

**Work Paper PGECOLTG165
LED A-Lamps
Revision # 4**

Pacific Gas & Electric Company
Customer Energy Solutions

LED A-LAMP

Measure Codes LT121 – LT135

8/10/2017

At-A-Glance Summary

Measure Codes:	LT121– LT135						
Measure Description:	LED A-Lamps, CEC and Energy Star						
Base Case Description:	Halogen Incandescent or CFL A-lamp						
Units:	Per lamp						
Energy Savings (Base Case – Measure):	Various. Refer to .xlsx file attached Source: PG&E Calculations.						
Full Measure Cost (\$/unit)	Various. Refer to .xlsx file attached Source: Web links						
Incremental Measure Cost(\$/unit)	Various. Refer to .xlsx file attached Source: PG&E Calculations						
Effective Useful Life (years):	ILtg-Com-LED-20,000hrs; ILtg-Res-LED-20000hr Refer to .xlsx file attached Source: DEER2017						
Measure Installation Type	ROB						
Net-to-Gross Ratios:	<table border="1"> <thead> <tr> <th>NTGR ID</th> <th>NTGR</th> </tr> </thead> <tbody> <tr> <td>NonRes-sAll-mLEDARefl</td> <td>0.91</td> </tr> <tr> <td>Res-sAll-mLEDARefl</td> <td>0.91</td> </tr> </tbody> </table> <p>Source: Screw in Lamp Disposition, 2017</p>	NTGR ID	NTGR	NonRes-sAll-mLEDARefl	0.91	Res-sAll-mLEDARefl	0.91
NTGR ID	NTGR						
NonRes-sAll-mLEDARefl	0.91						
Res-sAll-mLEDARefl	0.91						
Important Comments:							

Document Revision History

Revision #	Date	Section by Section Description of Revisions	Author (Company)
Revision 0	8/20/13	PGECOLTG165 R0 LED A-Lamps.doc. Original Workpaper	Alina Zohrabian (PG&E)
Revision 1	5/2/14	PGECOLTG165 R1 LED A-Lamps.doc Added DI values from (PGE3PLTG191-R0). For updated values, see file PGECOLTG165 R1.xlsx	Alina Zohrabian (PG&E)
Revision 2	1/1/2016	Updated NTG, annual hours of operation, IE, CDF, EUL, per DEER 2016. Costs have also been updated.	Linda Wan (PG&E)/Alina Zohrabian (PG&E)
Revision 3	1/1/2017	Updated from WRR to lumen equivalency method, which was rejected; therefore, updated to WRR of 2.96 as approved in R2	Alina Zohrabian (PG&E)
Revision 4	7/1/2017 8/10/2017	Updated from WRR to efficacy method as per May 26, 2017 disposition; Updated Program Restrictions and Guidelines All measure IDs were updated. Common area MFm measures were changed from Commercial to Residential sector as per "Review of Resubmitted workpapers for 2017 Screw-In Lamp Disposition", July 31st, 2017.	Alina Zohrabian (PG&E)/Mini Damodaran (PG&E) Mini Damodaran (PG&E)/Henry Liu (PG&E)/Randy Kwok (PG&E)

Commission Staff and Cal TF Comments

Rev	Party	Submittal Date	Comment Date	Comments	WP Developer Response
3	PG&E	Sept 22	Sept 22	After PG&E's presentation on Sept 22 nd CALTF staff received comments from ED consultant. These comments are presented in the Oct 27 presentation with IOU responses	The responses to the comments from the ED consultant are documented and presented and affirmed during the Oct 27 th CALTF meeting
3	PG&E	Nov 14	Nov 17	PG&E discussed the responses to Sept 22 nd comments, which were presented to CALTF in OCT 27 th meeting, with ED staff and consultants; other IOU's participated in this discussion. ED consultant asked for a separate document explaining the baseline model and the excel sheet with functional external links if links are used for reference.	Same comments from Sept22 nd were discussed. The comments were addressed in the Oct 27 th presentation. With the workpaper these additional materials will be submitted.

