436 14th Street
Suite 1020
Oakland, CA 94612

916-962-7001 PHONE
510-451-7002 FAX

www.trcsolutions.com

MEMORANDUM

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To: Alina Zohrabian, Doreen Caruth, and Adam Scheer (PG&E)

From: Marian Goebes, David Douglass-Jaimes, and Cathy Chappell (TRC)

LED Baseline Assumptions

Introduction

As part of the Lighting Evaluation, Measurement, and Verification (EM&V) technical support contract, Pacific Gas and Electric (PG&E) requested that TRC Energy Services (TRC) provide data to inform LED A-lamp baseline assumptions. The purpose of this assignment was to support current LED A-lamp work paper updates for 2017 and possibly beyond.

Summary of Conclusions

TRC reviewed several data sources that could inform LED A-lamp baseline assumptions.

- The residential California Lighting and Appliances Saturation Study (CLASS 2012 - DNV-GL 2014) found that for A-lamps, CFLs comprised 50% of installed lamps, with incandescent lamps comprising the remainder.[1] However, this study was conducted almost four years ago. Since residential interior incandescent lamps and residential interior CFLs have an EUL of 3.5 years or less [2], almost all of the incandescent and CFLs observed in CLASS 2012 have been replaced, based on DEER EUL assumptions.
- The California Commercial Saturation Survey (CSS – Itron 2014), found that (after removing LEDs) CFLs comprised 57% of medium screw-based (MSB) lamps, with incandescent and halogen lamps comprising the remainder. However, the CSS was conducted approximately 3.5 years ago[3]. Since commercial interior CFLs have an EUL of 4.7 years or less[4], most of the lamps observed in CSS should have been replaced, based on DEER EUL assumptions.

[1] LED and halogen lamps combined were less than 1% of A-lamps in CLASS 2012.
[2] Based on Database for Energy Efficiency Resources (DEER) 2016 update. http://www.deeresources.com/index.php/deer-versions/deer2016#EULupdate
[3] Based on the midpoint of data collection, which spanned Q1 2012 to Q4 2013.
[4] Based on Database for Energy Efficiency Resources (DEER) 2016.

- The most recent California shelf survey (the "2015/16 winter survey", conducted by DNV-GL) provides valuable data for indicating what lamps are available for purchase. Weighting all market channels equally, the 2015/16 winter survey showed CFLs as comprising 49% of A-lamps available (after removing LEDs[5]). However, results for most channels show CFLs comprising 30-44% of all A-lamps. The "average" value of 49% across all channels may be skewed by the membership club channel, as described below:
  - **CFLs comprised 30-44% of A-lamps (after removing LEDs) in all channels except the membership club channel.** This includes mass merchandise (44%) and home improvement stores (36%), which a survey of PG&E residential customers found to be the two channels where customers most often purchase lamps (Optimal Strategix Group – OSG, 2011).[6]
  - The membership club channel stands out as an outlier: CFLs comprise 98% of all available A-lamps (after removing LEDs) in this channel. However, this channel may be over-represented in the shelf survey, relative to consumer purchases. Approximately one-fifth (21%) of all A-lamps in the 2015/16 winter shelf survey were in the membership club channel, but only 9% of customers in the OSG (2011) survey reported this channel as the place where they most often purchase lamps. The high volume of lamps from the membership club channel in the shelf survey increases the average to 49%, but this "average" may not be representative of residential customers' purchases.
- NEMA provides quarterly data of U.S. A-lamp shipments from its members. Although NEMA data is only available at the national level, this data source illustrates the rapid changes in the residential lighting market, and provides a good indication of lamps currently available for purchase.
  - NEMA shipments at least somewhat capture sell-through rates, while shelf surveys cannot capture how long a product has been (or will be) on a retailer's shelf.
  - **NEMA data shows that (after removing LEDs[7]) CFLs peaked at 49% of A-lamp shipments in Q4 2014, but had declined to 26% of A-lamp shipments in Q1 2016**.

