THE SOUTHERN CALIFORNIA EDISON (SCE) ADVANCED LIGHT EMITTING DIODE (LED) AMBIENT LIGHTING PROGRAM CUSTOMER PREFERENCE AND MARKET PRICING TRIAL

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1. EXECUTIVE SUMMARY

The Opinion Dynamics Team, with sub-contractor StatWizards, is pleased to present our report for the Light Emitting Diode (LED) Market Pricing Trial. This effort was initiated by Southern California Edison (SCE)'s Lighting Incentive Program team. Specifically, Richard Greenburg and Brett Close of SCE were instrumental to this project. Initiated in May 2011, this study was conducted through December 2012 and focused on two ambient lighting categories: A-Lines and Reflectors. Within the Reflector category are the sub-categories: R, BR, PAR (screw-in Reflectors), and decorative recessed can retrofit lamps (Clip and Rim type).

1.1 INTRODUCTION TO THE STUDY

This document presents the LED Market Pricing Trial Study (SCE Trial) for the first time, and also includes findings from five other data collection activities. The SCE Trial included the following data collection activities: (1) Market Pricing Trial (Pricing Trial), (2) Latent Class Discrete Choice (LCDC) Study and Segmentation Analysis, (3) In-home Customer Lamp Trial (Lamp Trial) among SCE Customers, (4) An Installation Survey of Lamp Trial Customers, (5) In-depth Interviews with Lamp Trial Customers (IDIs), and (6) Preliminary Focus Groups with SCE Customers (Focus Groups)f.[1]

1.2 KEY FINDINGS

1.2.1 LED PRICING AND SALES

Here we present the key findings from our Pricing Trial. We note that retail LED prices continue to drop quickly. This test was not designed to identify particular prices for use in the future, but rather point toward principles for applying relative to the price at the moment (like the moment in the future that you are now reading this report). While the principles are applicable for the future, the exact prices are expected to change over time.

- **The LED market is very price sensitive.** While no ideal "sweet spot" was identified for specific incentive levels or prices to increase sales, several discoveries emerged from the Pricing Trial that could help the SCE optimize incentives in their programs (Pricing Trial).
  - **Reflectors and A-lines showed different reactions to price reduction.** Reflectors gained the greatest return on sales, selling at almost five times the rate of A-lines. For every 1% decrease in price, there is a 1.14% increase in A-Line sales as compared to Reflectors, where a 1% decrease in price means 3.25% increase in sales.

[1] Detailed descriptions of our methods can be found in the methodology section of this report.

- **LEDs sold much better when their prices were relatively close to the price of an equivalent CFL of the same type.** Products with prices $20 or less sold the best in all categories.
- **High prices are unacceptable to customers:** Irrespective of product type, income level, or other test factors, sales at prices above $40 were virtually non-existent.

- **High-income areas had the greatest sales rates when controlling for other factors.** On average, LED lamp sales in high-income areas were 4.1 times higher than sales in low-income areas and 1.9 times higher than stores in medium-income areas. LED lamp sales in medium-income areas were 2.2 times higher than low-income areas. We note here that this may not appear to be the case when examining the raw data, however covariates with medium-income store locations (such as retailer chain) drive up middle income sales. However, when controlling for these factors, we see that high-income have the greatest sales volume (Pricing Trial).
- **There is significant variation in sales by retailer.** Our data suggest significant retailer effects on sales. Although most programs are aware of the retailers that consistently sell at higher or lower volumes, this test verifies that the choice of retailer is important because some sell LED products significantly faster and in higher quantities than others (Pricing Trial).
- **Region had no statistically significant effect on sales.** Our data show that centrality to the L.A. Basin had no statistically significant effect on sales (Pricing Trial).

1.2.2 Customer Willingness to Pay

In addition to our Pricing Trial, we conducted a number of qualitative and quantitative efforts to understand customers' willingness to pay for LEDs. Below we describe these findings, indicating which studies produced these results.

- **As found in our Pricing Trial, our LCDC work confirmed that customers are extremely price sensitive and that price is the number one purchase decision for lighting.** Price was the primary driver of customer lamp selection among LCDC survey respondents indicating that price, when accounting for all other product attributes, determines which lamp customers were willing to select (LCDC).
- **As demonstrated in the Pricing Trial, our qualitative research indicated that customers will accept LED lamps priced comparably to Compact Florescent Lamps (CFLs).**
  - **Notably, customers indicate they will pay a premium for LED Reflectors, even though our Pricing Trial indicates high sensitivity to price for this category.** Specifically, customers indicated that they would pay as much but no more than $10 for LED A-Lines and $30 for LED Reflectors (IDIs). This indicates that customers are receptive to LED technologies for this particular category, and when considered with the Pricing Trial findings, the data suggests that marginal drops in price will net greater gains in purchases for this product due to customer interest. This data also suggests that the price floor could be higher

for reflectors relative to A-Lamps. We recommend additional research and tests to further examine this phenomenon.

1.2.3 Customer Perceptions and Awareness of Ambient LEDs

- **Customers are leery of LED technologies due to (1) little to no direct experience with the technology, and (2) negative past experiences with CFLs**. Due to low levels of self-reported exposure to ambient LEDs, customers tend to expect similar drawbacks to new LED technologies that were indicative of the early rollout of CFLs. Primarily, customers are concerned about lighting quality, ability to dim smoothly, flickers, and realization of longevity claims. Other concerns include disposability and safety. (Focus Groups)
- **Once experiencing LEDs, customers prefer the lighting quality of LEDs but skepticism lingers about unobservable attributes such as longevity.** Customers are overwhelmingly satisfied with LED light quality and prefer it to CFLs once they have had the opportunity to directly experience the product. However, this enthusiasm about LED quality is tempered by lingering concerns that the longevity claims will not be borne out. (IDIs)

1.2.4 Customer Attribute and Design Preferences

- **Notably, customers treat A-Lines and Reflectors as different products**. Our LCDC work and IDI findings have shown that customers have very distinct purchase and shopping preferences for A-Lines vs. Reflectors, indicating these categories are decidedly different purchases for consumers. (LCDC and IDIs)
- **After price, customers select products for purchase based on different attributes depending on whether they are selecting A-Lines or Reflectors**. Specifically, energy savings, product type (CFL vs. LEDs), and long-term savings drove A-Line selection. For Reflectors, product type, the purchase location or outlet, and brightness drove product selection. (LCDC)
- **Customers who tried LEDs in their homes expressed clear preferences for product attributes**. Specifically, customers are looking for warmer color temperatures; smooth, linear dimming; 100-watt equivalent lamps; and wider beam angles (115 degrees or more) for Reflectors. (IDIs)
- **Notably, customers are more receptive to LED technologies for Reflector purchases**. Our data suggest that customers are more interested in LEDs for Reflector technology. This is backed up by our Lamp Trial as well as our LCDC results. (LCDC, Lamp Trial and IDIs)

1.3 RECOMMENDATIONS

Ensure that Incented LEDs are the Gold Standard of Lighting Quality

- **SCE should be viewed as the arbiter of quality by influencing design and incenting only high-quality products.** Customers are very sensitive to lighting quality and skeptical of LEDs due to bad experiences with CFLs. For this reason, SCE should use its incentives to foster and "approve" higher quality products that will satisfy customers' expectations.
- **SCE should stock and incent more wide-angled Reflector lamps and consider in-store education on beam angle and applications.** Most customers did not/do not consider beam angle when purchasing lighting; however, their satisfaction with LED Reflector technology was *highly* affected by the beam angle of the lamps. Overall, customers preferred wide beam angles, but do cite situations where narrow angles are preferred. SCE should provide in-store signage or demonstrations to communicate the differences between the two technologies.
- **Minimum standards should be placed on dimming quality for incentives.** SCE should work with manufacturers to improve dimming quality of Reflector lamps and/or incent those that meet a minimum dim-ability standard.

Develop a Category- and Segment- Specific Strategy when Going to Market

- **Merchandise differently by product category:** The LCDC suggests that customers make very different decisions at shelf for Reflectors and A-Lines. Consider developing different marketing strategies for each product category, targeting the key selling points unique to each product category.
- **Target Early-Adopting segments first through online channels:** SCE should consider targeting early-adopting segments through online channels in the short term before prices drop enough to entice other segments. These segments (Tech Seekers and Product Explorers) are willing to pay more for new technologies, express high interest in LEDs, and look to make their purchases online.
- **Target the Reflector market first to gain LED market penetration:** Customers are substantially more receptive to LEDs when shopping for Reflectors. Our focus group and IDIs suggest that customers are willing to pay more for longevity for this product category to reduce the number of times they have to replace lamps in hard-to-reach locations. For this reason, the Reflector market may be an ideal market in which to gain consumer acceptance of LEDs.

Provide Customers with Insight into Both the Positive Observable and Unobservable Attributes of LEDs

- **SCE should use comparative displays and in-store demonstrations to demonstrate the enhanced quality of LEDs compared to CFLs.** To demonstrate the technological advancements and differences in key attributes between LEDs and CFLs, we

recommend that SCE create in-store experiences to encourage customers to explore and compare the lighting technologies. Such demonstrations can convey differences in observable light quality, brightness, and color temperature.

- **Provide customers with lifetime cost calculators.** Customers are still very price-sensitive when selecting lighting; however, some customers indicate that they may be willing to pay more if lifetime costs are lower. SCE should provide cost calculators to customers to help calculate the cost benefits of LED purchases at the shelf. This could be a simple display sheet offered at the shelf that shows savings based on the number of bulbs replaces, for example.
- **Promote the convenience benefits of LEDs generally and for Reflectors in particular.** Our research shows that customers found convenience to be one of the major selling points for LEDs, particularly for Reflectors which can be difficult and troublesome to replace in ceiling fixtures.

Educate Customers on LED Attributes and Applications

Our findings have shown that customer satisfaction is largely driven by their direct experience with lighting in the home. In addition to educating on energy-saving and longevity benefits, customers would benefit from more general lighting education. In this way, SCE can serve as the lighting expert that helps customers navigate diverse product offerings at the shelf to ensure satisfaction in the home. To do this, we recommend:

- **Educate on the monetary value of LEDs.** Focus group respondents indicated that they can adjust to other factors that differ about LEDs (such as their look and technology) once they are familiar with them; however, if they consider the bulbs too expensive, customers simply will not buy them.
- **Consider providing retailers with point-of-purchase communication materials or general training for sales associates on LEDs.** Customers are going to want information about LEDs and how they differ from CFLs. Even with the planned buy-down of customer purchase costs, it is not certain that SCE can bring down the point-of-purchase cost of LEDs to the point where no additional information would be necessary. Respondents in the focus groups and IDIs were willing to pay more for LEDs, but they would have to consider them a worthwhile investment (see next section for more detail).
    - **Information must particularly address LED lamp disposal, safety, and functional quality.** Focus group respondents were concerned that LEDs might also be hazardous or require special disposal the way that CFLs do. Information on LEDs must address these concerns, as well as emphasize the superiority of LEDs in terms of lifetime, long-term value and functional quality (color, dimming, noise).
    - **Information must carefully address longevity claims given past experience with CFLs that failed to deliver longevity.** Customers noted that longevity claims cannot be trusted due to past experiences with CFLs. This is important to call out because customers must believe in longevity claims in order to factor this into total cost estimates. With LED's first cost significantly above market, a lack of trust in longevity claims may present an additional barrier to purchase.

- **Educate on fixtures and application at home improvement stores.** Customers indicated a clear preference for purchasing application-specific lighting at home improvement stores. Given this insight, SCE should consider developing more in-depth educational materials and displays for these particular channels where customers go to make educated purchases.
- **Because Reflectors have more attributes to consider, be sure to focus on educating customers on the appropriate fixtures and beam angles to meet their ambient lighting goals.** Customers seemed to have the greatest difficulty selecting appropriate Reflectors for their application and fixtures. While this issue may not be specific to LEDs, SCE should consider ways to better educate customers on fixture sizes, lamp fit, and applications for different beam angle.

Conduct Additional Investigations of Pricing

- **Consider continuing the market Pricing Trial analysis to include a more formal analysis of price optimizations.** Our initial investigation of findings provides insight into price elasticities. We recommend that additional, follow-up research be conducted to estimate optimal price points for market adoption.
- **Develop market strategies that account for specific retail, income, and technology differences in market uptake.** Our analysis demonstrated that customer response to price drops differs dramatically by technology type, income levels, and retailer. SCE should consider these differences when developing a market strategy for incenting LEDs.
- **Aim to bring LEDs down to the same price range as CFLs.** Both our Pricing Trial and Focus Group data indicate that customers will not spend a premium on LEDs (with the exception of reflectors due to their longevity, though this is a modest premium). As such, SCE should develop strategies that consider customer acceptance of LED prices and current cost of CFL lighting along with the aforementioned insights gained in the Pricing Trial.

2. OVERVIEW OF METHODS

The Opinion Dynamics team conducted an in-depth qualitative and quantitative study to characterize the lighting market for ambient LEDs. This study included various qualitative and quantitative efforts to examine the drivers and barriers to LED market adoption and to determine ideal target groups for marketing LEDs. Table 1 below provides a brief overview of the various components that fall under the umbrella of our Latent Class Discrete Choice (LCDC) study. We provide a detailed methodology in Section 6.