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

Revision 3 of this workpaper was affirmed by CALTF on Sep 27, 2016 meeting, which was rejected by ED and was revised to use the previously approved WRR, based on March, 2017 disposition.

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Section 1 General Measure & Baseline Data

1.1 Measure Description & Background

This workpaper details the replacement of existing traditional incandescent, CFL and incandescent halogen A-lamps with Light Emitting Diode (LED) A-lamps.

Base, Standard, and Measure Cases

Case	Description of Typical Scenario
Measure	LED lamp
Existing Condition	Halogen incandescent or CFL lamp
Code/Standard	NA
Industry Standard Practice	Halogen incandescent or CFL lamp

Table 1 Measures and Codes

Measure Codes				Measure Name
SCG	SDG&E	SCE	PG&E	
NA	LXX1	LXX1	LT121	40W equivalent 68 LPW (lumens/watt)
NA	LXX2	LXX2	LT122	40W equivalent 80 LPW (lumens/watt)
NA	LXX3	LXX3	LT123	40W equivalent 90 LPW (lumens/watt)
NA	LXX4	LXX4	LT124	40W equivalent 100 LPW (lumens/watt)
NA	LXX5	LXX5	LT125	60W equivalent 80 LPW (lumens/watt)
NA	LXX6	LXX6	LT126	60W equivalent 90 LPW (lumens/watt)
NA	LXX7	LXX7	LT127	60W equivalent 100 LPW (lumens/watt)
NA	LXX8	LXX8	LT128	60W equivalent 110 LPW (lumens/watt)
NA	LXX9	LXX9	LT129	75W equivalent 90 LPW (lumens/watt)
NA	LXX10	LXX10	LT130	75W equivalent 100 LPW (lumens/watt)
NA	LXX11	LXX11	LT131	75W equivalent 110 LPW (lumens/watt)
NA	LXX12	LXX12	LT132	75W equivalent 120 LPW (lumens/watt)
NA	LXX13	LXX13	LT133	100W equivalent 90 LPW (lumens/watt)
NA	LXX14	LXX14	LT134	100W equivalent 100 LPW (lumens/watt)
NA	LXX15	LXX15	LT135	100W equivalent 110 LPW (lumens/watt)

SDG&E and SCE will create their internal codes after the measures are approved and uploaded in READI. The temporary LXX1 to LXX15 is created as a place holder.

Requirements:

- Must replace an incandescent, incandescent halogen, or CFL A-lamp

Program Restrictions and Guidelines

This workpaper is configured to accommodate any additional program changes to address higher efficacy lamps, if necessary. Currently the lamps rebated through the residential upstream program must meet both Energy Star and the CEC Voluntary California Quality Light-Emitting Diode (LED) Lamp Specification (CEC Spec) requirements. These lamps meet higher quality product performance criteria as defined by CEC. The CEC Spec has added new efficacy requirements.

For lamps rebated through the commercial programs the minimum efficacy requirements have increased due to stricter Energy Star requirements. IOU's program staff will work with CPUC program staff to make sure all the rebated lamps meet the appropriate program rules and to reach towards the same common goals. **In addition to Energy Star and CEC requirements, Energy Division has issued a disposition on May 26, 2017 that enforces additional minimum efficacy requirements for both programs as shown in Table 4.**

- The delivery method is Upstream/Midstream Programs for commercial customers and the Upstream Lighting Program for residential customers. This workpaper also covers Direct Install delivery channel. For Multifamily customers this product is also available through the downstream program.
- In support of the transition to the California Energy Commission's Voluntary California Quality Light-Emitting Diode (LED) Lamp Specification (CEC Spec), to qualify for a rebate in the program, the replacement LED lamps must fall into one of the categories shown in the table below. Only lamps that fully meet the CEC Spec will be supported in the Upstream Lighting Program after Dec 1, 2013.

