Break on Through to the Other Side: How to Help LEDs Emerge in the California Residential Lighting Market

Tyler Mahone, DNV KEMA Energy & Sustainability, Oakland, CA
Kathleen Gaffney, DNV KEMA Energy & Sustainability, Oakland, CA

ABSTRACT

There's a new bulb in town. Light-emitting diode (LED) lamps have arrived and are among the options Californians have for general purpose lighting. While LED penetration in residential household saturations is still miniscule compared to established technologies, there has been a noticeable increase in the last few years. As this emerging lighting technology begins to gain a foothold in the residential lighting market, now is the time for program intervention to help LEDs make a real savings impact over the next five to ten years. Questions of customer awareness, product availability, pricing disparities and baseline assumptions need to be understood for energy efficiency programs to help LEDs gain market share. Essentially: are there barriers to entry for mass market residential LEDs replacement lamps that utility programs could help mitigate?

These types of questions are being addressed by researchers in California to help inform the design of next generation of programs for efficient lighting. This paper presents results from recent research, including residential telephone surveys, retail store lighting shelf surveys, in-store intercept surveys with shoppers making lighting purchases, and onsite household lighting inventories. The bulk of the data collection and analysis occurred in the 2009-2013 timeframe, with some of this research conducted as far back as 2004-2005. The research addresses LED product awareness, availability, pricing, and penetration. Comparisons to more traditional lighting products, including CFLs, help provide context for characterizing current market conditions.

Results indicate that while LED products have definitely arrived, they have a long way to go before we should expect to see higher penetration rates among California households. In addition, even as sales of LEDs increase over time, continued study is needed to assess the impact these new products will have on reducing lighting consumption beyond what has already been achieved by CFLs and what will be achieved as more stringent lighting efficiency standards gain momentum. Utility program planners considering launching large-scale, mass market residential LED lighting programs need to act soon to avoid being late to the game. There remains a potentially significant amount of low-hanging LED fruit that should be intelligently harvested through more targeted incentive strategies.

Background

Investor-owned utilities (IOU) in the state of California have been implementing programs designed to increase energy efficiency in the residential lighting sector for nearly 25 years. In 1989, the California IOUs launched their first lighting programs in response to the introduction of integral-ballast compact fluorescent lamps (CFLs), and the utilities experimented with various program design, outreach, and delivery strategies over time.

By 2004-2005, the upstream program model became the dominant delivery mechanism, and has continued through to the 2010-2012 program cycle. In an upstream program, the utility typically provides incentives to manufacturers (or retailers) so that the ultimate retail price will be lower for consumers. Through their upstream programs, California's investor-owned electric utilities (Pacific Gas and Electric Company [PG&E], San Diego Gas and Electric [SDG&E], and Southern California Edison Company [SCE]) have provided discounts for hundreds of millions of CFLs over the last decade. In the last few years, LED lamps have begun to emerge as viable alternatives to incandescent lamps and CFLs, but residential utility programs in California have not yet provided incentives for them beyond small trial programs.

This paper will lay out findings from primary research conducted by DNV KEMA that sheds light on LED awareness, availability, diversity, pricing, and saturation and how understanding where LEDs fit in the residential lighting market can lead to more effective utility programs to help LEDs break through to the other side.

Data Sources

Consumer Telephone Surveys

Since as far back as 2004, DNV KEMA has been conducting market research with residential customers of California's investor-owned utilities (IOUs). Most recently, DNV KEMA completed just fewer than 1,000 consumer telephone surveys in mid-2012. The surveys employed a stratified random sampling approach across geographic and socio-economic strata, and included questions regarding awareness, purchase rates, installation and storage patterns, and general satisfaction with various energy-efficient lighting technologies. Another wave of this survey is currently being fielded; results expected in the fall 2013.