Table 1. Methodology Snapshot

Method	Sample Size	Date	Objectives
LED Market Pricing Trial (Pricing Trial)	Select Big Box Stores	10/2011-7/2012	• Assign varying incentive levels for LED lamps at big box stores across SCE's territory • Examine sales rates and elasticities associated with varying incentive levels • Identify correlates with sales, including location, store, and socio-economic status of the region.
Focus Groups	2 Groups	10/2011	• Examine customer lighting preferences and purchase priorities overall, specific to energy efficient lighting • Examine customer response to LED lighting demonstration • Test the LCDC instrument
In-Home Customer Lamp Trial (Lamp Trial)	98	5/2012 to 8/2012	• Deliver 4 LED A-Lines and 3 Reflectors to 98 SCE customers • Collect data on customer installation and replacement behaviors with new LEDs • Survey "experienced" customers for the LCDC • Conduct in-depth interviews with customers who installed lamps
In-Depth Interviews (IDIs)	20	8/2012	• 20 in-depth interviews were conducted with in-home customer Lamp Trial participants • Collect customer responses to LED technology and pros and cons related to the LED's attributes
Latent Class Discrete Choice Analysis (LCDC)	252 A-Line, 224 Reflector	10/2011 and 7/2012	• Identify customer purchase priorities by LED product attribute • Classify customers into segments based on their purchase considerations • Develop market adoption models

The next section provides a detailed methodology for this work.

2.1 LED PRICING TRIAL

2.2 PRICING TRIAL

Sample Design

One-hundred and seventeen large nation-wide retailers participated in the pricing trial, each belonging to one of three major chains in SCE territory. Two additional retailers dropped out of the program or never completed agreements.

In order to assure representation of store catchment areas with different characteristics that could influence the sales rate of LED lamps we employed a stratified design. For each retailer in the program, we attempted to distribute participating stores by median household income level and whether the store was centrally or remotely located based on their catchment areas. Catchment areas were defined as households within a five-mile radius of the store. The following sections describe our approach to sampling by the important variables.

Geographic Cluster Development

After combining all available data inputs and plotting the locations and income levels around each store, we identified natural geographic "clusters" of stores. To form a "cluster," stores should be closer to each other (possibly overlapping) than to stores in other geographic clusters or buffer zones. We also looked for clusters that represent a mix of income levels, and a mix of store chains.[2] For stores in more rural counties, it is relatively easy to identify clusters of stores that are near each other and more than five miles from other stores. For stores in the relatively more urban Los Angeles, Orange, and Riverside counties, we attempted to maximize distances between stores in different geographic clusters. However, this aspect of location was ultimately not predictive, so our description will not address it further.

Assignment of Incentive Level

After identifying naturally occurring geographic clusters with a mix of income levels, we assigned incentive levels to each cluster. Our goal in assigning incentive levels was meet the store selection guidelines described in Section 3. Therefore, the sample should have the following properties after we assign an incentive level to each geographic cluster:

- Each incentive level should contain a similar number of stores, and an adequate mix of stores from all five participating large chains. We anticipated some differences in product display and positioning in different store chains, as well as potential

[2] We allowed some clusters to contain only one or two income levels, if these clusters could help us achieve a mix of income levels at an aggregate level (for an incentive level). For example, we could have one cluster of low- and medium- income stores with a $10 incentive and one cluster of medium- and high-income stores with a $10 incentive, that together represent all store chains and income levels.

differences in consumer preferences and purchase behavior. Therefore, it was important that each incentive level contain stores representing each retail chain.

- In aggregate, the distribution of income levels (a) in the overall sample, and (b) at each incentive level should match the income distribution around all participating stores in SCE territory. Consumer purchase decisions and price sensitivity are highly related to income. Therefore, it is important that we observe sales at each incentive level from customers with a wide range of income levels, which we can achieve by ensuring we select stores from low-, medium-, and high-income regions.
- Incentive levels should be assigned to minimize big "changes" in incentive level between clusters, so that customers are less likely to price-comparison shop between stores. For analysis purposes, it is important that the sales rates we see at the end of the study reflect store-level conditions as accurately as possible - incentive level, income in the store's catchment area, and effect of the store chain. In practice, this means providing some separation between $0 incentive area and $30 incentive areas, such as geographic distance or "buffer" stores where advanced LED products may not be available.

The first three criteria aim to minimize differences between incentive levels in adjacent areas while assuring all store chains are represented in an incentive level, which is needed for regression analysis. Meeting all the criteria we discuss above required that we used multiple, smaller clusters to comprise an incentive level, instead of one large geography per level.

After developing these guidelines, we tested multiple incentive level assignment scenarios and determined how well each scenario met each guideline. The plan for distributing stores was not entirely under our control since retailers would not always agree with the plans. The next section describes our success in meeting these objectives.

Characteristics of the Final Sample

The distribution of final sample stores by Retailer within the SCE territory was quite close to the territory-wide figures, as shown in Table 2.

Table 2. Percent of Participating Stores by Retailer: by SCE Territory and Sample

Retailers	Territory	Sample
Retailer 1	22%	23%
Retailer 2	48%	44%
Retailer 3	30%	32%

Table 3 shows the distribution of stores falling in each Income level for the SCE territory and the sample. The distributions of sample and territory are close enough that we did not consider it necessary to weight the data by these strata.

Table 3. Percent of Stores by Catchment Area Income Level

Income Level	Territory[3]	Sample
Low	16%	19%
Medium	58%	55%
High	26%	26%

Table 4 shows that while not a balanced design, there is representation of incentive levels across Income strata, as evidenced by the absence of a zero value in any cell. There were at least 2 or 3 store-model combinations in each Income-Incentive combination.

Table 4. Number of Store-Model Combinations Assigned to Incentive Levels by Income and Lamp Type

Lamp Type	Incentive Level	Income Level			Total
		Low	Medium	High	
A-Line	0	6	12	7	25
	5	3	12	3	18
	10	6	18	10	34
	15	3	7	5	15
	Total	18	49	25	92
Reflector	0	7	17	8	32
	5	5	11	4	20
	10	2	9	8	19
	15	3	10	5	18
	20	5	9	4	18
	25	2	8	3	13
	Total	24	64	32	120
Total	0	13	29	15	57
	5	8	23	7	38
	10	8	27	18	53
	15	6	17	10	33
	20	5	9	4	18
	25	2	8	3	13
	Total	42	113	57	212

[3] This is the distribution if income levels that have at least one of the study's participating stores within 5 miles. Income tertiles were defined by the census block groups within SCE territory. Then, the percentage of homes at each income level that have a participating store within five miles was determined to establish the income distribution of the relevant population. E.g. 16% of homes that have a store within 5 miles are in the lowest tertile income level in the SCE territory.

Table 5 reveals how successful we were in the effort to ensure representation of all incentive levels across Retailers. There are a few cells with no store-model combinations in them, but most cells have coverage.

Table 5. Number of Participating Stores by Catchment Area Location and Incentive Level

Lamp Type	Incentive Level	Retailer			Total
		Retailer 1	Retailer 2	Retailer 3	
A-Line	0	4	21	0	25
	5	6	7	5	18
	10	10	24	0	34
	15	7	0	8	15
	Total	27	52	13	92
Reflector	0	4	21	7	32
	5	6	7	7	20
	10	5	8	6	19
	15	3	7	8	18
	20	2	9	7	18
	25	7	0	6	13
	Total	27	52	41	120
Total	0	8	42	7	57
	5	12	14	12	38
	10	15	32	6	53
	15	10	7	16	33
	20	2	9	7	18
	25	7	0	6	13
	Total	54	104	54	212

While the design cannot be said to be entirely balanced these tables do show that there is a considerable spread of stores across conditions and characteristics so that most situations likely to affect sales are represented.

Data Cleaning

Opinion Dynamics received data files from SCE that included sales figures from multiple sources. There were 117 individual stores of three major retail chains that participated in the study. Seven different manufacturers contributed 18 different LED lamp models, those models were categorized into two major lamp type categories: A-Line and Reflector.

The data cleaning process involved several steps. Since the data sources included different manufacturers and retailers, we had to calculate unit conversions for several variables to ensure that our testing compared “apples to apples.” First, we checked each data file for the

presence of all variables. If a key variable was missing, we worked with SCE to obtain the necessary information. In the cases where two or more data files needed to be merged, we matched data by retailer, store address, and lamp model.

The sales data exhibited a lot of variability over time in the volume of sales of program products. Different retailers and manufacturers tracked sales over different time increments, so the raw sales data came in various time units: daily, weekly starting Monday, weekly starting Sunday, bi-weekly, and monthly. All data were converted to weekly units with a sales period starting Monday. To do this, e.g. a monthly figure was divided evenly into weeks. There were large spikes, numerous zeros and blanks, all of which have since been interpreted with guidance from SCE. Blank sales records were eliminated because they represented situations where stores ultimately had not carried the product but it remained in the file. Zero sales entries were included in the analysis and are associated with the lack of any incentive allocation. Spikes were included but tended to be smoothed out with the averaging of sales over weeks to produce mean weekly sales.

We added a variable to identify the two major types of LED lamps. The design variables of Income Level and Location were merged onto the file by Store. The final dataset consisted of the 17 variables listed below.

1. Manufacturer
2. Retailer
3. Address
4. City
5. Zip Code
6. Location
7. Income Level
8. Model
9. Wattage
10. Lumens
11. Lamp Type
12. Incentive Level
13. Regular Retail Price
14. Reduced Retail Price
15. Allocated Quantity
16. Cumulative Sales
17. Average Weekly Sales

Each unit in our final analysis file consists of a unique store address and LED lamp-model combination.

Modeling

The Opinion Dynamics Team's approach to estimating the effects of price on sales used fixed-effects models with both price and mean weekly sales in a logged form. A fixed effects model creates separate but parallel regression lines for each store, so that each store has its own intercept and all stores have the same regression line slope. Because we used the log of average weekly sales as the dependent variable and regressed it on (log of) program retail price, the slope is equal to the elasticity. The fixed effects model cannot tell us the measure of each explanatory variable's effect. However, by not forcing every store onto the same regression line with the same intercept, the fixed effects model uses the information from each data point to calculate the best possible slope; in this case, the price elasticity of LED lamps in Southern California. The log-log approach also has the advantage that a store with very large overall sales will not dominate the model since each store will contribute with equal weight to the overall slope.

We wanted to combine the two product types into one model to provide more statistical power than would be possible by estimating separate models by lamp type. However, we know from other components of this study that the consumer sees A-Line and Reflector lamps in a different way. In addition, preliminary testing showed that price had a different effect for Reflectors compared to A-Lines. We therefore included an interaction term for Reflector by Price in addition to the main effect term for Reflectors. Our result is a fixed effects model that predicts LED lamp sales by price, or elasticities, for both A-Line and Reflector lamps.

The equation used in our fixed-effects models is as follows:

$$\log(Sales_i) = \beta_1 \log(Price_i) + \beta_2 LampType\ 'A\ Line'_i + \beta_3 LampType\ 'Reflector'_i + \beta_4 LampType\ 'Reflector'_i \cdot \log(Price_i) + \beta_j Store_{j[i]} + \epsilon_i$$

Where:

- $\log(Sales_i)$ is the weekly sales for a store-model unit
- β_1 is the A-Line elasticity
- β_4 is the increment in elasticity due to Reflectors
- $\log(Price_i)$ is the program retail price for a store-model unit
- LampType 'A-Line'$_i$ is one if the lamp in the store-model unit is an A-Line type and zero otherwise
- LampType 'Reflector'$_i$ is one if the lamp in the store-model unit is a Reflector and zero otherwise
- LampType 'Reflector'$_i$ * $\log(Price_i)$ is equal to the log of program retail price if the lamp in the store-model unit is a Reflector type and zero otherwise
- $Store_{j[i]}$ is one if the store in the store-model unit is store j and zero otherwise
- β_2, β_3, and β_j are the regression coefficient of their respective variables
- ε_i is a normally distributed error term with mean zero

Because we used log of average weekly sales, we had to designate a value other than zero for the store-model units with zero sales during the program period (because log(0) is undefined). We assigned a value of 0.04 to the store-model units with zero sales. We selected this value after several trial models and after concluding that a 0.04 substitution for zero values created the best representation of what was happening in the data. The lowest average weekly sales value is 0.05 so using a value of 0.04 allows us to include all of the zero sales units, but without allowing the zero sales data to dominate the model. Assigning zeros a smaller value, like 0.001, produced excessively high elasticities. The value set at 0.04 reduces the leverage of the large number of 0 sales data on the model calculations. We substituted 0.04 for zero average weekly sales in all models that used average weekly sales. As stated earlier, three store-model units were dropped as extreme outliers. These three units were 10 to 20 times the standard deviation above the mean sales. Without these data points, the final dataset consisted of 684 store-model units.

Beyond looking at price elasticity, we modeled non-price effects as well. For estimating non-price effects such as Retailer, Income Level, and Location, we used a mixed-effects model. Mixed effects, or panel data models, are a hybrid of random effects and fixed effects models. The model fixes the intercept on one variable, but also accounts for the effects of other independent variables, even if the independent variables are at the store address level. Our mixed effects model calculates a unique intercept for each store address, assuming normal distribution of the intercepts. As with the price elasticity models, we removed the outliers from our models.