The California shelf survey, adjusted for the importance of each channel in consumer purchasing trends, as well as NEMA lamp shipments could inform current market availability. Other potential data sources include Consortium for Retail Energy Efficiency Data (CREED) LightTracker, CFL import data, estimates for the ENERGY STAR lamp program, and interviews with market actors (including manufacturers and retailers).

Summary of Findings

TRC compared the composition of A-lamps in the following data sources:

1. CLASS 2012, an on-site study conducted in residential buildings the second half of 2012 (DNV-GL 2014).

[5] LED lamps comprised 36% of the raw shelf survey data, as noted in Table 8 in the Appendix
[6] Based on a survey of 1,031 PG&E residential customers by Optimal Strategix Group (2011), presented in Figure 4 in the TRC Lighting Preferences Literature Review. Of the surveyed customers, 28% and 24% reported buying lamps "most often" in mass merchandise and home improvement stores, respectively. The other responses were 8 to 9% each to the following categories: hardware, drug, grocery, membership club, and discount.
http://www.calmac.org/publications/TRC_PGE_Customer_Lighting_Preferences_Lit_Review_-_For_CALMAC_072314.pdf
[7] When LEDs are included CFLs were 47% of A-lamp shipments in Q4 2014, but have declined to 19% of shipments in Q1 2016, as noted in Table 7 in the Appendix

2. CSS, an on-site study conducted in commercial buildings the first quarter of 2012 through the fourth quarter of 2013 (Itron 2014)
3. U.S. shipments of A-lamps according to NEMA – a trade organization that includes lamp manufacturers. Table 1 provides the average of the last four quarters (Q2 2015-Q1 2016).
4. Results for A-line lamps from the California 2015/16 winter shelf survey, conducted by DNV-GL. These values reflect the number of lamps available for consumer purchase, by technology.

In general, the CLASS and CSS data reflect installed lamps, while the NEMA and shelf survey data reflect market availability.

TRC presents results in Table 1. Note that these results do not include the percent of LEDs available, because the net savings adjustment in the impact evaluation will account for participants that would have purchased LEDs in the absence of the program. In other words, TRC removed LEDs from the baseline analysis to avoid double counting LED free ridership. The Appendix provides the raw data from each data source, including the fraction of lamps that are LEDs.

Table 1. A-lamps by Technology: Comparison across Data Sources

		% of Avail A-Lamps (without LEDs)			
Source	**Timeframe Data Represents**	**Incandesc**	**Halogen**	**Incandesc + Halogen**	**CFL**
CLASS 2012 (DNV-GL 2014): Installed A-lamps[8]	May – Nov 2012	50%	0.2%	50%	50%
CSS (Itron 2014): Installed Medium Screw Based (MSB) Lamps[9]	Q1 2012 – Q4 2013	33%	10%	43%	57%
NEMA shipment data, average of last four quarters[10]	Q2 2015 through Q1 2016	12%	57%	69%	31%
DNV-GL CA shelf survey data for A-lamps (winter 2015/16)[11]	Late 2015/early 2016	17%	34%	51%	49%

In summary:[12]

- The most recent market data, which is the NEMA shipment data, shows that only 31% of A-lamps are CFLs (after removing LEDs).

[8] See Table 2 and Table 3 in the appendix below for raw data
[9] See Table 4 and Table 5 in the appendix below for raw data
[10] See Table 7 in the appendix below for raw data
[11] See Table 8 in the appendix below for raw data
[12] All percentages in the subsequent bullets are normalized by the sum of halogen, incandescent, and CFL lamps. LEDs have been removed in the calculations.