Shelf Stocking Surveys

In addition, DNV KEMA has been conducting lighting product inventories (shelf surveys) at retail stores throughout California since 2008. As shown in

Table 1, early shelf survey efforts focused solely on CFLs, but have been expanded to include data collection on all replacement lamps. Most recently, DNV KEMA researchers completed shelf surveys in roughly 600 retail stores during fall 2011, summer 2012 and winter 2012. Shelf survey results provide representation of lighting products available across a broad range of retail channels, including discount, drug, grocery, hardware, large home improvement, mass merchandise, and membership club stores.

Over time, DNV KEMA has compiled the shelf survey data into a database to facilitate time-series comparisons. A version of this database has been uploaded to a beta online tool[1] that allows for analysis of stocking patterns in California over time. Today, this database contains detailed product information for over 2 million lamps. Each record in the database includes key information regarding the store visited (such as the retail channel, store name, IOU service territory, and store address), and beginning in 2009, records contain information specific to each package of lamps in the store, including model number, lamp type, base type, lamp style, manufacturer, wattage, and number of lamps in each package. Additionally, field staff recorded information on product pricing, including the full price per package, the discounted price and

[1] http://websafe.kemainc.com/projects62/crlss/Home.aspx

discount provider (if relevant). Since fall 2011, data collection has captured additional product details, such as lamp life, color temperature, lamp coating, lumens, wattages, and whether each model was 3-way, dimmable, and/or Energy Star labeled.

Table 1. Number of Stores Inventoried and Data Collected by Wave

Data Collection Period	Number of Stores Visited	Type of Data Collected
Spring 2008*	123	9-30Watt medium screw base (MSB) spiral CFLs (non-dimmable, single wattage) and incandescent equivalents (no package counts**)
Fall 2008	202	All MSB CFLs and incandescent equivalents (no package counts)
Spring 2009A	76	All MSB CFLs and incandescent equivalents (no package counts)
Spring 2009B	48	Full lighting inventory and package counts of replacement lamps
Fall 2011	184	Full lighting inventory and package counts of replacement lamps
Summer 2012	200	Full lighting inventory and package counts of replacement lamps
Winter 2013†	200	Full lighting inventory and package counts of replacement lamps

* Data collected in PG&E and SCE territories only.
** "Package count" refers to an actual count of lamp packages present in the stores for each lamp model. Coupled with data on the number of lamps per package, package counts enable calculation of the number of lamps per store for each lamp model.
† Data not included in analysis for this paper.

Consumer Intercept Surveys

In conjunction with the latest wave of shelf surveys starting in the winter of 2013, DNV KEMA field staff conducted over 1,000 consumer intercept surveys of both purchasers of lighting products as well as non-purchasers.[2] Consumer intercept surveys occur in the aisles within retail stores; customers are engaged after they have already made decisions regarding which products to purchase. Using a survey administered on iPads, field researchers asked customers about their purchases of replacement lamps. Researchers also asked lamp purchasers to play a randomized pricing choice game that will be used in a nested logit model to estimate price elasticity. A second wave of data collection and modeling are still ongoing, but this paper includes preliminary results from some of the questions included in the first wave of intercept surveys.

[2] Field researchers attempted to conduct surveys with purchasers in every store they visited. However, certain stores, such as small grocery stores, have few, if any, customers who purchase lighting while field researchers are in stores. Non-purchaser surveys allow for the collection of additional data in retail stores that typically have few customers purchasing lamps.

Residential Onsite Surveys

This paper includes results from two comprehensive onsite surveys conducted by DNV KEMA. The first is the household lighting inventory survey from the impact evaluation of the California IOUs' 2006-2008 Upstream Lighting Programs. Field researchers collected these data from 1,200 randomly-sampled homes throughout California between July 2008 and December 2009. The second is the 2012 California Lighting and Appliance Saturation Survey (CLASS), which was conducted in nearly 2,000 randomly sampled homes through California between May and November, 2012. Both surveys collected similar data, and this paper compares changes observed between 2009 and 2012. In both studies, researchers collected comprehensive inventories of all replacement lamps installed and stored in customers' homes. This included:

- Location in home (room type);
- Control type (on/off switch, dimmer, etc.);
- Fixture type;
- Lamp wattage;
- Lamp technology (incandescent, CFL, halogen, etc.);
- Lamp shape (spiral, globe, tube, etc.); and
- Base type (small screw-base, pin, MSB, etc.).