Table 2 Lamp Specifications

Residential: Upstream Lighting Program	Residential: Downstream & Direct Install Commercial Midstream / Upstream & Direct Install
Must meet CEC specification 3.0 ¹ and Energy Star 2.0 ² and be listed on both Energy Star and Modernized Appliance Efficiency Database System (MAEDBS) databases. The lamps in MAEDBS must be listed on the "State-regulated Light Emitting Diode Lamp" list ³ .	Must be on THE ENERGY STAR Qualified Products List.

Effective 7/1/2017, efficacy minimum is 68 LPW and compliance score of 282. For Rebate Programs effective 1/1/2018, efficacy minimum is 80 LPW and combined efficacy score of 297 (Compliance score = Efficacy + (CRI x 2.3)).

Terms and Conditions:

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

Market Applicability:

A-Lamps are mostly found in residential and small commercial building types.

The table below shows applicable delivery types, building types, and application types.

Table 3 Delivery Method and Applicable Building Types

Delivery Type	Applicable Building Types	Application Type
Upstream/Midstream	“Com” & “Res”	ROB
Direct Install	DEER Building Types	ROB
Downstream	MFM	ROB

The May 26, 2017 disposition⁴ provided minimum efficacy requirements for program implementation as shown below:

Table 4 Screw in Lamp disposition, May 26, 2017 minimum efficacy requirements

EISA Wattages (W)	2017 efficacy (LPW)	2018 efficacy (LPW)	2019 efficacy (LPW)
40	68	80	95
60	80	90	100
75	90	90	110
100	90	90	110

1.2 Technical Description

A-lamps are the general purpose lamps that are used vastly in residential applications. Light emitting diode (LED) sources have improved over the past decade making them an efficient and reliable lighting technology. Many LED products successfully replaced other lighting sources and made their way into the market by continuing to improve and to compete in any application.

1.3 Installation Type Descriptions

The DEER Measure Cost Data Users Guide found on www.deeresources.com under DEER2011 Database Format hyperlink, DEER2011 for 13-14, spreadsheet SPTdata_format-V0.97.xls, defines the terms as follows:

Table 5 Measure Application Type

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
New Construction (NEW/NC)	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
Retrofit Add-on (REA)	Above Customer Existing	N/A	EUL	N/A

All the measures within this workpaper are ROB.

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
New Construction	The program offers financial incentives and/or design assistance to customers involved with new building construction. This is intended is to motivate customer to exceed Title 24 building energy efficiency requirements (residential or nonresidential).
Partnership	The program implements projects through a partnership between the utility and an institutional, government, or community-based organization.
Up/mid-Stream Programs	See Up/mid-Stream Incentive in the Incentive Method table.

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.
Mid-Stream Incentive	The program gives a financial incentive to a midstream market actor, such as a retailer or contractor, to encourage the promotion of efficient measures. The incentive may or may not be passed on to the end-use customer.
Up-Stream Incentive	The program gives a financial incentive to an upstream market actor, such as a manufacturer or distributor, to encourage the manufacture, provision, or distribution of an efficient measure. The incentive may or may not be passed on to the end-use customer.

1.4 Measure Parameters

1.4.1 DEER Data

The Database for Energy Efficient Resources (DEER) 2016 does address LED lamp savings by WRR methodology. This workpaper follows the efficacy method as per May 26, 2017 disposition.

Net-to-Gross Assumption:

The NTG values are from 2017 screw in lamp disposition. The table below summarizes all applicable Net-to-Gross ratios for programs that may be used by this measure.