The equation used in our mixed-effects model is as follows:

$$\begin{aligned}\log(Sales_i) = {} & \alpha_{j[i]} + \beta_1 \log(Price_i) + \beta_2 Retailer\,'Retailer\ 2'_i + \beta_3 Retailer\,'Retailer\ 3'_i \\ & + \beta_4 LampType\,'Reflector'_i \\ & + \beta_5 IncomeLevel\,'MediumIncome'_i + \beta_6 IncomeLevel\,'HighIncome'_i \\ & + \beta_7 Location\,'Remote'_i + \beta_8 Retailer\,'Retailer\ 2'_i \cdot \log(Price_i) \\ & + \beta_9 Retailer\,'Retailer\ 3'_i \cdot \log(Price_i) + \beta_{10} LampType\,'Reflector'_i \\ & \cdot \log(Price_i) + \epsilon_i\end{aligned}$$

Where:

- log($Sales_i$) is the weekly sales for a store-model unit
- $\alpha_{j[i]}$ is the store-specific intercept, calculated using random effects
- β_1 is the elasticity for A-Line lamps at Retailer 1
- log($Price_i$) is the program retail price for a store-model unit
- Retailer 'Retailer 2'$_i$ is one if the store in the store-model unit belongs to Retailer 2 and zero otherwise
- Retailer 'Retailer 3'$_i$ is one if the store in the store-model unit belongs to Retailer 3 and zero otherwise
- LampType 'Reflector'$_i$ is one if the lamp in the store-model unit is a Reflector type and zero otherwise
- IncomeLevel 'MediumIncome'$_i$ is one if the store in the store-model unit is in a medium income area and zero otherwise

- IncomeLevel 'HighIncome'$_i$ is one if the store in the store-model unit is in a high income area and zero otherwise
- Location 'Remote'$_i$ is one if the store in the store-model unit is in a remote area and zero otherwise
- Retailer 'Retailer 2'$_i$ * log(Price$_i$) is equal to the log of program retail price if the store in the store-model unit belongs to Retailer 2 and zero otherwise
- Retailer 'Retailer 3'$_i$ * log(Price$_i$) is equal to the log of program retail price if the store in the store-model unit belongs to Retailer 3 and zero otherwise
- LampType 'Reflector'$_i$ * log(Price$_i$) is equal to the log of program retail price if the lamp in the store-model unit is a Reflector type and zero otherwise
- β_2 through β_{10} are the regression coefficients for their respective variables
- ε_i is a normally distributed error term with mean zero

2.3 Focus Groups

Opinion Dynamics conducted two focus groups with SCE customers on October 20, 2011. Residents were recruited using SCE customer lists. Lists were randomized and customers were screened to ensure representation in each group across homeownership, income, age, and ethnicity. Both groups were conducted in English.

The goal of the focus groups was four-fold: (1) examine customer attitudes towards and purchase preferences for lighting products in general and LEDs in particular, (2) assess barriers and drivers to adoption of new energy efficient lighting technologies and LEDs in particular, (3) gather customer recommendations on LED attributes, and (4) test the LCDC instrument for comprehension.

Focus groups were recorded and transcribed. Findings were delivered to SCE in the form of a memo on November 21, 2011.

2.4 In-Home Customer Lamp Trial (Lamp Trial)

The Opinion Dynamics team sent LED lamp kits to 97 customers in early May 2011 that included four A-Lines and three Reflector lamps. The four A-Lines were identical but the three Reflector lamps differed across various attributes, including brand, price, brightness, and beam angle. A list of lamps provided and their specifications is included in Table 6 below. For an example of educational materials and instructions provided with the lamps, please see Appendix B: In-Home lamp trial Study Instructions.

Table 6. Specifications of Lamps Sent to Lamp Trial Participants

Specifications	Feit A-Line	Feit Reflector	Philips Reflector	Nexxus Reflector
Price	$15	$27	$27	$50
Beam Angle	300°	30°	25°	115°
LEDs in Lamp	1	6	10	11
Watt Equivalent	60	75	60	45
Brightness	800 lumens	650 lumens	630 lumens	465 lumens
Color	Soft White	Soft White	White	Soft White
Average Life	22.8 years	22.8 years	22.8 years	22.8 years
Dimmable	Yes	Yes	Yes	Yes

The purpose of the Lamp Trial was to collect installation practices (Installation Inventory below), collect qualitative information on customers' experiences, and develop a sample of customers for the LCDC study that had direct experience with LED lamps.

Installation Inventory

After installing the lamps, participants filled out and mailed installation sheets that recorded where each lamp was installed, the fixture-type, how the lamp is used, lamp type replaced, and the wattage of the lamp replaced.[4] A portion of these customers also completed an LCDC survey, which we describe in detail in the LCDC section of this methodology. Of the 97 customers who received kits, 85 returned installation sheets (providing us with installation data on a total of 595 individual bulbs) and 71 completed the online survey. For an example of the installation sheet completed by participants, please see Appendix C.

In-depth Interviews (IDIs)

After experiencing the LEDs for approximately 8 weeks of having the lamps in home, 20 of the 71 customers who completed the online survey were recruited to participate in an in-depth interview (IDI). Opinion Dynamics chose a census approach to obtain our sample for the IDIs. We randomized the list of 71 customers and called each customer at least once. The

[4] The trial study instructions that were included with the kits recommended locations and fixtures as well as listed specifications for each of the lamps. Appendices B and C provide the materials sent to the customers.

evaluation team completed IDIs with the first 20 customers willing to do so. Overall, 21 customers (30%) refused to interview and 50 customers (70%) could not be reached.

Through the IDIs, the Opinion Dynamics team collected qualitative information on customer opinions, preferences, and practices related to LEDs and lighting in general. This information will answer the following research questions: (a) satisfaction with and perceptions of LEDs, (b) likelihood to purchase LEDs, and (c) required/preferred attributes of lighting and how LEDs do/do not meet these requirements. The IDI guide, including questions asked of customers, is included in Appendix E: In-Depth Interview Guide.

2.5 LATENT CLASS DISCRETE CHOICE ANALYSIS

The evaluation team conducted an LCDC analysis with the objective of segmenting SCE's customers based on their lighting product attribute preferences. Our LCDC study involved two "shopping exercises" completed by customers of varying experience with LEDs. Using the results, we developed eight distinct "purchaser groups" (four for each product category, A-Lines and Reflectors) that highlight the different trade-offs and purchase considerations made by SCE's customers.

LCDC Methods

The LCDC approach generates purchaser groups by identifying product attribute preferences through a trade-off analysis. Each of the two surveys (described below) consisted of "store visits" where customers select their ideal lighting products for purchase based on their "attributes." Attributes included, for example, technology type (LED, CFL, etc.), brightness, color, price, and brand. "Products" and their assigned attributes were presented via familiar "Lighting Facts"[5] labels to aid in the clarity of options available. An example of the shopping exercise completed by customers is included in Appendix A: LCDC Final Instrument.

Each product is assigned attributes to ensure that each attribute is perfectly uncorrelated with all other attributes. This enabled us to identify the importance of attributes "all else equal," or regardless of the other attributes of the product being considered. For example, when customers select wattage, this is not correlated with energy savings.

Customers go through mock store visits eight times for A-Lines and eight times for Reflectors. For each visit, customers choose to purchase the product they are *most* likely to buy based on the product attribute levels as well as products they are *least* likely to buy based on the product attribute. They can also choose not to buy at all. In this way, the exercise closely mimics actual shopping experiences.

[5] "Lighting Facts" are voluntary labels sponsored by the U.S. Department of Energy that present the specifications for energy efficient lighting products. For more information, please visit: www.lightingfacts.com

LCDC Surveys

Overall, 252 customers completed the LCDC surveys, but 28 customers did not complete the Reflector proportion of the shopping experience (bringing the sample size for Reflectors to 224).

Two samples were used in the analysis meant to represent the general population and the "experienced" customers.

Table 7. LCDC Surveys Sample Sizes

Survey	A-Line Respondents	Reflector Respondents
General Population Survey	181	155
"Experienced" Customers Survey	71	69
Total	**252**	**224**

General Population Survey

A total of 181 customers completed the general population survey. The general population survey was completed by customers who had little to no experience with LEDs. The results of this survey represent the lighting product market currently, before the mass-scale introduction to LEDs.

"Experienced" Customer Survey

As described in the In-Home Customer Lamp Trial (Lamp Trial) methodology section above, 97 customers participated in the Lamp Trial and of these 71 completed an online survey that included the shopping exercise (2 did not complete the Reflector portion). Because these customers had the opportunity to experiment with LEDs in their home for an average of eight weeks, the results from this "experienced" customer survey represent the residential lighting market once LEDs have fully entered it and most consumers are aware of or have experienced LEDs.

LCDC Segments

Assessing Customer Interest in Non-Incandescent Bulbs

In the research plan, one of the activities was to learn more about the various factors customers might consider when purchasing bulbs, what features are attractive to them, and what characteristics of the customer trigger decisions to participate. Understanding these issues could help program planners modify the design of their programs as well as deepen their understanding of markets.

Data were collected from a representative sample of residential customers who were asked to state their preference for different kinds of bulbs. Such an analysis is called a stated preference study, the methods for which are presented next.

Experimental Design

In the experimental design phase of the project we create product offerings that respondents will see in hypothetical stores. During the survey, respondents are asked to choose between these offerings. In building a design, we adhere to two principal objectives. First, we want the product attributes to be completely uncorrelated with each other; second, we would like each level for every attribute to appear an equal number of times throughout the entire design. The statistical terms for these desirable characteristics are orthogonality and balance, respectively. The better the orthogonality and balance are, the more efficient the design.

Fortunately, the research community has assembled an extensive library of arrays that meet these criteria. A particular class of arrays having perfect orthogonality and balance is the set of orthogonal arrays, two of which were used to develop the experimental designs for this study. Appendix I presents these arrays in detail.

Latent-Class Discrete Choice Analysis

Understanding the following technical discussion is not necessary to understanding the ultimate results of this analysis and its value. However, this technical discussion may be of interest to some.

A major task of the project was to generate latent-class discrete-choice (LCDC) models of non-incandescent bulb demand. This methodology combines the strengths of latent-class analysis and discrete-choice estimation in a single analytical framework. The discrete-choice component helps inform the relationship between independent variables such as bulb type and life, respondent characteristics such as gender and past purchase habits, and the probability of future bulb purchase. The latent-class component tested for the existence of separate customer groups who respond to these variables in distinct ways.

Classification is based on a probability model. For each respondent, the technique calculates a probability for membership in each class, the probabilities summing to one for a given respondent. In so doing, the approach creates a profile of class membership across the sampled population.

To estimate customer purchaser groups, we employed a LCDC methodology developed by Jay Magidson and Jeroen Vermunt (2003). For notation, i represents one respondent among the total number of respondents I. We presented each subject i with S choice sets consisting of K alternatives, where k is a particular alternative in choice set s. Each alternative k is described by a set of attributes A, where a is a single attribute. Let y_{is} represent the choice respondent i makes among the K alternatives in choice set s. More generally, let vectors $\mathbf{y}_i$, $\mathbf{z}_{iatt}$ and $\mathbf{z}_{icov}$ refer respectively to all responses, attributes and covariates for individual i. In this sense, attributes are characteristics of alternatives presented to subjects, and covariates are characteristics of the subjects themselves. Within this context, z_{iasatt} represents the attributes of a single alternative k evaluated by subject i in choice set s, and z_{icov} represents the set of R covariates describing subject i. We will also estimate the probability that each respondent falls into a latent class x, where x is an integer value $1 \le x \le C$, where C is the total number of latent classes.

For each latent class, a conditional logit model is estimated, using the form:

$$P(y_{is} = k \mid z_{is}^{att}) = \frac{e^{V_{k|z_{is}}}}{\sum_{k'=1}^{K} e^{V_{k'|z_{is}}}} \qquad \text{Eq. 1.}$$

Where $V_{k|z_{is}}$ is the systematic component in the utility of alternative k for subject i in choice set s, and k' is an index for each alternative in K. V, sometimes called representative value, is a linear combination of part-worths and attributes, plus an error term ε that is assumed to have a Gumbel distribution.

$$V_{k|z_{is}} = \sum_{a=1}^{A} \beta_a^{att} z_{iask}^{att} + \varepsilon \qquad \text{Eq. 2.}$$

For simplicity, we will omit the error term below and focus on the systematic component of utility. Also, note that this particular specification omits alternative-specific constants, though other specifications sometimes include them.

In a latent class (sometimes called finite mixture) model, individuals are assumed to belong to latent classes that differ with respect to one or more of the β parameters. The choice probabilities therefore depend on latent class membership x, and the logit model takes the form:

$$P(y_{is} = k|x, z_{is}^{att}) = \frac{e^{V_{k|x,z_{is}}}}{\sum_{k'=1}^{K} e^{V_{k'|x,z_{is}}}} \qquad \text{Eq. 3.}$$

The term $V_{k|x,z_{is}}$ represents the systematic component of the utility of alternative k within choice set s for respondent i, who is a member of latent class x. The representative value equation therefore becomes:

$$V_{k|z_{is}} = \sum_{a=1}^{A} \beta_a^{att} z_{iask}^{att} + \varepsilon \qquad \text{Eq. 4.}$$

Therefore, the only difference between this version and the aggregate model is that the β parameters are class-specific.

The probability density associated with the LCDC model is:

$$P(y_i|z_i) = \sum_{x=1}^{C} P(x) \prod_{k=1}^{K} P(y_{is}|x, z_{is}^{att}) \qquad \text{Eq. 5.}$$

Here, P(x) is the unconditional probability of belonging to class x. It is also the size of class x. We will show that we can modify this probability so that it depends on an individual's covariates z_i^{cov}, so P(x) is replaced by P(x | z_i^{cov}).