Results

Consumer Awareness

As part of the consumer telephone surveys conducted in 2012, interviewers asked respondents to describe the types of lamp technologies they were aware of without any prompting or clarifications from the interviewer. If respondents did not mention CFLs or LED lamps, interviewers described each lamp technology and asked respondents whether they were aware of them. As shown in Figure 1, unprompted awareness of LED lamps is still relatively low, as consumers have heard of the technology, but do not necessarily recognize that LED lamps that can be used as replacement lamps. However, when respondents were prompted, we can see that the majority of consumers were aware of CFLs and LEDs: 96 percent of respondents reported awareness of CFLs and 84 percent reported awareness of LED lamps as of summer 2012. This difference in prompted versus unprompted awareness paints an important picture for how consumer awareness can be improved. A large majority of customers are aware of LED lamps, but it is not at the top of their mind when they are asked to think of different lighting alternatives. If LED awareness can be raised to a level similar to CFLs, we may see an increase in LED adoption as well.

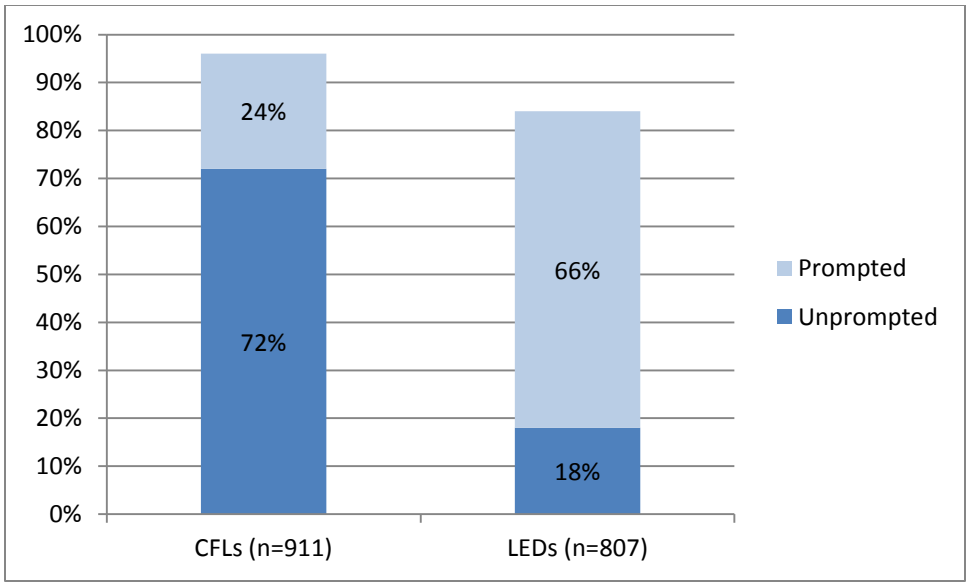

Figure 1. Consumer Awareness of CFLs and LED Lamps, Summer 2012

LED Product Diversity

The shelf stocking surveys allow for analysis of the availability and diversity of LED replacement lamps at the individual model number, store and retail channel levels. The availability of a diverse range of LED products is still limited when compared to incandescent lamps and CFLs. Looking at the average number of unique model numbers per store in Figure 2; we see that there are half as many options for LED as CFLs, with both lagging far behind the diversity available for incandescent lamps. It should be noted that in some cases multiple model numbers were found for similar or exact incandescent lamps. This redundancy was less common for CFLs and was not found for LEDs. As more and more technologies and products compete for the same shelf space, it is likely that the product diversity of each technology in a given store will go down. Utility programs that focus on increasing the diversity of LED products available to customers in a targeted way could help drive increased adoption.

