers [[[6]](#endnote-6)] and the costs were averaged to obtain a cost per linear foot value. No information was obtained to estimate labor costs so a conservative estimation of about 10% of the measure cost was assumed.

For RET, GMC is represented by the equation below:

*GMC = Measure Equipment Cost + Measure Labor Cost*

Table 11 shows the gross measure costs, per linear foot, of the linear LED strip for display case lighting measures.

Table Gross/Incremental Measure Costs Summary

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Product Code | WP Measure Description | Base Cost | Measure Cost / ft. | Labor Cost / ft. | Gross/Inc. Measure Cost / ft. |
| L-O11 | New Linear LED Strip (T8 base case) | $0.00 | $23.82 | $2.38 | $26.20 |
| L-O21 | New Linear LED Strip (T12 base case) | $0.00 | $23.82 | $2.38 | $26.20 |
| L-O31 | New Linear LED Strip (Bi-pin Halogen base case) | $0.00 | $23.82 | $2.38 | $26.20 |

For a complete list of measure costs, see WPSDGENRLG0999 Master Lighting Look-up Table workpaper.

## 4.3 Incremental Measure Cost

For RET measures, IMC is represented by the equation below:

*IMC = (Measure Equipment Cost + Measure Labor Cost) – (Base Case Equipment Cost + Base Case Labor Cost)*

See workpaper WPSDGENRLG0999 for actual incremental measure costs used in this workpaper.

# Attachments

Measure savings provided in workpaper WPSDGENRLG0999 (provided under separate cover).







# References



[21]

[31]

[132]

Lookup Table ID Summary

EUL

|  |  |  |
| --- | --- | --- |
| EUL\_ID | Description | Sector |
| GrocDisp-FixtLtg-LED | Display Case Lighting LED Lighting | Com |

NTGR

| NTGR\_ID\* | Description\* | Sector\* | BldgType\* | ProgDelivID |
| --- | --- | --- | --- | --- |
| ET-Default | Emerging Technologies approved by ED through work paper review | All | Any | All |

GSIA

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| GSIA\_ID | Description | Sector | BldgType | UseCategory | TechType |
| Def-GSIA | Default GSIA | Any | Any | Any | Any |

BUILDING TYPE & LOAD SHAPE

| Building Type | Load Shape |
| --- | --- |
| Retail - Multistory Large | NON\_res:DEER:Indoor\_Non-CFL\_Ltg |
| Retail - Single-Story Large | NON\_res:DEER:Indoor\_Non-CFL\_Ltg |
| Retail - Small | NON\_res:DEER:Indoor\_Non-CFL\_Ltg |

1. [] SDG&E Energy Efficiency Business Rebates Lighting Product Catalog - https://www.sdge.com/rebates-finder/earn-rebates-your-improvements [↑](#endnote-ref-1)
2. [] The 2013 Building Energy Efficiency Standards for Residential and Nonresidential Buildings – Title 24, Part 6: http://www.energy.ca.gov/2012publications/CEC-400-2012-004/CEC-400-2012-004-CMF-REV2.pdf [↑](#endnote-ref-2)
3. [] The 2014 Appliance Efficiency Regulations – Title 20: http://www.energy.ca.gov/2014publications/CEC-400-2014-009/CEC-400-2014-009-CMF.pdf [↑](#endnote-ref-3)
4. [] Attachment #1 – Work Paper WPSDGENRLG0999, Master Lighting Lookup Table – Non Residential, San Diego Gas and Electric [↑](#endnote-ref-4)
5. [] Attachment #2 - Wattage calculation workbook. [↑](#endnote-ref-5)
6. [] Attachment #4 – Linear LED strip costs from online retailers. [↑](#endnote-ref-6)