Table 6 Net-to-Gross Ratios

NTGR ID	Description	Sector	BldgType	Delivery Method	NTGR
NonRes-sAll-mLEDARefl	Nonresidential LED A-lamp and screw-in reflector, all delivery mechanisms	NonRes	Any	Any	0.91
Res-sAll-mLEDARefl	Residential LED A-lamp and screw-in reflector, all delivery mechanisms	Res	Any	Any	0.91

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 7 Installation Rate

GSIA ID	Description	Sector	BldgType	ProgDelivID	GSIAValue
Com-LED-PGE	Non-Res LED; Non-Upstream Program; Annual Installation Rate	Com	Any	NonUpStrm	1
Def-GSIA	Default GSIA values	Any	Any	Any	1

Effective Useful Life / Remaining Useful Life

The EUL value is from DEER and it is based on 20,000 hour of rated lamp life. The EUL is calculated using the following equation:

$$\text{EUL} = (\text{Rated Life of Lamp (20,000 hours)}) / (\text{Average Annual Operating Hours for Building Type})$$

Table 8 Effective and Remaining Useful Life

EUL ID	Description	Sector	UseCategory	EUL (Years)	RUL (Years)
ILtg-Res-LED-20000hr	LED lamp - Indoor - Residential	Res	Lighting	16	5.33
ILtg-Com-LED-20000hr	LED Lamp - Indoor- Commercial	Com	Lighting	Varies (max 12 years)	Varies

1.4.2 Codes & Standards Analysis

Title 20: These measures do fall under Title 20 of the California Energy Regulations.

Title 24: These measures do not fall under Title 24 [2013 or 2016] of the California Energy Regulations.

Federal Standards: Federal DOE or EPA Energy Regulations are no stricter than, and in the same format as, the Title 20 regulations.

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

The most relevant EM&V reports are summarized in TRC’s LED Lighting baseline data memorandum⁵.

1. The residential California Lighting and Appliances Saturation Study (CLASS 2012 - DNV-GL 2014)
2. The California Commercial Saturation Survey (CSS – Itron 2014)

3. The most recent California shelf survey (the “2015/16 winter survey”, conducted by DNV-GL)
4. NEMA provides quarterly data of U.S. A-lamp shipments from its members

PG&E presented the above data in California Technical Forum (CALTF) and received feedback from the Ex-Ante consultants that although the DNV-GL shelf survey is the most recent data but it is not representative of sales and IOUs should be looking into what LEDs will be replacing next year. The Ex-Ante consultants also mentioned that latest NEMA shipment data (#4) is the best up-to-date source of data to use to find out what LED’s will be replacing in 2017. Ex-Ante consultants also mentioned that the residential saturation data (#1) would have been the most representative but unfortunately it is 4 years old.

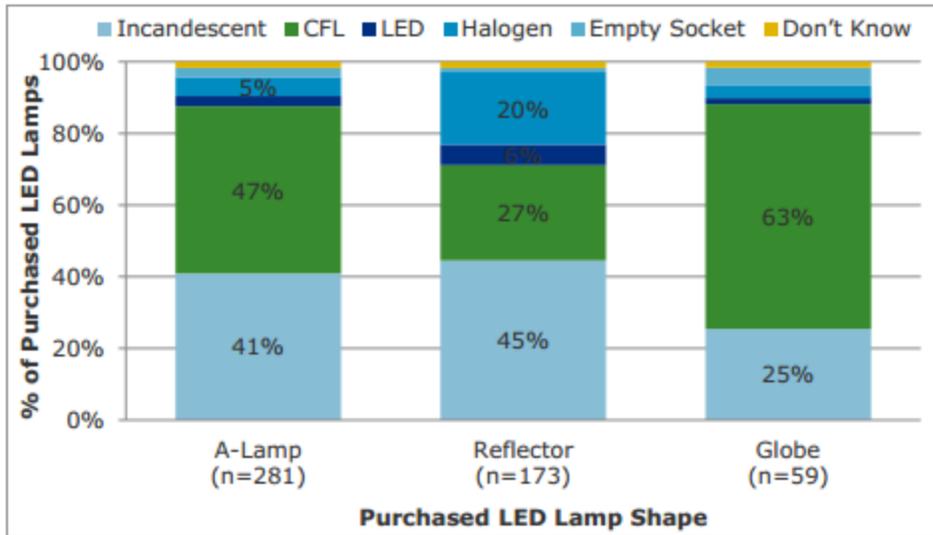
Based on the comments provided, PG&E took the residential California Lighting and Appliance Saturation data (#1) and built a model to simulate an update of CLASS saturation based on the NEMA shipment data through Q2 2016. The inputs of the model are the 2012 saturation, NEMA quarterly data, and the expected lamp failures based on lifetime. The model then predicts what percentage of each technology would be failing at this point in time, providing a mix of baseline lamp technologies. Comparing the baseline to the latest NEMA sales shows the differences in the mix of failures and the mix of replacement sales, suggesting where one technology type is replacing failures of another technology in the current market. The model calculation, data sources and assumptions are listed in the excel sheet provided with Revision-3. The results of the model suggest that for new LED A-lamp sales about 58% of the baseline is CFL, 40% of the baseline is traditional incandescent and 2% is LED.