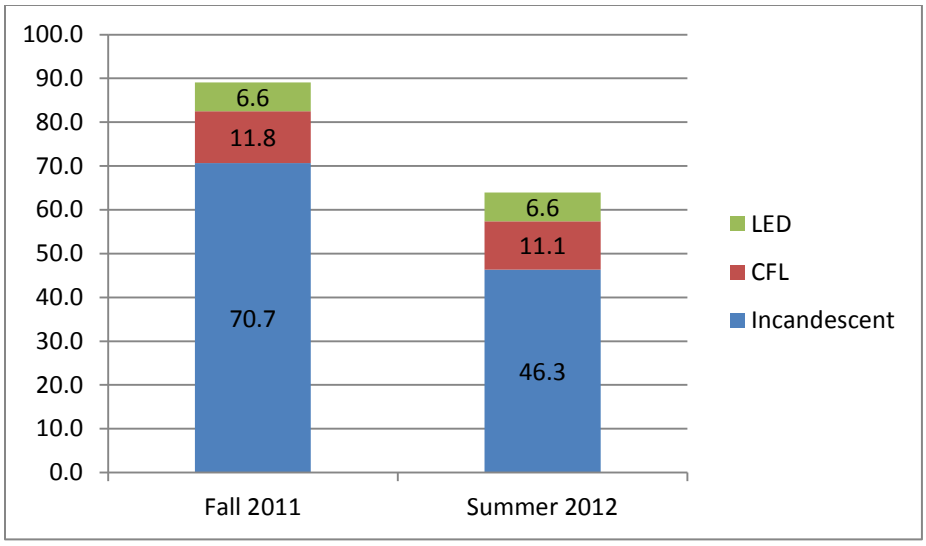

Figure 2. Average Number of Unique Model Numbers per Store

When looking at the average number of LED models broken down by retail channels, it becomes evident that a consumer is most likely to find product diversity in the large home improvement stores. Figure 3 shows the breakdown of LED product diversity by retail channel. Discount and drug stores have limited to zero LED replacement lamps available. This indicates an opportunity to introduce LED lamps in places they are not currently available and thus improving product customer exposure to these new products. However, LED replacement lamp prices are generally too high for these types of channels.