As the above equation implies, the y_{is} choices from each set of alternatives are assumed to be independent of each other given class membership. This is equivalent to the assumption of local independence common in latent class models. Responses are also assumed to be independent conditional on the value of the random coefficients.

Covariates

Our LCDC model includes covariates, which are used to predict class membership. With covariates, the model specification changes to:

$$P(y_i|z_i) = \sum_{x=1}^{C} P(x|z_i^{cov}) \prod_{k=1}^{K} P(y_{is}|x, z_{is}^{att}). \quad \text{Eq. 6.}$$

Now we assume that class membership of individual i depends on a set of covariates z_{icov}. We accomplish this by specifying a multinomial logit model in which class membership is regressed on covariates:

$$P(x|z_i^{cov}) = \frac{e^{m_{x|z_i}}}{\sum_{x'=1}^{C} e^{m_{x'|z_i}}}, \qquad \text{Eq. 7.}$$

Where m is a linear combination of parameters and covariates:

$$m_{x|z_i} = \delta_{0x} + \sum_{r=1}^{R} \delta_{rx} z_{ir}^{cov}. \qquad \text{Eq. 8.}$$

Here δ_{0x} represents the intercept or constant term corresponding to latent class x, and δ_{rx} represents the coefficient for the r^{th} covariate for class x.

Notice that the treatment of covariates differs from the one often employed in traditional logit specifications. For traditional logit models, covariates are often evaluated using specifications that involve interaction terms in which one or more covariates (e.g., gender) are interacted with one or more attributes (e.g., price). If the resulting coefficient(s) pass significance tests, one cannot reject the hypothesis that members of the covariate group express different utilities for the interacted attributes. Formally, a traditionally specified logit model with covariates looks like:

$$P(y_{is} = k|z_{is}) = \frac{e^{V_{k|z_{is}}}}{\sum_{k'=1}^{K} e^{V_{k'|z_{is}}}} \qquad \text{Eq. 9.}$$

where

$$V_{k|z_{is}} = \sum_{a=1}^{A} \beta_a^{att} z_{iask}^{att} + \sum_{b=1}^{B} \beta_b^{cov} z_{ibsk}^{cov} + \sum_{c=1}^{C} \beta_c^{i} z_{icsk}^{att} z_{icsk}^{cov} + \varepsilon. \qquad \text{Eq. 10.}$$

By contrast, LCDC models do not allow for interactions between covariates and attributes because of the separate and distinct role each plays in specification. In the LCDC specification, covariates are used to model the probabilities of membership in each latent class. The latent classes themselves are groups of respondents that share a common set of utilities expressed in their selections among alternatives with different attributes. The function that was served by using interactions between covariate and attribute terms in the traditional specification is served by latent classes in the LCDC specification.

Estimation

Latent-class models assume that a sample population consists of discrete segments, each of which is characterized by a separate logit model relating participation to a set of independent variables, and within each of which the IID assumption[6] holds. Not only are these models less restrictive than aggregate logit, they also can reveal insights into marketing strategy that aggregate models miss. In essence, they assume that individual tastes are homogeneous

[6] Independent variables are assumed to be Independently and Identically Distributed (IID), such that the off-diagonal elements of the variance/covariance matrix are zero.

within classes but heterogeneous between classes. Marketing executives will recognize this as the underlying premise for the theory of market segmentation.

Latent-class choice models describe relationships between a number of elements such as program attributes, covariates that describe individual respondents, and segment membership. For each segment, a logit model relating product attributes to purchase decision is estimated, while simultaneously calculating at the individual level probabilities of membership in each segment. Using covariate values, separate logit models are estimated concurrently to predict membership in each segment. This entire process is repeated for different segment counts, assuming that the total number of segments is 1, 2, 3 … n, and the "best" model is chosen based on the calculated Bayesian Information Criterion (BIC) for each iteration. Significance tests are applied to each parameter, as are Wald tests for equality of parameters across all segments.

For both A-Line and Reflector models we tested a number of attributes hypothesized to affect bulb choice. The following tables list these attributes, including the variable abbreviations used in the model summary later in this section and the description of attributes and levels provided to respondents. The tables also list special variables that were included in the model but because they were derived from manifested attributes were not shown to respondents.

Table 8. Variables Available for Latent-Class Discrete Choice Models

Attribute	Level	A-Line	Reflector
None of these	Prefer not to buy	√	√
Bulb type	LED - A-Lamp [appears twice]	√	
	CFL	√	
	Halogen	√	√
	LED - PAR Reflector		√
	CFL Recess		√
	LED - Recessed Trim		√
Brand	Familiar brand	√	√
	Unfamiliar brand	√	√
Outlet	Lighting store	√	√
	Drug store	√	√
	Hardware store	√	√
	Online lighting-only store	√	√
	Big-box mass retailer	√	√
	Grocery store	√	√
	Big-box building supplies retailer	√	√
	Online retail store	√	√
Price	$1	√	
	$5	√	√
	$10	√	
	$15	√	
	$20	√	
	$25		√

Attribute	Level	A-Line	Reflector
	$30	√	
	$40		√
	$50	√	√
	$65		√
	$75	√	√
	$100		√
Brightness, wattage equiv.	40 Watt	√	√
	60 Watt	√	√
	75 Watt	√	√
	90 Watt		√
	100 Watt	√	
Color temp.	2700K (warm white)	√	√
	4100k (cool white)	√	√
Energy Star	Energy Star	√	√
Beam angle	180 degrees	√	
	270 degrees	√	
	Flood		√
	Spot		√
Glare	Glare		√
Dim-able	Dim-able	√	√
Life (yrs)	2 years	√	√
	8 years	√	√
	20 years	√	√
	30 years	√	√

Calculated variables

In addition to the above variable set, two other variables, **Energy Savings Over 10 Years Compared to Incandescents** and **Total Savings Over 10 Years Compared to Incandescents**, were calculated for each bulb presented to respondents. The difference between the two was the cost of bulb purchases over 10 years, such that

Total savings = Energy savings – Bulb costs.

Where,

The first component, Energy Savings, was calculated as

$$Energy\ savings = Energy\ cost_{Equivalent\ incandescent} - Energy\ cost_{Product}$$

Energy cost for a given bulb was calculated as

$$Energy\ cost_{bulb\ type} =$$

$$10 \times Wattage_{Incandescent\ equivalent} \times Avg\ yearly\ usage \times Electricity\ rate \div 1000$$

Appendix J contains the lookup tables used in these calculations.

The second component, Bulb Costs, was calculated as the total cost of bulb purchases required over 10 years, assuming like replacement, if necessary.

$$Cost_{bulb} = \frac{10\ (yrs)}{Life\ (yrs)_{bulb}} \times Price_{bulb}$$

Calculated energy costs for each bulb were shown to respondents, but total costs were not. We included total costs as independent variables in our models to test whether respondents were making total cost calculations, if not explicitly then at least on some intuitive level.

Parameters of the LCDC models were estimated using a combination of Expectation-Maximization (EM) and the Newton-Raphson variant of Maximum Likelihood (ML) estimation. Random points were chosen as seeds to begin the estimation process. EM is typically chosen to get the estimates close to a solution, then the algorithm switches to ML to speed up convergence and provide estimates for parameter variances. Wald tests are conducted for parameter significance and equality across classes. Separate Wald statistics test the significance of covariates.

3. LED MARKET PRICING TRIAL

In this section, we report our findings for the LED Market Pricing Trial (Pricing Trial). The Pricing Trial was conducted using a field test and quasi-experimental design to obtain insight into optimal incentive levels for LED market interventions. Specifically, our team worked with SCE to develop a field test plan in which various big box retailers were assigned incentive levels for an upstream buy down across SCE's territory. Incentive levels were assigned to ensure that each incentive level varied by socio-economic status of a region, location (central vs. remote), and store type. The field test design was developed and modified throughout the course of the test due to varying levels of engagement and compliance among retailers. Weekly sales were then collected to examine price effects, or elasticities, based on sales volumes and incentive levels. We detail the data characteristics, our findings from three price elasticity models, and limitations to the study in this section.

3.1 ANALYSIS OF THE DATA

3.1.1 DATA CHARACTERISTICS

The primary unit of analysis for this test is average weekly sales of program LED lamps observed across retail stores in SCE's territory during the trial period (October 28, 2011 through July 9, 2012). Retailer start dates varied within these dates based on when individual stores[7] came into the program and when they sold out of the incentive allocations for lamps included in the Pricing Trial. In most analyses, the full period of each store's participation was included in the models.

Table 9 provides some summary descriptions of the products and their sales. The dataset contains 687 unique retail store-model combinations that were the basis for the results reported here. Some stores carried models resulting in no sales. These provide the baseline of comparison for the products and stores that were incented.

Table 9. Summary Facts about Program Products

Summary Facts	A-Lines	Reflectors	Total
Number of Models	4	14	18
Price Range	$3.99-$36.98	$7.99-$59.98	$3.99-$59.98
Total Sold	25,031	636,502	661,533
Number of Store-Model Combinations	144	547	687
Number of Stores with at Least One Model with No Sales	4	102	106
Number of Models with No Sales	3	10	13

[7] Store refers to the individual locations within a given retail chain.

We provide sample allocation tables and our data cleaning steps in the methods section of this report.

3.1.2 Discussion on the Data

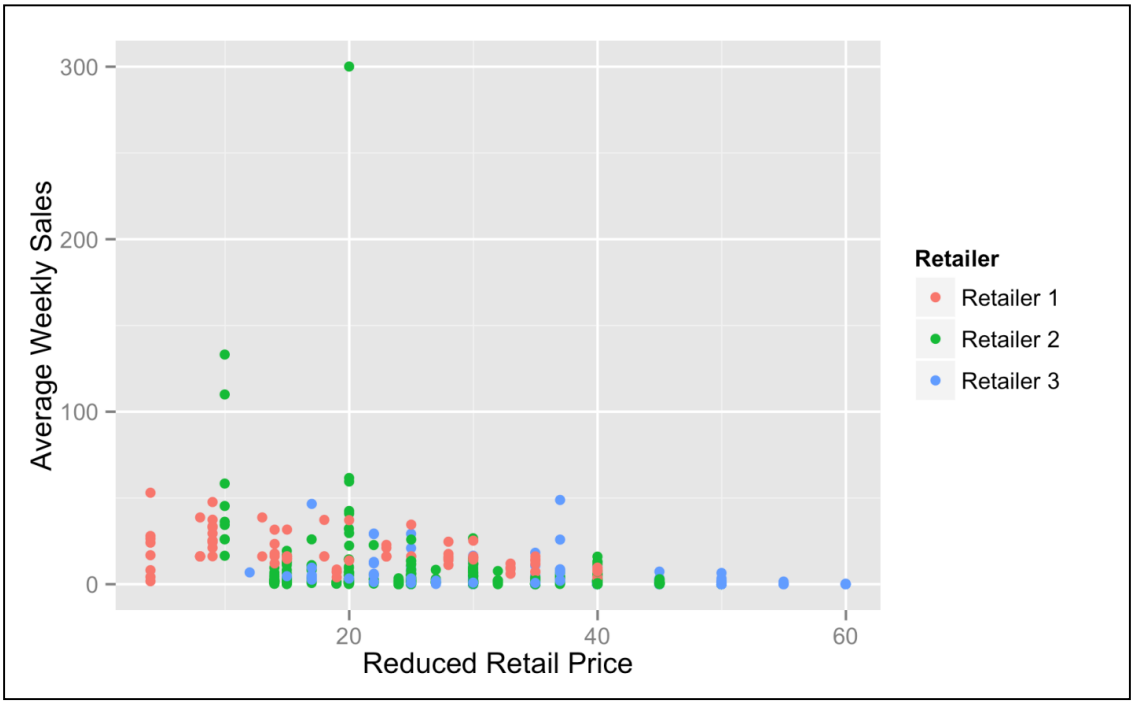
In this section, we discuss several factors that are important to understanding our modeling approach.

- **Historic sales data was not available to serve as a baseline for sales volume on many of the incented lamps.** Two types of LED ambient lighting products were tested, A-Lines and Reflectors. Some analyses treat them separately, and some combine them. Our team attempted to collect pre-trial sales data for each lamp by store and retailer. However, this was not possible largely because most products offered during the trial were new to the market. This Pricing Trial started in the infancy of high quality ambient LEDs in the retail market place. To give perspective, only one omnidirectional Energy Star labeled A-lamp was on the shelf in SCE territory. That A-lamp was priced at $45. By the time the test was complete, five such A-lamp brands were available and most bore regular prices near the $20 range.
- **Store locations varied in the speed with which lamps were sold during the Pricing Trial.** The success of the program brought out two data issues for our elasticity analysis. First was a small set of stores with very high levels of sales and the second was stores reaching their limit of sales and stopping the incentive. We discuss each next.

Here, we detail the implications on our data as a result of these two limitations.

Three stores were extreme outliers based on sales volume. Two were 10 standard deviations above the sample mean, and one was more than 30 standard deviations above. Figure 1 is a scatter plot of average weekly sales by program retail price to demonstrate the outliers.

Figure 1. Average Weekly Sales of Stores by Program Retail Price



The three extreme outliers were dropped for the elasticity analyses to improve the model fit. Notably, the results did not vary dramatically when these three outliers were included[8]. We also did not feel certain these sales figures were valid data entries.