PG&E recommend using 40% halogen incandescent instead of the traditional incandescent to avoid the double dipping issue with codes and standard and to be conservative. Also since the LED percentage is very small PG&E recommend rolling the percentage into the CFL. This will raise the baseline CFL percentage from 58% to 60% CFL. Rolling the LED percentage into the CFL will simplify the calculation since otherwise we need to find out LED lumen equipment wattages for each of the four calculation lumen bins.

Evergreen Economics in their recent (July 2016) preliminary findings from their 1000 audits of residential customers in PG&E territory, PG&E Home Energy Use Study (HEUS), presented the mean lamps per household. The data compared the PG&E HEUS data to the CLASS data from 2012. The data supports that most LEDs will be replacing traditional incandescent lamps and the CFL lamp saturation has not significantly increased from 2012 to 2016. The HEUS data aligns reasonably well with the saturation assumptions in the model, again considering incandescent and halogen as a combined category.

The latest preliminary data from the DNV-GL report on California replacement lamp market status shows in Figure-58, below that 41% of LED A-Lamps purchased would replace traditional incandescent and 5% would replace Halogen incandescent and about 47% would replace CFLs. This suggests overall that the 40% halogen incandescent model is slightly conservative.

Figure 58: existing installed lamps (and empty sockets) as a percentage of purchased LED lamps by LED lamp shape, 2014/2015 (shopper intercept surveys)



Note: Results may not total 100% because of rounding.
 Note: Figure combines results from 2014-15 and 2015-16 shopper intercept surveys.

In general all the reports suggest that CFLs should not comprise more than 60% of the baseline for LED A-Lamps.

Energy Division rejected all the above data and presented the following percentages in the May 26, 2017, screw in lamp disposition.

- For lamps greater than or equal to 90 lpw, the baseline is revised to be 75% CFLs and 25% halogens.
- For lamps less than 90 lpw, the baseline is revised to be 55% CFLs, 20% LEDs and 25% halogens.

1.5.4 Assumptions and Calculations from other sources – Base and Measure Cases

For the base case as discussed above PG&E complied with the percentages in the 2017 ED disposition and used the delta watts provided in the disposition.

The halogen incandescent wattages are defined by EISA for the specified lumen bins as shown in Figure 1. For this version of the workpaper the halogen incandescent wattages are not going to be used but the EISA lumen bins will be used to define the equivalency to the traditional incandescent wattages.

Figure 1-EISA Lumen Bins and Wattages

GENERAL SERVICE INCANDESCENT LAMPS

Rated Lumen Ranges	Maximum Rate Wattage
1490-2600	72
1050-1489	53
750-1049	43
310-749	29

To define the wattages of CFLs PG&E recommends using lumen equivalency to be consistent within the new methodology. PG&E investigated using both DEER2016 and DEER2014 residential WRR of 2.48 and 3.47 to back calculate the CFL wattages and presented in CALTF. The analysis showed that using DEER WRR would incorrectly increase the LED savings. The following CFL wattages are proposed to be used for savings calculations.