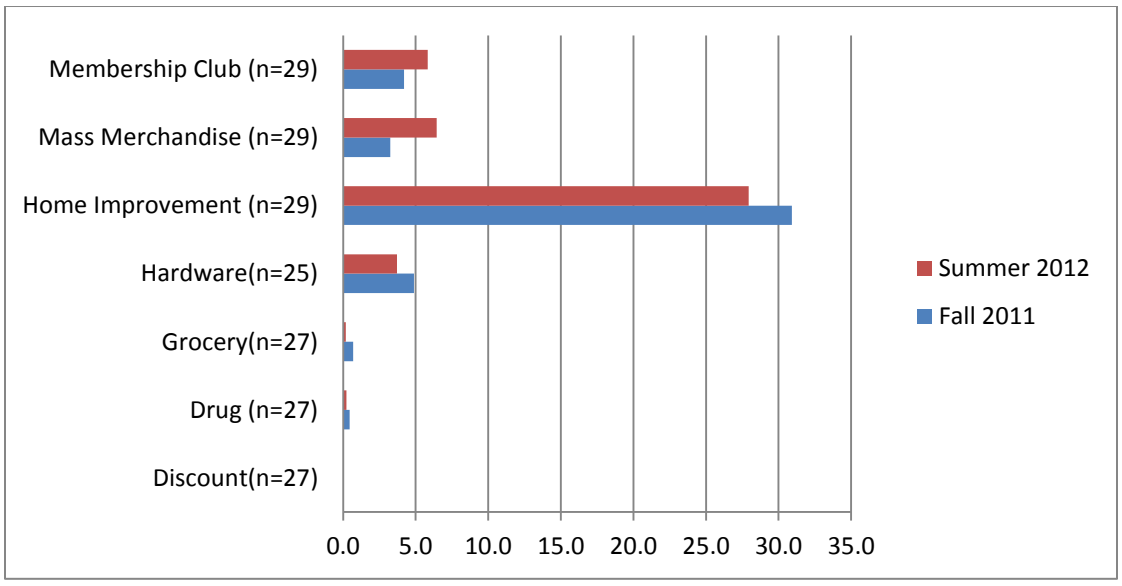

Figure 3. Average Number of LED Replacement Lamp Models per Store by Channel

LED Product Pricing

Figure 4 shows the average price of lamps by technology in fall 2011 and summer 2012 based on shelf surveys conducted during these periods. The price shown is the average price of A-lamp, globe, twister, and reflector lamps across all channels for the two different time periods. LED lamps were still almost ten times more expensive than CFLs or incandescent lamps as of summer 2012.

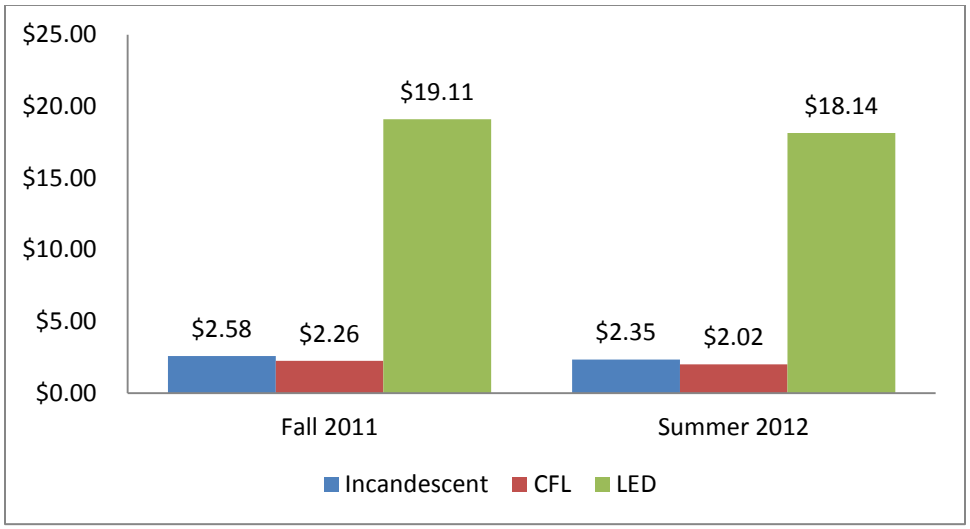

Figure 4. Average Price per Lamp in California across All Retail Channels[3]

Table 2 shows a more detailed breakdown of pricing by lamp technology and style, focusing on big box channels, which include home improvement, mass merchandise and membership club retail channels. For the most part, prices have come down since fall 2011 to the summer of 2012, with both reflectors and globes seeing a significant drop between the two shelf survey waves. The increase in the average price of LED A-lamps might have occurred due to the introduction of new A-lamp models with greater light output. Comparing the LED prices to CFLs and incandescents at a more granular level shows price discrepancies vary by lamp style. Utility programs should look to create targeted incentives that lower LED prices for specific applications and product types.

[3] Pricing data is not weighted, and only represent what was observed in the stores that were visited.

Table 2. Average Price per Lamp by Technology and Style, for Big Box Channels Only[2]

Lamp Style	Lamp Technology	Fall 2011	Summer 2012
Twister	CFL	$2.05	$1.97
A-lamp	CFL	$3.40	$4.54
	Incandescent	$1.12	$1.29
	LED	$10.29	$16.04
Globe	CFL	$2.66	$4.67
	Incandescent	$1.71	$1.83
	LED	$21.43	$7.32
Reflector	CFL	$4.38	$3.93
	Incandescent	$4.24	$3.87
	LED	$34.88	$26.37

A recent study (Opinion Dynamics 2012) conducted for California utility Southern California Edison found that LEDs sold much better when they were priced relatively close to equivalent CFLs. As we can see in Table 2, different incentive levels would be needed for various products. Finding the 'sweet spot' in incentive levels for LEDs, so that a high price becomes less of an adoption barrier, should be a key goal for any utility programs.