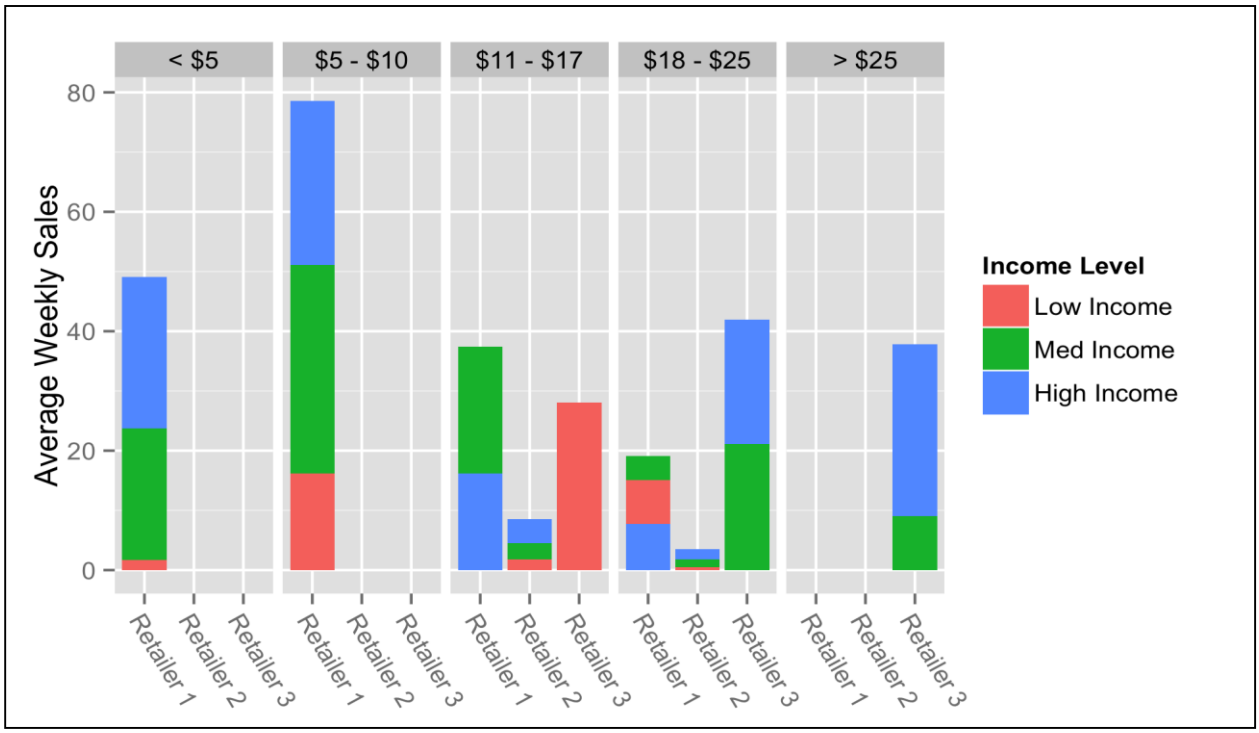
The second challenging issue that the team faced was a clear "ceiling effect." This effect occurred when the high-incentive stores sold out of the lamps creating a ceiling on the number of lamps sold at a given incent level. Due to program budgets, incentives could not be supplied in large enough volume to counteract this effect. As a result, sales ceilings created a suppressing effect on estimated elasticities by artificially driving down effects (sales) for higher incentive levels. However, the suppressing effect was expected by the Program Manager in allocating quantities and even where it appeared, it generally supported the finding of sales increases associated with the higher incentive levels. Exact price elasticity figures of higher incentives were not needed or expected for energy efficiency program.

After removing the outliers, we graphed the sales by pricing groups to visualize what the price effect might be without modeling. We saw somewhat surprising results that required us to consider additional approaches. Figure 2 shows average weekly sales by price ranges for A-Lines. Categorizing prices into ranges presents an imperfect picture, but the graph does show that the lower-priced bulbs had less sales than the next higher range of bulb prices very likely

[8] All three of these store-model combinations had high incentives that took their prices to quite a low point. They were also sold much past their allocations, funded by the store. This is likely a part of the explanation for why sales were so high, but these factors can't be the entire explanation since quite a few other models with high incentives and that sold past their allocations were not close to this level of sales, and others didn't even sell to their allocations.

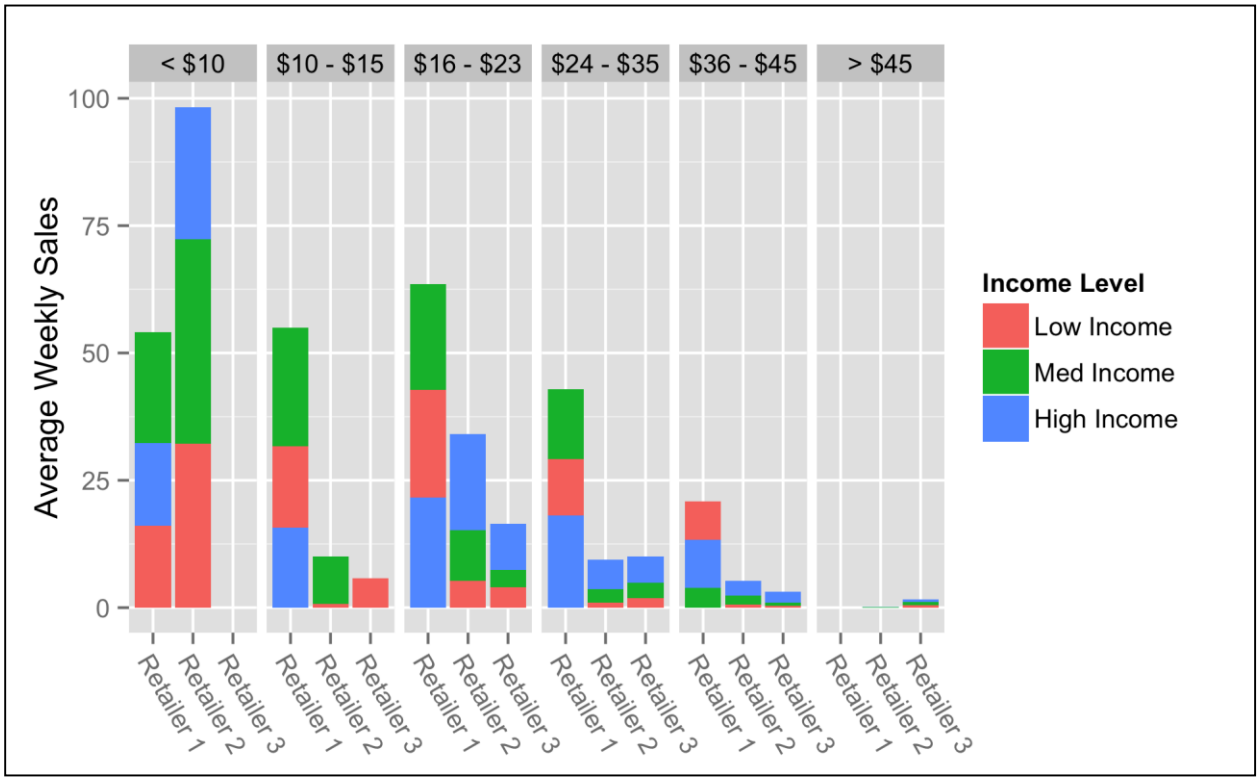
representing the ceiling effect of allocations, especially for lamps priced below $5 for A-Lines. Other ceiling effects may also be present but appear less obvious. Figure 3 shows a similar picture for Reflectors. It incorporates stores that did not go above the ceiling as well as those that exceeded the quotas in program price but without the expectation of being reimbursed for them. These are distorting factors that had to be dealt with at the modeling stage of analysis.

Figure 2. Average Weekly Sales by Price Category, Neighborhood Income, and Retailer: A-Lines



Both figures also show a clear and large effect of retailer. The retailer effect would appear even more pronounced had the three outliers been included in this graph since all three of them were Retailer 2 stores. They were not included in these graphs because they would have changed the scale of the graph too much to be useful in analyzing the rest of the store-models.

Figure 3. Average Weekly Sales by Price Category, Neighborhood Income, and Retailer: Reflectors



3.1.3 THREE MODELS ESTIMATING PRICE ELASTICITY

To explore the ceiling, or censoring[9] effect and its influence, we estimated three models with different characteristics to estimate price elasticity. The idea of this approach was to conduct a sort of sensitivity analysis to see how much of an effect the censoring was having.

- **Model 1** provides elasticities based on all observations except the three outliers. This will include the ceiling effect of allocation limits.
- **Model 2** uses the peak sales week as a measure of sales in place of the average weekly sales. This model is much less affected by limited allocations. It also includes the three outliers since their peak-week sales are less far from the mean than was true with other measures of sales.
- **Model 3** excludes the stores that sold exactly their allocation. This model gives us an estimate of price elasticity that is less biased by allocation since we would not include

[9] Censoring is a term used by statisticians to describe a dataset where a variable is sometimes not observable beyond a certain value for some or all cases. In this case, the distribution of the sales variable is "right-censored" indicating that values above the allocation level for that store-model are not observable because the price of the item would have gone back to the regular retail price, thus reducing sales, and/or the model was no longer carried, so that sales could not accrue beyond the allocation.

those stores where the ceiling was hit. The downside of this approach is that the model is based on fewer observations.

- It would have been ideal to estimate models designed specifically to correct for the "ceiling" or censoring effect. However, the methods in common use are not available in statistical packages for fixed-effects models, and fixed-effects models were necessary for this study because of the absence of consistent baseline sales for all models in all stores.

All models estimated provide statistically significant results.

Table 10 summarizes the results of the three approaches to estimating elasticities. All three are based on fixed-effects models, meaning all store-specific factors that do not vary over time or product models are controlled. We summarize our model results at a high level below:

- **Model 1**, which includes all observations, indicates that for every 1% decrease in price, there is a 1.14% increase in A-Line sales. For Reflectors, a 1% decrease in price means 3.25% increase in sales. (See Appendix for tables of model coefficients).
- **Model 2** deals with the ceiling effect of allocations by basing the model on only one week of sales, the week chosen being the week with maximum sales for each store-model combination. This approach produces an A-Line estimate of a 1.06% increase in sales for each 1% decrease in price. For Reflectors, the increase in sales would be 2.51%.
- **Model 3** handles the ceiling effect by eliminating the 71 store-model combinations where the quota was sold and was not exceeded. In this approach, the A-Line elasticity is 1.14%, and the Reflector elasticity is 2.88%.

Table 10. Three Estimates of Elasticities

Elasticity	All Observations (Recommended Estimate)	Maximum Sales Week	Eliminates Store-Models Sold "Just At Quota"
A-Line	-1.13501	-1.063419	-1.13618
Reflector	-3.25413	-2.510165	-2.87735

We recommend that SCE use the first approach that includes all store-model combinations except the three outliers. All three of the fixed effects models produced similar elasticity values, indicating that this dataset consistently reports LED lamps as a highly elastic product. However, based on the available data, this model provides the most reliable elasticity result for several reasons:

1. This dataset includes all of the potential data, so it captures as much of the information as possible from the study outputs.
2. As compared to the peak weekly sales model, the data in the average weekly sales model provide a more realistic scale of the difference between the zero and low incentive prices and the high incentive prices. Because the peak weekly sales model

selects only the highest sales week for all store model units, it gives greater leverage to the low sales units by focusing on the one week that those units actually sold a lamp. The peak week gives less leverage to the store-model units with consistently higher weekly sales. The peak weekly sales model also loses much of the variability in the low incentive prices, since a store-model unit that sold a cumulative total of two would have the same dependent variable value in the model calculation as a store-model unit with a cumulative sales of twelve, but sales of one or two lamps each week over the program period.

3. As compared to the model excluding the "just at allocation" store model units, the average weekly sales model better captures what is happening at the high incentive prices in Reflector lamps. Because all of the "just at allocation" store model units were Reflector lamps with $15-$25 incentives, the model excluding the "at allocation" lamps effectively gave greater leverage to the high incentive store model units that sold over their allocation. While, in theory, the additional models would have helped correct for the "ceiling effect," practice, those models hit other limitations of the dataset.

4. As is commonly practiced, certain parts of the sample were eliminated from the test due to unacceptable fit statistics. For this test, removals included the three highest-selling store-model combinations were eliminated from modeling. These cases were all Reflectors at a high-incentive rate ($20-$25), and the stores allowed sales at that price to continue beyond the set quota. These were real sales and may indeed indicate how fast these lamps would sell at that price. This implies the advisability of using the approach that produces the highest elasticity for Reflectors as we have recommended. It bears noting that had all stores continued sales beyond their quotas once they reached them, the three store-model units probably would not have been outliers and would therefore have stayed in the model.

Table 11, Table 12, and Table 13 show the coefficients that were the output from the three elasticity models.