Table 9 Base Case Equivalent Wattages

Equivalent Incandescent	max wattage halogen	max wattage CFL (based on Lumen Equivalency)
40	29	10
60	43	13
75	53	18
100	72	23

The above proposed values were rejected by the May 26, 2017 disposition. PG&E used the values provided in the disposition.

Delta Wattage Assumption (ΔW)

The assumptions used in ED screw in lamp disposition, May 26, 2017 disposition are used for savings calculation. Please refer to the excel spreadsheet to see the details of the calculation for each measure.

Table 10- Approved LED A-Lamp delta watts savings

EISA Bin	LPW	Δ Watts
40	68	6.8
	80	7.6
	90	8.7
	100	8.8
60	80	7.8
	90	9.2
	100	10.9
	110	11.0
75	90	12.6
	100	13.5
	110	15.4
	120	17.6
100	90	17.2
	100	19.1
	110	19.9

Section 2. Calculation Methods

This version of the workpaper follows the efficacy method as per May 26, 2017 disposition and uses the savings provided within the disposition. Other IOUs will be using the same methodology but calculate their savings using DEER interactive effects appropriate for their service territory.

2.1 Electric Energy Savings Estimation Methodologies

The lighting wattage difference (Watts per unit) is the difference between the electric demand of the base case unit and the electric demand of the measure case unit. The hours of operation and interactive effects are based on the most recent DEER values.

Annual Electric Savings:

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

Example:

40W equivalent 68 LPW (lumens/watt), com

$$\text{Energy Savings} \left[\frac{\text{kWh}}{\text{unit}} \right] = \left(\frac{6.8}{1000} \right) * (2130) * (1.07) = 15.497$$

2.2. Demand Reduction Estimation Methodologies

The lighting 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 demand savings is calculated based on the formula below:

Demand Reduction:

Demand Reduction [kW/unit] = (Δ Watts/unit) x (Lighting Coincident Demand) x (Demand Interactive Effects) / (1,000 Watts/kW)

Example:

6-Watt LED A-Lamp 310-749 Lumens

$$\text{Demand Savings} \left[\frac{\text{kW}}{\text{unit}} \right] = \left(\frac{6.8}{1000} \right) \times (0.439) \times (1.230) = 0.0037$$

Demand Reduction:

Demand Reduction [kW/unit] = (Δ Watts/unit) x (Lighting Coincident Demand) x (Demand Interactive Effects) / (1,000 Watts/kW)

2.3. Gas Energy Savings Estimation Methodologies

There is no gas energy savings associated with this measure. However the negative impacts are calculated based on the formula below.

Annual Gas Savings:

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

Example:

6-Watt LED A-Lamp 310-749 Lumens

$$\text{Gas Savings [Therm/Unit - year]} = \left(\frac{6.8}{1000} \right) \times (2130) \times (-0.0070) = -0.101$$

Annual Gas Savings:

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

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 residential and commercial lighting end use load shape.

3.2 Measure Load Shapes

The measure load shape for this measure is determined based on the applicable residential and non-residential market sector and the lighting end-use.

Table 11 Building Types and Load Shapes

Building Type	Load Shape	E3 Alternate Building Type
All Commercial	PGE:DEER:Com:Indoor_CFL_Ltg	NON_RES
All Residential	PGE:DEER:Indoor_CFL_Ltg	RES

Section 4. Costs

PG&E is submitting this workbook as a statewide lead and shared the cost provided in Table 13 with other IOUs to get consensus on cost values to make sure all the cost info is the same. Please refer to the LED A-lamp cost workbook for detailed information on cost research.