LED Lamp Saturation

In the three years that elapsed between the residential lighting inventories conducted by DNV KEMA in 2009 and 2012, CFL saturation increased from 28 percent of all MSB lamp sockets in California households to almost 40 percent (see Figure 5 below). The rise of LED lamps from effectively zero percent of sockets to almost 1 percent is also an important finding, especially absent any significant intervention on the part of California IOU utility programs thus far. The overall drop in incandescent lamp saturation in Figure 5 is mostly a result of increased CFL installation.

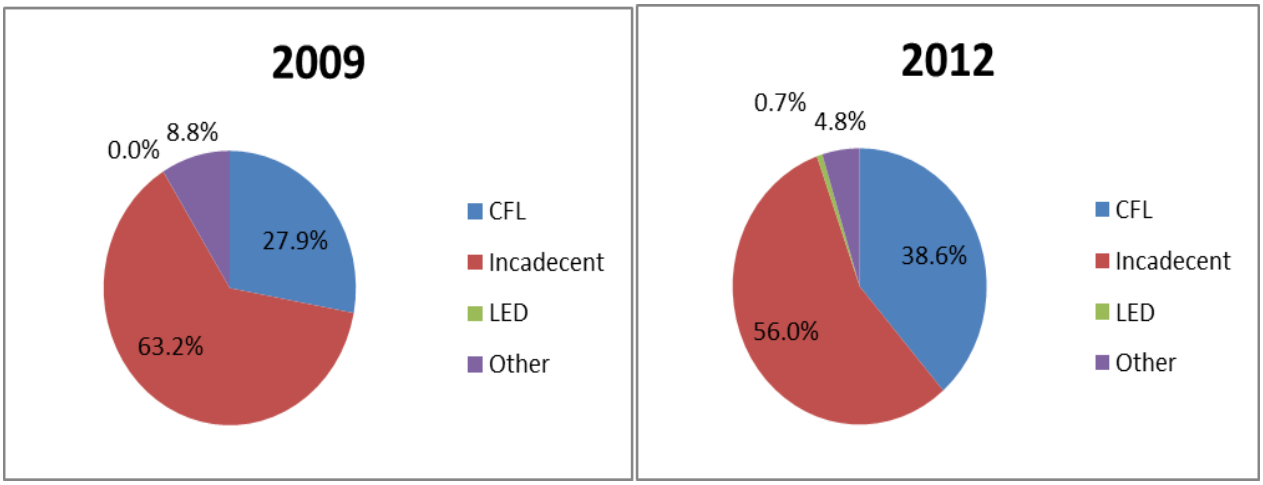

Figure 5. Overall Saturation of MSB Lamps in California Households by Technology

LED Installations by Lamp Type

Focusing just on the LED lamps, in Figure 6 below, it becomes apparent that there was more than a 60-fold increase in the number if LEDs installed in California households between 2009 and 2012. By analyzing weighted totals from the household inventories, there is an increase in installed LEDs from around 40,000 in 2009 to almost 2.4 million LED lamps in 2012. It is important to note that the most dramatic increase was in LED A-lamps. While field researchers found no LED A-lamps installed in California households during the 2009 study, researchers found more than 1.2 million LED A-lamps in 2012. The fact that A-lamps are the most common LED lamp style found in homes in 2012 suggests that consumers are adopting general purpose LEDs lamps at a higher rate than some of the specialty lamps.