Table 11. Fixed-Effects Model Estimating Price Elasticities: All Observations

Variable	Coefficient	Std Err	t-Value
log(Program Retail Price)	-1.13501	0.34219	-3.317
A-Line	2.45094	1.14836	2.134
Reflector Dummy	9.85416	1.13638	8.672
log(Program Retail Price) X Reflector	-2.11912	0.30903	-6.857
Note: Adjusted R-squared=.5458, F=7.85, df=120, 564, p < 0.0001			

Table 12. Fixed-Effects Model Estimating Price Elasticities: Peak Sales Week

Variable	Coefficient	Std Err	t-Value
log(Program Retail Price)	-1.063419	0.287906	-3.694
A-Line Dummy	4.317982	0.956939	4.512
Reflector Dummy	9.593398	0.934832	10.262

Variable	Coefficient	Std Err	t-Value
log(Program Retail Price) X Reflector	-1.446746	0.260177	-5.561
Note: Adjusted R-squared=.8135, F=26.3, df=119, 571, p < 0.0001			

Table 13. Fixed-Effects Model Estimating Price Elasticities: Store-Product Combinations Selling at Quota Dropped

Variable	Coefficient	Std Err	t-Value
log(Program Retail Price)	-1.13618	0.3257	-3.488
A-Line Dummy	3.34885	1.15966	2.888
Reflector Dummy	9.71415	1.12314	8.649
log(Program Retail Price) Price): Reflector	-1.74117	0.30985	-5.619
Note: Adjusted R-squared=.5742, F=8.004, df=118, 495, p < 0.0001			

3.1.4 Non-Price Effects

Table 14 shows the results of a mixed-effects model (without store-specific intercepts) that contains both price and non-price predictors. This model was estimated in order to be able to study the non-price effects on sales. Therefore, the price effects shown in this table are not interpreted since they were better estimated and interpreted in the prior section with the fixed-effects models. The coefficients in Table 14 reveal a very strong retailer effect. However, interpreting them is complex due to the logged dependent variable and the fact that there are interaction terms involving retailer. Some specific interpretations of these effects are on page 41.

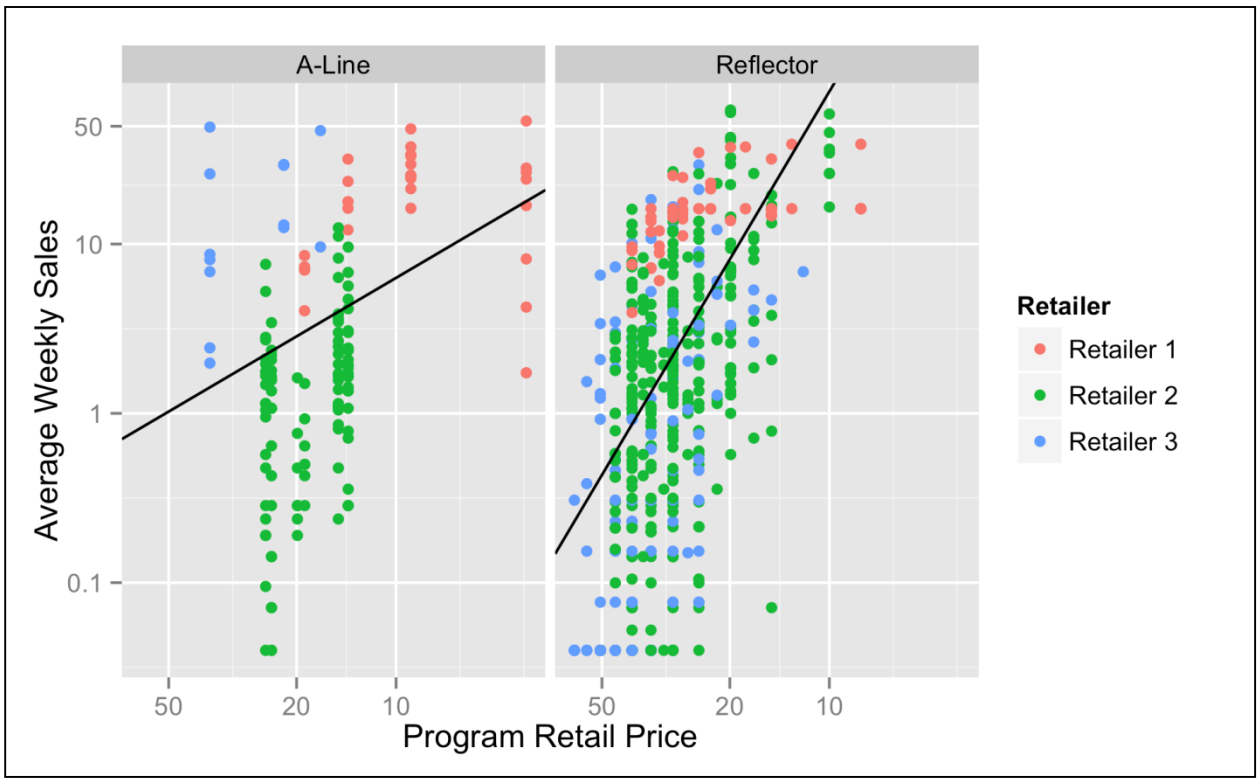
Table 14. Model of Price and Non-Price Factors Predicting Log of Average Weekly Sales

Variable	Coefficient	Std Err	t-Value
Intercept	1.81719	0.81293	2.235
log(Program Retail Price)	-0.14274	0.2924	-0.488
Retailer 2	2.29275	1.15693	1.982
Retailer 3	7.74467	1.77059	4.374
Reflector	4.80266	1.07345	4.474
Income Level 2	0.80334	0.19282	4.166
Income Level 3	1.41888	0.22371	6.342
Remote Location	-0.09298	0.14843	-0.626
log(Program Retail Price) X Retailer 2	-1.35905	0.37174	-3.656

Variable	Coefficient	Std Err	t-Value
log(Program Retail Price) X Retailer 3	-2.90437	0.52323	-5.551
log(Program Retail Price) X Reflector	-1.35583	0.35724	-3.795

Figure 4 shows the relationship between price and sales (both in logged form) by retailer. The x-axis in each chart is the log of price (getting smaller as you move from left to right), and the y-axis is the log of average weekly sales. Each dot on the graph represents one unique store-model combination. The line that is drawn through the chart is the best-fit regression line that shows how sales tend to go up as price goes down. The A-Line chart reveals a clear upward trend for sales as price goes down. However, the Reflector chart reveals a much steeper incline for sales as price goes down. This indicates a strong price effect for both, but especially for Reflectors. In addition the color of the dots represent the three retailers in the study.

Figure 4. Scatterplots of Log(Average Weekly sales) by Log(Program Retail Price) and Retailer: A-Lines and Reflectors



Income shows a smaller, though statistically significant effect. The model also confirms what we have seen in other parts of this study, namely that Reflectors appear to be the more popular product compared to A-Lines, although this depends on the price points of each. Whether the store is located in a central or a remote location is not a significant factor in sales. This finding is a measured characteristic of the test conducted in the early introductory market phase, which could last a few years. Based on historic incandescent and CFL market

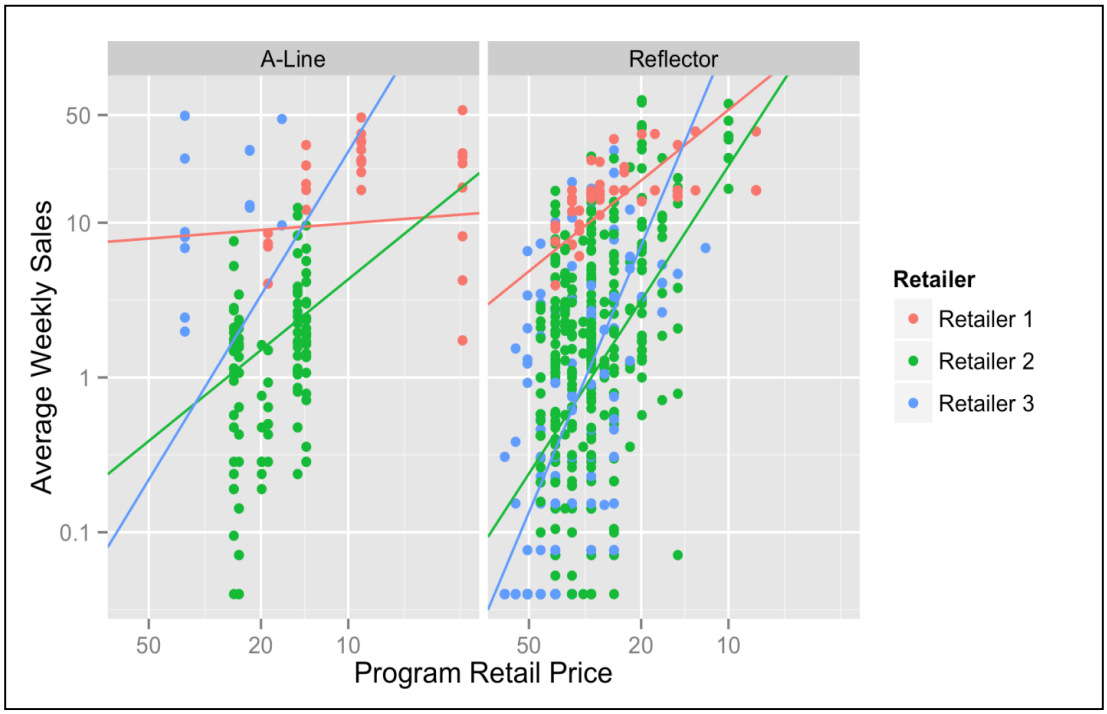
share tracking, the popularity of LED reflectors over A-Lines is not expected to sustain long term.

Evaluating the model allows us to provide further interpretations of these results:

- On average, LED lamp sales in high-income areas were 4.1 times higher than sales in low-income areas and 1.9 times higher than stores in medium-income areas when controlling for all other factors. We note here that this may not appear to be the case when examining the raw data, however covariates with medium-income store locations (such as retailer chain) may be driving middle income sales in the raw data. However, when controlling for these factors, we see that high-income have the greatest sales volume. On average, LED lamp sales in medium-income areas were 2.2 times higher than low-income areas.
- At a $20 price point, Retailer 2 sells 16% of the lamps sold by Retailer 1, although this percentage would be much higher if the three high-sales outliers were included because they were all from Retailer 2.
- At a $20 price point, Retailer 3 sells 40% of the lamps sole by Retailer 1.

This shows a clear retailer effect since the lines are not at all parallel. For A-Lines, Retailer 1 showed only a modest price effect on sales, while the other two showed quite steep lines, or strong price effects. For Reflectors, all three retailers show steep price effects on sales, but Retailer 1 is still less steep than the other two. For both types of lamps, Retailer 3 provided the strongest price effect as represented by its much steeper regression line than the other two.

Figure 5. (Log) Average Weekly Sales by (Log) Program Retail Price and Retailer



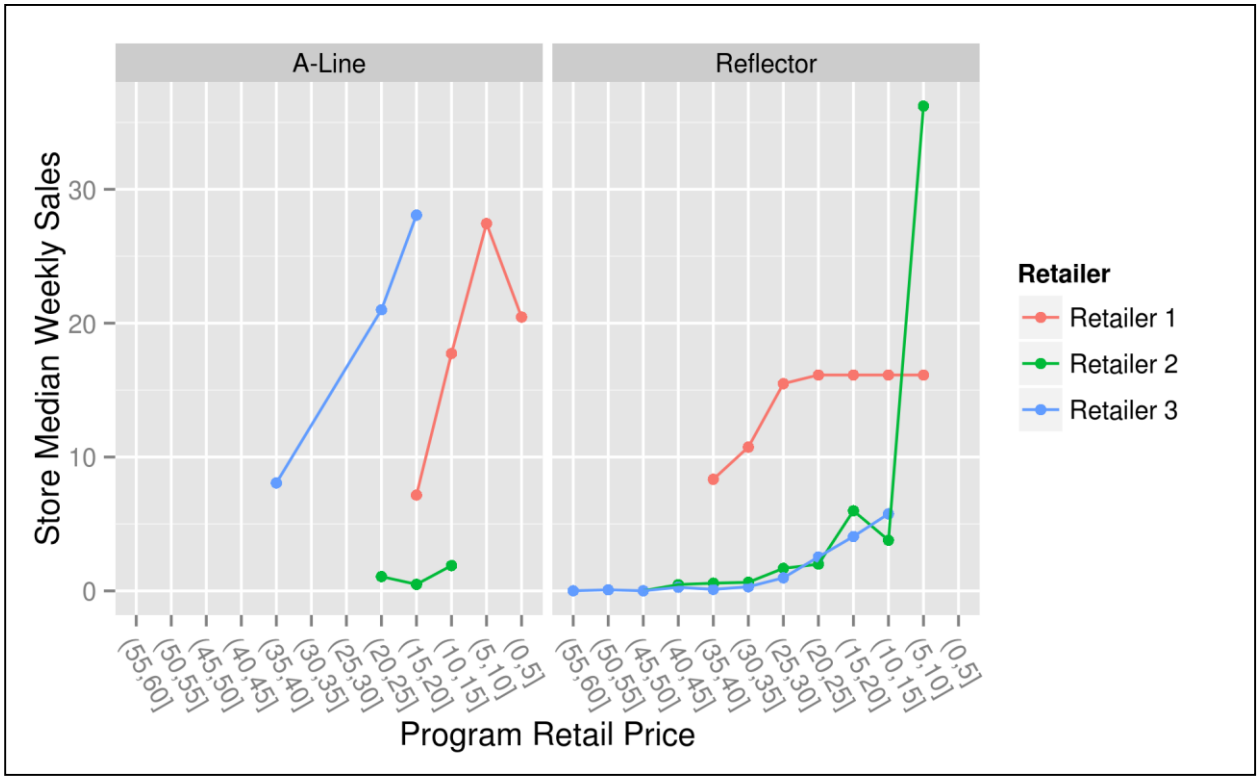
3.1.5 Optimizing on Price

A primary purpose of the test was to compare various prices and related factors that influenced sales, with the hope of discovering ways the Lighting Incentive Program could optimize incentives around discoveries pertaining to price. However, price optimization in the statistical sense was not part of the study design or data collection. The most desirable approach to optimization would be to determine at what price point (or range) sales are high enough with a low-enough incentive to support a positive benefit:cost ratio. This was not in the scope of the study and cannot be produced accurately with the data at hand. However, the Opinion Dynamics Team thought it would be useful to provide even a relatively crude look at where points of inflection on the price curve might be.