- The most recent California retail shelf survey (2015/16 winter) shows that CFLs comprise 49% of all A-lamps (after removing LEDs), averaged across all market channels. CFLs comprise 30-44% of all A-lamps in all market channels except membership clubs, including the two channels that are likely the most important for residential customer lamp purchases (mass merchandise and home improvement stores).
- The CLASS 2012 data show that approximately 50% of lamps were CFLs, and CSS shows that 57% of commercial lamps were CFLs (after removing LEDs). However, these data sources are older and do not reflect current market conditions. For example, CLASS 2012 found that only 0.2% of installed A-lamps were halogens, but NEMA data shows that halogen comprise almost half of all A-lamp shipments in 2016.

References

Database for Energy Efficiency Resources (DEER) 2014. http://www.energy.ca.gov/deer/

DNV-GL 2014. "Residential On-site Study: California Lighting and Appliance Saturation Study (CLASS 2012)". www.energydataweb.com/cpucFiles/pdaDocs/1096/2014%2005_21%20WO21%20CLASS%20Final%20Report.pdf

DNV-GL 2016. "Impact Evaluation of 2013-14 Upstream and Residential Downstream Lighting Programs."

DNV-GL CA Retailer Shelf Survey, on-going. https://webtools.dnvgl.com/projects62/crlss/Home.aspxItron 2014. California Commercial Saturation Survey (CSS). http://www.calmac.org/publications/California_Commercial_Saturation_Study_Report_Finalv2ES.pdf

TRC 2014. "Literature Review of Customer Lighting Preferences". http://www.calmac.org/publications/TRC_PGE_Customer_Lighting_Preferences_Lit_Review_-_For_CALMAC_072314.pdf

National Electrical Manufacturers Association (NEMA). Lamp indices, published at: http://www.nema.org/Intelligence/pages/lamp-indices.aspx

Appendix. Detailed Results

CLASS 2012 Results

Table 2 shows CLASS 2012 (DNV-GL 2014) results, as the percent of total lamps that were A-lamps by technology. This table includes spiral lamps for CFLs. A small fraction of A-lamps were also LEDs (<1%), which are not shown.

Table 2. Percent of All Lamps that are A-lamps (by Technology) in CLASS 2012

	CFL A-Type	CFL Spiral	Halogen A-Type	Inc. A-Type	Total
% of Total lamps	1.0%	22.5%	0.1%	23.1%	46.7%

As shown in Table 2, almost half of the lamps found in CLASS 2012 were A-lamps. Other lamp types included reflectors, globes, candelabra lamps, linear lamps, and other lamp types.

Based on these values, TRC calculated the percent of each technology for the A-lamps found in CLASS 2012, as shown in Table 3.

Table 3. Fraction of A-Lamps by Technology in CLASS 2012

	CFL	Halogen	Incandescent
% of Total A-lamps	50.3%	0.2%	49.5%

TRC notes that the data in CLASS 2012 are almost four years old. Since DEER 2016 estimates that the EUL for an indoor lamp is 3.5 years for residential, and 4.7 years for nonresidential, many of the lamps observed in that survey – particularly the incandescent lamps – have likely burned out and been replaced. It is difficult to estimate how consumers would have replaced these lamps, although the lamp market availability data sources (including NEMA data and California shelf survey data) provide indications.

California Commercial Saturation Survey (CSS)

TRC reviewed lamp saturation data from the CSS (Itron 2014). The CSS collected data from 1,439 on-site surveys of office, retail, warehouse, colleges, healthcare (non-hospital), restaurants, grocery, schools, hotel/motel, and miscellaneous buildings, surveyed between the first quarter of 2012 and the fourth quarter of 2013. Table 4 shows the distribution of incandescent, halogen, CFL, and LED lamps as a percentage of all lighting. This table includes both medium screw-based (MSB) and pin-based lamps – e.g., MR-16s and pin-based CFLs. CSS does not separate out MSB versus pin-based lamps in their data for all incandescent, halogen, CFL, and LED lamps. But many of the CFLs captured in Table 4 are pin-based lamps. Overall, this table indicates that MSB and pin-based lamps comprise a small fraction of lamps in commercial buildings (16% total).