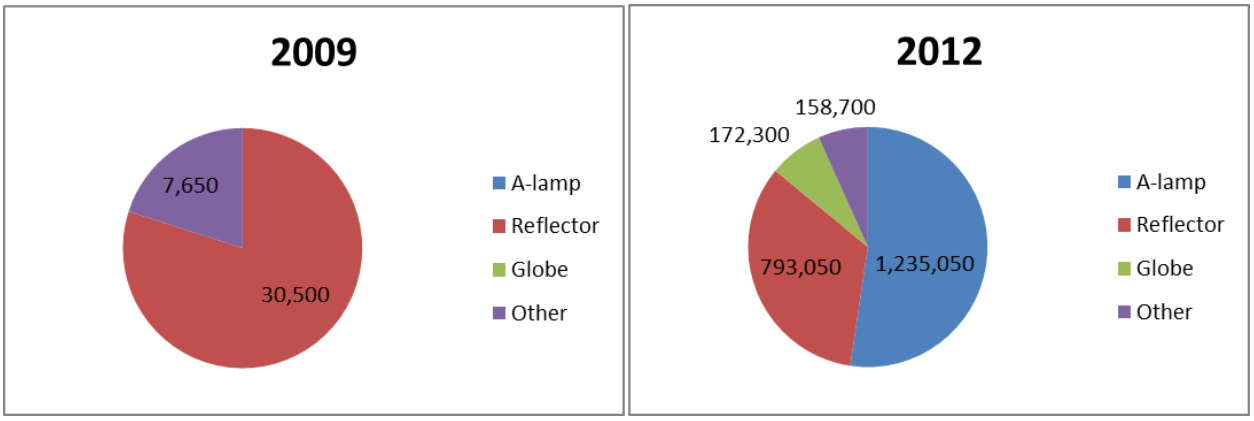

Figure 6. Weighted Number of LEDs Installed in California Households by Lamp Shape

LED Saturation by Room Type

The comprehensive household lighting inventories also reveals installations by room type in California households. Kitchens, exterior locations, bathrooms, and bedrooms are typically the highest-use locations for residential lighting. While LED hours-of-use estimates have not been studied in as much detail as CFLs, Figure 7 suggests that LED lamps are being installed in room types that tend to have higher hours-of-use. Utility programs that can target higher use applications will see a greater return in savings.

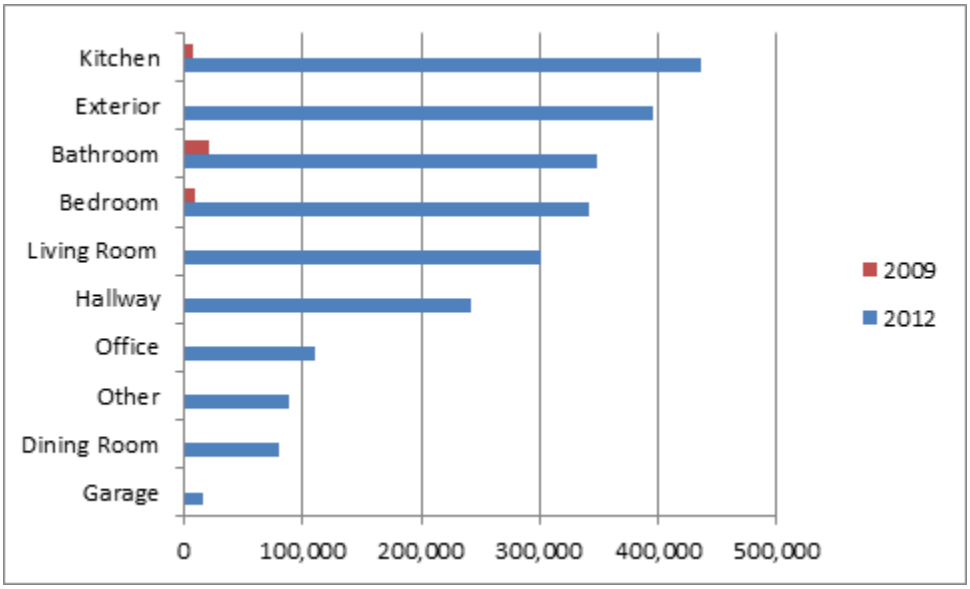

Figure 7. Number of LED Lamps Installed by Room Type

Technologies Being Replaced by LEDs

As part of the consumer intercept surveys conducted in winter 2013, field researchers asked customers where they planned to install the lamps they were purchasing, and what type of lamp technologies they planned to replace with the new lamps. Researchers surveyed 40 customers purchasing LED replacement lamps in winter 2013;