Figure 6 shows the median weekly sales rate at each $5 price point by retailer. Clearly, the answer is different for different retailers. For A-Lines, the sales curve does not seem to have an inflection point strong enough to make decisions from, regardless of retailer. The lower sales rate for Retailer 1 at the $0-$5 price almost certainly reflects the ceiling caused by the allocation quota at that price, so that point should be disregarded.

There is a much clearer picture for Reflectors. In this case, we might be tempted to disregard the very high sales level at the price level of $5-$10. However, this may be too drastic since it likely also represents a real situation of Retailer 2 continuing to sell lamps at a low price after the allocation ran out. Absent that point, a critical price point seems to be between $15-$20 for Retailer 2, and at $25-$30 for Retailer 1. After that point, sales do not increase much with a lower price, for this retailer.

Figure 6. Price-Sales Curve for A-Lines & Reflectors



Note: Graphic does not include three *very* high-sales outliers.

3.2 RECOMMENDATIONS

Conduct Additional Investigations of Pricing

- **Consider continuing the market Pricing Trial analysis to include a more formal analysis of price optimizations.** Our initial investigation of findings provides insight into price elasticities. We recommend that additional, follow-up research be conducted to estimate optimal price points for market adoption.
- **Develop market strategies that account for specific retail, income, and technology differences in market uptake.** Our analysis demonstrated that customer response to price drops differs dramatically by technology type, income levels, and retailer. SCE should consider these differences when developing a market strategy for incenting LEDs.
- **Aim to bring LEDs down to the same price range as CFLs.** Both our Pricing Trial and Focus Group data indicate that customers will not spend a premium on LEDs (with the exception of reflectors due to their longevity, though this is a modest premium). As such, SCE should develop strategies that consider customer acceptance of LED prices and current cost of CFL lighting along with the aforementioned insights gained in the Pricing Trial.

4. DRIVERS AND BARRIERS TO LED ADOPTION

In this section, we discuss customer drivers and barriers to LED adoption. The findings presented here are derived from the LCDC, focus groups, and in-depth interviews (IDIs) with Lamp Trial participants. We have organized our findings from these efforts into a three-staged process, each with unique drivers and barriers to LED adoption.

- **General Perceptions of LEDs (Un-experienced):** In the first section, we present our findings on customer attitudes and perceptions about LEDs before they experience them, and whether or not they intend to try them. These findings represent the residential lighting market as it stands today.
- **Customer Purchase Preferences at the Shelf:** The second section summarizes findings from our IDIs and LCDC study to explore the key purchase considerations made by customers when they are at the shelf.
- **Satisfaction with LEDs (Experienced)**: The third section, drawn from our IDIs, presents customers' attitudes towards LEDs after having a chance to learn about them and experiment with them at home. These findings give us insight into what customers consider to be the key markers of design quality for LEDs (and lighting products in general) and motivators for continued LED adoption as LEDs become more commonplace in the future.

4.1 GENERAL PERCEPTIONS OF LEDS (UN-EXPERIENCED)

According to a shelf study performed in 2012, only 4% of current California consumers have experienced LEDs[10], indicating that the great majority of Californian's have not interacted with ambient LED products. For this reason, it is necessary to assess perceptions of LEDs and energy efficient lighting in general to examine barriers and drivers to LED adoption in the current market. To do this, we have drawn on our focus group findings derived from conversations with general market customers, known to have limited to no experience with ambient LEDs (un-experienced).Thus, these findings represent the attitudes and perceptions of customers today, when LEDs have just begun to enter the residential lighting market.

Drivers for Trying LEDs

Our findings indicate that unexposed customers are most receptive to the *longevity* claims of LEDs. As an extension of longevity benefits, customers are interested in the *convenience*

[10] June 2012. DNV KEMA Energy & Sustainability. "California LED Lamp Market Characterization Report". Prepared for the CA Public Utilities Commission (CPUC). Page 12.

benefits of longevity, which reduces the number of replacements over time. We describe each of these benefits in greater detail below.

When considering long-term value, customers considered life span a greater motivator for purchasing LEDs than energy savings. Customers see the energy efficiency of LEDs to be an important advantage when they compared them to other lighting technologies. However, while respondents thought of energy savings as a positive factor, they were more interested in long life and not having to replace bulbs frequently. One respondent said:

> *"I think I would see that [energy savings] as a bonus, you know? I mean the length of how long it lasts would be the primary. The fact that it reduces your energy output is good on your bill to some extent. … But it kind of wouldn't be the make or break decision. It would be more like the price for the life of it."*

During our focus group sessions, at least one respondent said that LEDs must have a longer life cycle to be worth the additional cost:

> *"If it's really going to last for 10 years… I mean if it is going to be more expensive then it would really have to last for 10 years."*

Lifetime and convenience are especially important for Reflector applications. Because Reflector lamps are often placed in hard-to-reach recessed or tracked lighting fixtures, convenience and lifetime become intertwined. A key factor in life cycle considerations was convenience of reaching the fixture where the bulb would be installed. During the focus group sessions, respondents mentioned that they would be especially interested in LED bulbs for out-of-the-way fixtures that they disliked changing.

Barriers to Trying LEDs

Most barriers to LED purchases stem from direct experiences with other energy efficient lighting, namely CFLs, and a lack of experience with LEDs. Key barriers included: price and quality concerns. We discuss each of these in detail in this section.

Price was mentioned as the top barrier to energy efficient lighting, especially in the case of LEDs. Several focus group respondents were hesitant to try LEDs due to the high price points. Many mentioned that they expected LEDs (and efficient lighting in general) to provide a return on investment and last over time.

> *"If you're going to pay like $10 for an LED bulb, you want it to work."*

Several respondents were unsure that they would buy multiple lamps.

> *"You're not going to buy them in bulk if they are $10 a piece."*

Note that these respondents defaulted to referring to $10 as the standard "expensive" price for a light bulb, not knowing what the actual cost of LED bulbs might be. For these respondents, therefore, these barriers are likely even more pronounced given the higher actual price of LEDs.

We discuss pricing and related lifetime expectations in further detail in the "Customer Purchase Preferences at the Shelf" section below.

Customers lack awareness and direct experience with ambient LEDs.

As would be expected of a product so new in the marketplace, lack of awareness was one key barrier to trying LEDs that we uncovered during our focus groups. When discussing LEDs specifically, only two respondents—one in each group—said they were previously aware of LED lighting.

Respondents had mixed interest in purchasing LEDs during the focus groups, with about half of respondents in each group saying they would be willing to purchase them. Of those who said they were not willing to purchase, however, most did not reject LEDs outright but instead wanted to know more information first:

> *"Might? I'd have to know more about it. I mean what are the features? What's it gonna do? I'd have to have more information. I couldn't just say because you pull something new out that I would use it. I need to know the bells and the whistles on it."*

Customers' first association with energy efficient lighting is with CFLs, and customer attitudes toward CFLs set the template for their expectations from LEDs. The first association in both focus groups with the concept of "energy efficient lighting" was CFLs. All respondents across both groups were aware of CFLs—although few participants were immediately familiar with the term itself, instead referring to CFLs as *"squiggly"* or *"the spiral ones."* All but one respondent had purchased CFLs in the past, and all but one said that they plan to purchase CFLs in the future.

Because CFLs are so pervasive and so heavily promoted for their energy savings, the focus groups generally demonstrated that they thought of "energy efficient lighting" as the same as "CFLs." Respondents often expressed general concerns with efficient lighting in terms of specific issues with CFLs. Because respondents' pre-existing awareness of LEDs was so low, they generally had no point of comparison between the two bulb types.

However, respondents knew very little else about how the two bulbs were different. This poses a major barrier for LEDs. Respondents were more cautious about LED purchases because of their perceptions of CFLs and negative experience with their past performance.

This was made clear through respondents' questions about LED performance based on their past experience with CFLs. Questions included bulb failure rates, the life cycle, energy usage, price, health, and disposal characteristics. These questions particularly related to the comparison between LEDs and CFLs.

> *"They are safer than the CFLs, right? … [meaning] there is no mercury in them."*
>
> *"Now what's the length of … the life of these compared to the fluorescent?"*
>
> *"Oh, overheating. Is there any chemicals that would be released if you, you know, I don't know, I don't know anything about it."*
>
> *"I have one [a CFL] that flickers off and on"*
>
> *"Especially with the dimmer lights? Yeah they wouldn't work with CFLs."*

Disposability of CFLs, and by extension all energy efficient lighting, was a particular concern during the discussions. Respondents in both groups expressed concerns about the special disposal requirements for CFLs, unprompted, during the general discussion of energy efficient lighting. One group quickly brought up mercury content as an association for all energy efficient bulbs:

> *M: What's the top of mind thing you think of? When I say energy efficient lighting?*
>
> *R1: CFLs.*
>
> *R2: Those are the spiral ones, right?*
>
> *R3: It stands for compact fluorescent light bulbs like those down there.*
>
> *R2: Oh ok.*
>
> *R4: Or LEDs.*
>
> *R3: I think mercury. I think I read that CFLs have mercury in them and if you break one in your house you are supposed to get out of the area for 15 minutes.*
>
> *R4: It's like hazardous, yeah.*

One respondent said that she did not plan to buy CFLs again specifically because of her concerns about their disposal and their mercury content. However, this respondent said that if LEDs addressed these issues, she would be very interested in them.

> *"I bought regular bulbs because I do not like the disposal problem with the other bulbs [CFLs]. I do not like the fact that they are not very bright. … And also the price was better. I'm sort of waiting for the LED bulbs to be more prominent because I am a rabid energy saver but the bulbs I don't like."*

4.2 Customer Purchase Preferences at the Shelf

During both the focus group studies and IDIs, respondents discussed the most important considerations they make when purchasing lighting products. Overall, these considerations remain consistent between respondents who have never tried LEDs and those who have had a chance to experiment with them (represented by the focus groups and IDIs, respectively). We discuss these findings in this section.

In addition, we find that the LCDC analysis supported our findings; price is the primary purchase driver for lighting across both A-Line and Reflector categories. After price, attribute preferences vary by category (A-Line vs. Reflector) at the point of purchase.

Customers Shop with an Application in Mind

Many focus group respondents indicated that lighting purchases are application-specific. Overall, respondents recalled or required a specific application, including fixtures, when

commenting on lighting attributes and lamp varieties, particularly when discussing specific considerations when shopping. In terms of attributes that they preferred, respondents said frequently that their preferences depended on where the lighting would be installed and how it would be used.

> *"So say you are at the shop and you know you are going to be shopping for your living room do you pick a different light than you would [another room]."*
>
> *"For the bathroom I have to buy a certain type. They have to be the round kind."*

Few respondents indicated that they purchase their lighting without a use in mind, although they acknowledge that "stocking" behavior is also common.

Respondents also said that it is often important for lights to "match" lighting that is nearby or grouped in a fixture. This is particularly an issue when a customer is replacing a bulb rather than buying one for a new fixture. One respondent said that they looked specifically for the right bulb to match the overall lighting array.

> *"Yeah, yeah you have to watch cause I've got 3 lights in my kitchen and then take the circular bulbs and I had to get the same… and it was hard. I have to find the exact same… cause one went out and I didn't want the light to be more warm or more cool than the other ones. So now I've kept the box of the one that works. And I take the box in and match it up with all the specifications."*

When considering purchasing LEDs, some customers were concerned about how a single LED fixture would fit within an overall lighting array, especially as it may lead to increased overall cost. While one LED might be expensive but manageable, the cost of replacing every light in an array may be prohibitively high:

> *"Well in my case I would buy one [LED], and the cost would really have to be a consideration. Because if I have to buy one it would be different from the other ones that I would have, 'cause you can see them. I like this (pointing to recessed LED light) because well… again if would have to be a cost issue because I have many that I would have to switch out."*

The preference for "matching" lighting became especially important as focus group respondents considered the design of the LEDs presented to them and how aesthetically different they appear from CFLs and incandescents.

Customers have very clear preferences for locations and fixtures that are prominent in the home, and these preferences differ between A-Lines and Reflectors. Table 15 and Table 16 below present the results of the installation sheets filled out by our Lamp Trial participants.

Table 15. Most Common Locations of Installed LEDs among Lamp Trial Participants

Lamp Shape	Installed Lamps	First	Second	Third
A-Line	306	Bedroom (33%)	Living Room (30%)	Kitchen (11%)
Reflector	209	Kitchen (34%)	Hallway (21%)	Bathroom (12%)

A-Lines are most popular in living spaces and Reflectors are most popular in spaces that require higher levels of brightness. About two-thirds of A-Lines (63%) were installed in bedrooms and livings rooms. Reflectors, on the other hand, are most common in work spaces that require good lighting (such as kitchens). Hallways were also popular locations for installing Reflectors, and this may be part because recessed lighting (the top fixture for Reflectors, as shown in the table below) is fairly common in hallways.