Table 4: Incandescent, Halogen, CFL, and LED Lamps as a percent of all lighting from CSS

	Incandescent	Halogen	CFL	LED	Total
% of all sources	4%	2%	9%	1%	16%

Table 5 presents the distribution of MSB lamps for incandescent, CFL, halogen, and LED lamps. For these technologies, the CSS study distinguishes between MSB lamps and pin-base lamps, but does not further differentiate within the MSB category. Thus, data shown in Table 5 includes all MSB lamps, including A-lamps, reflectors (PAR- and R-lamps), and globes.

In addition, the CSS report did not report lamp distributions for the survey sample as a whole. Instead, results were segmented by building type, business size, or program participation. To determine overall distribution, TRC calculated a weighted average based on program participation values, as shown below in Table 5. Note that TRC removed pin-based lamps, because these are not included in A-lamps; consequently, each row in Table 5 totals to less than 100%.

Table 5: MSB Incandescent, Halogen, CFL, and LED lamp distribution from CSS

	Incandescent	Halogen	CFL	LED
EE Lighting Non-Participant (n=900)	22%	6%	34%	3%
EE Lighting Participant (n=300)	13%	6%	31%	8%
EE CFL/LED Participant (n=159)	14%	5%	35%	6%
Weighted Average (TRC Calculated)	**19%**	**6%**	**33%**	**4%**

Based on these values, TRC recalculated the percentages of each technology type after removing LEDs, shown in Table 6.

Table 6: Percent of MSB Incandescent, Halogen, and CFL lamps from CSS

	Incandescent	Halogen	CFL
% of Total	33%	10%	57%

NEMA Data

TRC obtained the following data on U.S. A-lamp shipments from the NEMA website (cited in References). Figure 1 presents NEMA shipment data by technology, as percentages of all A-lamp shipments, from 2011 through Q1 2016. CFLs are shown in blue. As shown, CFLs comprised approximately 25-30% of A-lamp shipments from 2011 through Q1 2014, and then increased to 47% in Q4 2014. CFL shipments then declined to only 19% by Q1 2016.