Figure 8 shows the distribution of what types of lamps they planned to replace with the new LED lamps. Although the sample sizes are small, half the customers planned to replace inefficient incandescent lamps, while nearly 40 percent were intended as replacement for lamps that are already energy-efficient (CFLs or LEDs). Replacing CFLs with LED lamps represents much lower energy savings than replacing incandescent lamps with LED lamps, as the change in wattage is far lower. Utilities setting up LED incentive programs should factor in a baseline that includes CFLs, as LEDs will be replacing both inefficient and efficient lamps.

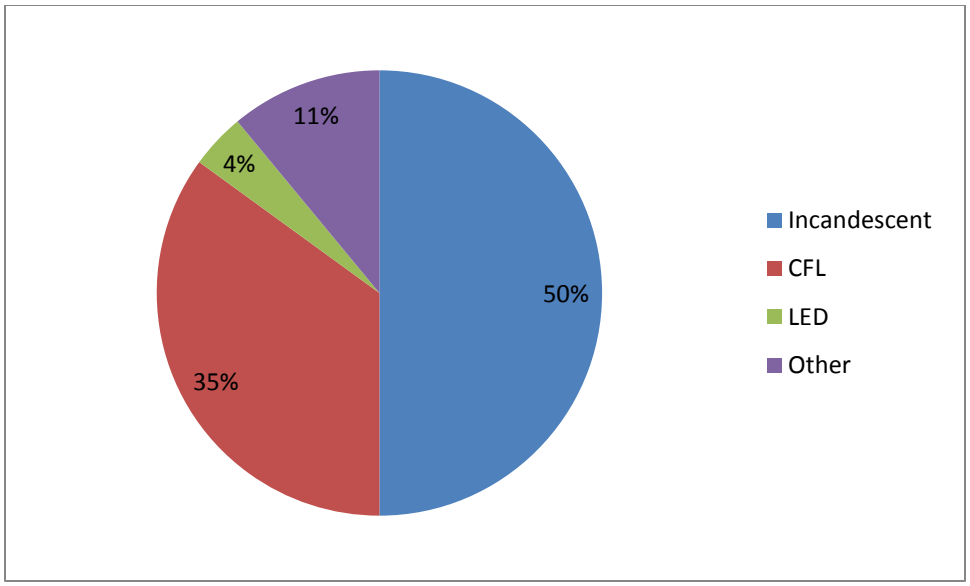

Figure 8. Lamp Technologies that California LED Lamp Purchasers Plan to Replace with LED Lamps, Winter 2013

Conclusion

The window of opportunity of the California IOUs to develop programs for residential LED replacement lamps is wide open. LEDs have begun to gain traction, largely without the help of incentives and outreach, but could really take off if given the right kind of help.

Simple programs geared towards marketing and outreach would raise customer awareness and bring LEDs to the top of customers' minds when considering residential lighting options. It is also important to educate consumers that more savings can come from using LEDs to replace old inefficient lamps rather than trade out current efficient lamps. Creating a positive narrative around LEDs could mitigate some of the public relations problems that CFLs have encountered. Utility programs that target retail channels with limited LED product diversity would expand consumer exposure. Utility programs should also focus on creating intelligent and targeted incentive structures that focus on lowering LED prices to be competitive with comparable products.

References

KEMA, Inc. and Cadmus Group. 2010. *Final Evaluation Report: Upstream Lighting*. Prepared for the California Public Utilities Commission. Available at CALMAC, Study ID: CPU0015.02. http://www.calmac.org/publications/ Final_Evaluation_Report.PDF.

Opinion Dynamics. 2012. *The Southern California Edison (SCE) Advanced Light Emitting Diode (LED) Ambient Lighting Program Customer Preference and Market Pricing Trial*. Study SCE0324.01. Rosemead, Calif: Southern California Edison. Available at CALMAC, http://www.calmac.org/publications/LED_Report_Final_v2.PDF.