4.1 Base Case Cost

The base case costs are split into the different technologies based on the percentages provided in the May 26, 2017 screw in lamp disposition. The disposition splits the percentages based on the efficacy as shown below.

- For lamps greater than or equal to 90 lpw, the baseline is revised to be 75% CFLs and 25% halogens.
- For lamps less than 90 lpw, the baseline is revised to be 55% CFLs, 20% LEDs and 25% halogens.

All the base case costs are webscraped from multiple online websites. The excel sheet has the reference links.

4.2 Measure Case Cost

Measure costs are also webscraped from multiple websites. The measure case is only for energy star products. Where possible the CEC spec lamps are included. Please refer to the excel workbook for all the cost and reference information.

4.3 Full & Incremental Measure Cost

For Direct Install the labor cost of \$5.75 is used from the WO17.

Table 12 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

Incremental Costs

Installation Type	Incremental Measure Cost	Full Measure Cost	
		1 st Baseline	2 nd Baseline
ROB	Please refer to the LED lamp cost workbook for detailed information.	NA	NA

Table 13 Cost for A-Lamp

Measure description	LED cost	CFL cost	Inc cost	IMC
40W Equivalent 68 LPW (lumens/watt)	\$ 9.76	\$ 2.53	\$ 1.85	\$ 5.95
40W Equivalent 80 LPW (lumens/watt)	\$ 8.01	\$ 2.53	\$ 1.85	\$ 4.55
40W Equivalent 90 LPW (lumens/watt)	\$ 7.71	\$ 2.53	\$ 1.85	\$ 5.35
40W Equivalent 100 LPW (lumens/watt)	\$ 8.10	\$ 2.53	\$ 1.85	\$ 5.73
60W Equivalent 80 LPW (lumens/watt)	\$ 10.24	\$ 3.50	\$ 1.79	\$ 5.82
60W Equivalent 90 LPW (lumens/watt)	\$ 10.93	\$ 3.50	\$ 1.79	\$ 7.86
60W Equivalent 100 LPW (lumens/watt)	\$ 7.30	\$ 3.50	\$ 1.79	\$ 4.22
60W Equivalent 110 LPW (lumens/watt)	\$ 7.16	\$ 3.50	\$ 1.79	\$ 4.08
75W Equivalent 90 LPW (lumens/watt)	\$ 12.87	\$ 4.73	\$ 2.10	\$ 8.79
75W Equivalent 100 LPW (lumens/watt)	\$ 10.00	\$ 4.73	\$ 2.10	\$ 5.92
75W Equivalent 110 LPW (lumens/watt)	\$ 11.97	\$ 4.73	\$ 2.10	\$ 7.89
75W Equivalent 120 LPW (lumens/watt)	\$ 11.97	\$ 4.73	\$ 2.10	\$ 7.89
100W Equivalent 90 LPW (lumens/watt)	\$ 17.36	\$ 4.41	\$ 1.82	\$ 13.59
100W Equivalent 100 LPW (lumens/watt)	\$ 15.58	\$ 4.41	\$ 1.82	\$ 11.82
100W Equivalent 110 LPW (lumens/watt)	\$ 18.37	\$ 4.41	\$ 1.82	\$ 14.61

References:

¹ CEC Spec v3.0: http://www.energy.ca.gov/business_meetings/2016_packets/2016-12-14/Item_09.pdf

² EnergyStar v2.0:
<https://www.energystar.gov/sites/default/files/asset/document/ENERGY%20STAR%20Lamps%20V2%20Revised%20Spec.pdf>

³ MAEDBS, State-regulated Light Emitting Diode Lamp list,
<https://cacertappliances.energy.ca.gov/Pages/ApplianceSearch.aspx>

⁴ Comprehensive Workpaper Disposition for: Screw-In Lamps. Revisions to Disposition Originally Issued on March 1, 2017. California Public Utilities Commission, Energy Division. May 26, 2017

⁵ TRC-LED Lighting baseline data_10-12-16.pdf