Figure 1. NEMA A-lamp Shipments by Technology

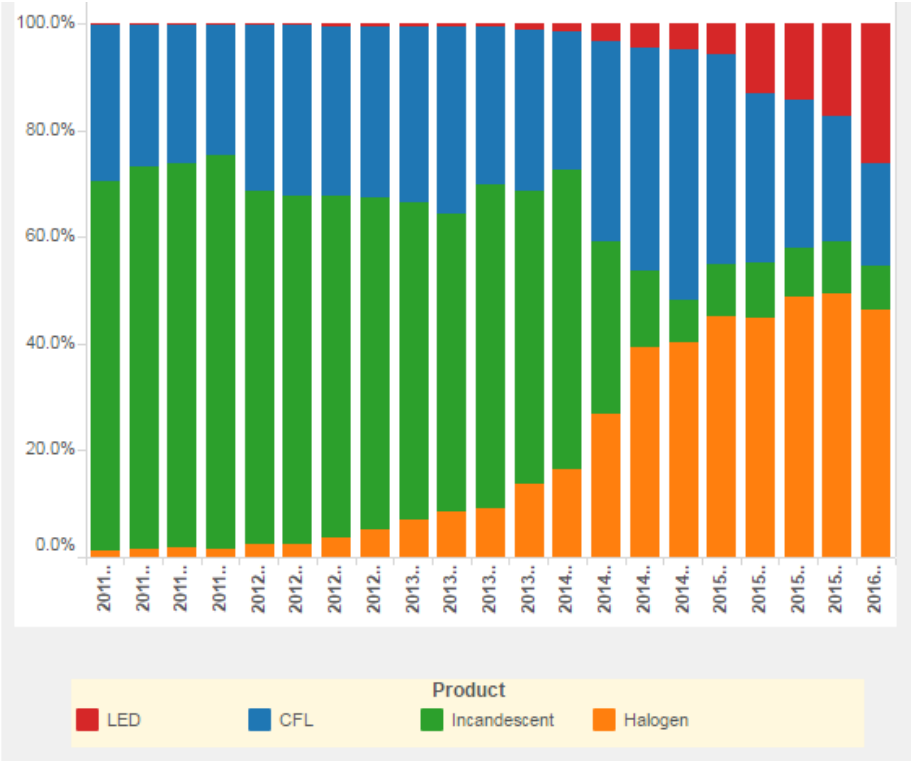

Table 7 presents the numerical values for specific timeframes to illustrate the following:

- The 2014 Q4 data shows values when CFLs reached its maximum penetration of A-lamp shipments.
- The four quarters of 2015 illustrate the quarter-to-quarter change and the rapidly evolving A-lamp market. As shown, CFL shipments declined significantly during 2015.
- The 2016 Q1 data is the most currently available. As shown, after removing LEDs, the fraction of shipments that are CFLs has dropped to almost half its value from Q4 2014 – from 49% to 26%. Retaining LEDs in the analysis, CFL shipments have dropped by more than half – from 47% in Q4 2014 to 19% in Q1 2016.

Table 7. NEMA A-Lamp Availability

NEMA data		Raw Data				Removing LEDs		
Year	Quarter	Incan	Halogen	CFL	LED	Incan	Halogen	CFL
2014	Q4	8%	40%	47%	5%	8%	42%	49%
2015	Q1	11%	44%	40%	5%	12%	46%	42%
2015	Q2	11%	44%	32%	13%	13%	51%	37%
2015	Q3	9%	49%	28%	14%	10%	57%	33%
2015	Q4	10%	50%	24%	16%	12%	60%	29%
	2015 Average	*10%*	*47%*	*31%*	*12%*	*12%*	*53%*	*35%*
2016	Q1	8%	47%	19%	26%	11%	63%	26%

CA Shelf Survey Data

Table 8 shows results of the 2015/16 winter shelf survey. This table presents results across all market channels based on total numbers of lamps – first for all technologies, and then after removing LEDs.

Table 8. California 2015/16 Winter Shelf Survey Results (DNV-GL)

	Raw Data (All Technologies)				Removing LEDs		
	Incandesc.	Halogen	CFL	LED	Incandesc.	Halogen	CFL
% of Total A-lamps	11%	22%	31%	36%	17%	34%	49%

Table 9 presents the results of the Winter 2015/2016 California shelf survey (DNV-GL), compared with customer purchase location (OSG 2011).

- The first row of the table shows that membership club stores have a much higher proportion of CFLs than other retail channels: 98% for membership clubs, compared to 30-44% for all other channels.
- The second row shows that membership clubs make up a large proportion of the lamps included in the shelf survey: 21%.
- However, as shown in the third row, a PG&E residential customer survey (OSG 2011) found that membership clubs are not one of the higher rated primary purchase locations for lamps.

Based on this comparison, the result that CFLs comprise 49% of available A-lamps (after removing LEDs) may be skewed by the results in the membership club channel, because this average is not weighted by consumer purchase location for each market channel.

Table 9: Winter 2015/2016 Shelf Survey (DNV-GL) and Customer Purchase Location (OSG 2011)

	Discount Store	Drug Store	Grocery	Hardware Store	Home Improvement	Mass Merchandise	Membership Club	Overall
CFLs, as % of all Incandescent, Halogen, and CFL (LEDs removed)	30%	44%	40%	38%	36%	44%	98%	49%
Fraction of A-lamps included in 2015-16 shelf survey	3%	2%	2%	6%	46%	19%	21%	N/A
Percent of consumers identifying channel as primary purchase location for lamps (OSG 2011)	8%	8%	8%	9%	24%	28%	9%	N/A