Table 16. Most Common Fixtures of Installed LEDs among Lamp Trial Participants

Lamp Shape	Installed Lamps	First	Second	Third
A-Line	306	Table Lamp (26%)	Recessed Ceiling (19%)	Floor Lamp (15%)
Reflectors	209	Recessed Ceiling (78%)	Flood Lighting (11%)	Wall Lighting (5%)

A-Lines and Reflectors are both common in recessed lighting fixtures. The vast majority (78%) of Reflectors were installed in recessed lighting fixtures. While table lamps are the most common fixture type for A-Lines, we also found that 51% of our trial participants placed at least one A-Line in a recessed ceiling fixture (19% of total A-Lines were installed in recessed ceiling fixtures). However, we suspect that this may in part be because trial participants lacked sufficient sockets for the A-Lines (most installed only one A-Line in a recessed fixture) or because of a noted preference to place energy efficient lighting in hard-to-reach and inconvenient places, noted in the focus groups.

Customers prefer putting energy efficient lighting (CFLs) in recessed lighting. We found that 62% percent of A-Line LEDs installed in recessed fixtures replaced CFLs of some kind. This suggests that customers have a general preference for installing energy efficient lighting in recessed fixtures.

Price and First Cost

During the LCDC segmentation process, choices made by respondents in the "General Population" and "Experienced" surveys revealed key purchase considerations made by customers when "at the shelf" (purchasing lighting products). The results of these surveys changed depending on whether the respondent was "shopping" for A-Lines or Reflectors. Table 17 below presents the results of this effort, showing the top four most important attributes by product category (A-Lines versus Reflectors). Overall, we found that price was

consistently the dominant consideration for lighting purchases. This finding is consistent with all other data collection efforts.

Purchase Preferences Vary by Category after Cost

When shopping for A-Lines, customers are most concerned with price (which comes first in importance) and the intangible benefits of lighting products. Technology (i.e. CFL, LED, or Halogen) is the third most important attribute when shopping for A-Lines, with many customers expressing a preference for CFLs, but only to the extent that energy efficient lamps offer customers value in terms higher energy and long-term savings (which is the second most considered attribute, indicating that efficiency is a major selling point for A-Lines.

Similar to when shopping for A-Lines, price is the first concern when customers shop for Reflectors. However, customers tend to take technology into greater consideration when purchasing Reflectors. As discussed in the "Customer Purchase Preferences" section, Reflector shoppers are much more interested in LEDs compared to when shopping for A-Lines. Also, customers are more concerned about where they shop for Reflectors. Brightness is also of special concern to Reflector shoppers. Our IDIs indicated that Reflector were especially popular for workspace applications (i.e., kitchens) where higher levels of brightness are required (for more detail, see the "Customers Shop with an Application in Mind" section above).

Table 17. Attribute Importance by Product Category

Bulb Attribute	Rank of Importance by Product Category	
	A-Line Segments	Reflector Segments
Price	First	First
Technology	Third	Second
Outlet	-	Third
Brightness	-	Fourth
Energy savings	Second	-
Long-term savings	Fourth	-

Overall, price remains the most important consideration for customers before and after trying LEDs, and CFLs are a benchmark for price and savings expectations. Regardless of experience with LEDs, CFLs were consistently used as a reference for the price of LEDs. Focus group respondents said that savings on the bulb would need to be at least as much as those of a CFL, with one saying that savings should be "*at least as much as you paid for the bulb*."

Customers will not pay more for LEDs after experiencing them, but customer do become more nuanced about what they are willing to pay for. We found during our focus groups that, before knowing much about LEDs, customers are willing to pay $5-$30 regardless of technology type. While our IDIs indicate that this price range remains about the same, customers who have

experienced LEDs have a more nuanced sense of what they are willing to pay for certain technologies. For A-Lines, customers were willing to pay between $2 and $10, pricing them in comparison to CFL bulbs. For Reflectors, customers were generally willing to pay a premium of $10-$20 dollars more than A-Lines.

Higher prices correlate to higher lifetime expectations. Customers expect energy efficient lighting to have a longer life cycle and be more reliable than standard bulbs. Before experiencing LEDs, focus group respondents indicated that they expect a lifetime of 5 to 20 years for more expensive lamps. During our IDIs, we found that, despite positive experiences with the LEDs, customers' willingness to pay more for LEDs still depended strongly on if they were absolutely certain they would get a long lifetime out of the product.

Outlet, Brand, and Label Preferences

Our findings from the focus groups regarding brand, third-party labeling and outlet preferences support the insight we gained from the LCDC surveys (as seen in the "Customer Purchaser Groups" section). Respondents in both qualitative studies indicated strong preferences for the stores at which they buy lighting products, and our LCDC results suggest that this outlet preference is even stronger when purchasing Reflectors. Notably brand and the ENERGY STAR label were not mentioned as a high priority among focus group respondents, and do not appear within the "top four" most important attributes drawn from our segmentation efforts. The following findings are drawn from the focus group studies. We note here that brand and third-party labeling were *not* mentioned during IDIs by any respondents as key purchase considerations for general lighting products or LEDs.

Outlet Preferences

Focus group respondents overwhelmingly said they purchased energy efficient lighting at home improvement stores. Store type played a much larger role in driving customer purchase decisions than brand. Several respondents mentioned that they would purchase light bulbs at other outlets (such as club stores or big box retailers) when it was convenient, but the only stores they would go to if they were specifically planning to make a lighting purchase would be home improvement stores. Respondents indicated that they have a higher level of trust in the quality of the products at home improvement stores than they do at stores such as discount retailers. One respondent said:

> *"I think if it's at a big, you know, [Home Improvement 1] or [Big Box 1] then you know it's going to be a quality product. But where it's being sold. … You know, I don't know if you would have the same level of interest if you saw the same product at a [dollar] store."*

Due to the application-specific nature of their bulb purchases, respondents in one group also agreed that they preferred home improvement stores because they carry all the types of lighting they need:

> *"I wouldn't go to [Club Store 1] for a light bulb. And you know sometimes it's a lot easier to find it at [Big Box 1] vs. [Club Store 1]. [Club Store 1] sometimes they have certain items and then, you know, you don't see them anymore. So why risk it? I'm going to go wherever I know they have it for sure."*

Several participants noted that they disliked buying bulbs from grocery stores, as their prices for light bulbs tend to be higher. One respondent said that she would most likely shop for light bulbs at a grocery store if she felt there was no other shopping option:

> *"If the bulb was already in the grocery store and that happened to be something that I needed, I would. But I wouldn't go to a grocery store to buy a light bulb. Unless I was somewhere where there was no place else to go like in the boon docks or something."*

Customers in the focus groups were polarized on whether they would be willing to purchase light bulbs online. Several customers said that they would never purchase light bulbs online because they were concerned about them breaking in the mail and not wanting to wait for them to arrive. One said that brick-and-mortar retailers were *"more trustworthy"* places to buy light bulbs.

> *"Light bulbs don't come through the mail real easily."*

> *"For this product though I would think it would be important to get it out in front of the public, on a shelf, you know interaction… And you know like any product, once it's been out for a long time then online it's a much more easier sell. … Because it's been in the market place. It's established."*

Others, however, prefer the convenience of shopping online and the ability to compare across multiple stores without extensive travel.

> *"I like to order online. Save gas. And when you are shopping for a bargain, instead of going to 10 different stores and looking you can just do it all on their sites."*

Our segmentation efforts drawn from the LCDC surveys indicate that the early adopter segments (and Tech Seekers and Product Explorers) have a preference for purchasing online, in great part because they value information gained from product review sites.

Brand Preferences

Focus group respondents had mixed opinions on the importance of brand in their purchase decisions, but only discussed brands after prompting from the moderator. Respondents were aware of several top brands and were generally more likely to trust name brands (with the exception of one respondent who mentioned that they were *l*ess likely to trust one name brand). One respondent said that he only trusted name brands in his purchases:

> *"Well those [name] brands, we are familiar with those. I am familiar with those brands. And if I don't see no brand and that I don't know (sic), I don't buy it. I go ahead and buy whatever I'm familiar with. Something that I've used before."*

However, overall, respondents did not consider brand as important as price. One respondent said she would be willing to pay slightly, but not much, more for a name brand.

> *"Like if there are two and one was a brand I hadn't heard of and one was, I'd probably buy the one that was. Even if it cost a little bit more. I mean if it was a lot more I might… I don't know."*

While testing the LCDC shopping exercise during the focus groups, one respondent said that in a shopping situation, other factors were more important than brand.

> *"And if it lasts 20 years, I don't care about the brand name. I'm learning through this [shopping] exercise that brand name doesn't mean as much to me as I thought."*

ENERGY STAR® Labeling

Focus group respondents had low to mixed reactions to third-party seals or labels. One said that seals of approval would be helpful, though many said that it would be a "positive" but not a deciding factor.

> *"Yeah but now in this day and age we are all looking for the label. You know, energy efficiency and anything that will cut costs. But I don't think it would tip the balance."*
>
> *"I think it would alert me to the fact that there are some that are more efficient than others and I maybe would look at the feature and I'd compare several that were there that had the options. You know and I'd want to go with the most efficient one. So yeah when I see the ENERGY STAR notice on things I … it's like a good thing."*

This finding is supported by the results of our LCDC surveys, as shown in the "Customer Purchase Preferences" section below. While the majority of most customer groups (with the exception of Thrifty DIY-ers) would prefer ENERGY STAR® labeled products, it is not among the top five purchase considerations for any of the groups.

4.3 SATISFACTION WITH LEDS (EXPERIENCED)

In this section, we detail customers' attitudes towards and perceptions of LEDs after having them in home and directly experiencing the technology. We draw our findings in this section from our IDIs with Lamp Trial participants. These findings reveal the drivers and barriers for continued LED adoption, including the key markers of design quality customers look for when experiencing LEDs at home.

Drivers for LED Adoption

In general, once customers experimented with LEDs at home, they loved them. Almost all participants felt LEDs were a superior lighting technology in terms of energy efficiency and lifetime. As we expand upon in the following section, "Key Markers of LED Design Quality." Customer satisfaction with the LEDs they received was driven in large part by observed superiority to other technologies in terms of brightness, color, and functionality (i.e., warm-up).

> *"I liked [the A-Lines]…cause of the fact that they are a little brighter than the one I originally had."*
>
> *"The LED by far turns on quicker than CFLs and even the halogens don't even come on quite as quick."*

> *"It had a very direct brightness and the color was enhanced…it made [the color] more brilliant."*

Customers indicated that the lifetime of LEDs is an attractive advantage over other lighting technologies. Lamp Trial participants did not prioritize the lifetime when discussing what they look for in lighting products; this became the most salient attribute when they compared LEDs to other lighting technologies or considered purchasing LEDs specifically. Customers unequivocally felt LEDs lasted longer and that this was an important technological improvement.

Barriers to LED Adoption

Past experiences with CFLs continue to inform perceptions of LEDs, even after customers have experimented at home. Our IDIs indicate that poor experiences with CFLs have cast a shadow on LEDs and caused customers to feel leery to try new energy efficient technologies. Although customers generally feel LEDs are superior to other technologies once they have experienced them at home (discussed in more detail below), positive experiences with LEDs and their observable attributes do not fully convince customers of unobservable value of LEDs (i.e., lifetime and energy savings).

> *"The normal compact fluorescents, they look good for a while but then they turn dark. Even though the package says, you know, they're gonna last 'eight-thousand-million' years, after about a year they are getting dark and dim…I don't believe what it says on the package."*

Furthermore, customers' past experiences with CFLs not lasting as long as the manufacturers claim has fueled some skepticism about the actual lifetime of LEDs.

> *"When I read [what is on the box] I tend not to believe all that stuff. I'm going to look at cost."*

Key Markers of LED Design Quality

When experiencing LEDs at-home, customers are looking for multiple markers of quality. During our IDIs, we asked participants what they liked or disliked about the LEDs they received and whether they would purchase them in the future. Table 18 below presents the key design attributes identified by customers, based on how frequently they were mentioned.

Table 18. Key Markers of LED Design Quality

Attribute	Customers Want . . .	Number of Mentions (n=20)**	Voice of the Customer
Beam Angle*	115 Degrees for Reflectors	11 (55%)	*"The wide angled [Reflector]…I really like that one…it lights up [the hallway] really, really nice. That would be a premium there."*
Brightness	100 Watt Equivalent	10 (50%)	*"You get some light bulbs that, yeah, it's gonna save you money but you're not really getting the full lighting it says it should be…the brightness."*
Color	Warm Colors	9 (45%)	*"I'm looking for more warm white colored light bulbs…that's pretty important to me. I don't like the bright white type light bulbs."*
Functionality	No flickers, quick turn-on/warm-up	4 (25%)	*"I had another light before… [that] you had to wait for it to warm up…and that was annoying…If someone came knocking at my door I'd like to be able to turn my light on right away."*
Dimming	Smooth Dimming	3 (15%)	*"[On the Reflectors] the dimness range is kind of limited…it's bright for a while, which is fine, and then it gets real dark. There's kind of no middle range."*

*Beam angle consideration apply only to Reflectors. Because customers received A-Lamps that had wide beam angles (300 degrees), customer generally did not comment on A-line beam angle. However, our findings on Reflector lamps suggests that if customers were to purchase A-Lines of 180 degrees or less (narrow beam angles) they would be much less satisfied.
**the total number of mentions exceeds 20 because each respondent may have mentioned several attributes

Brightness was the most salient physical attribute when it came to satisfaction with LEDs at home. More than half of the respondents interviewed mentioned brightness**.** Respondents most often expressed happiness with the brightness of the A-Lines, but were also pleased with the brightness of the LEDs in general. The participants were generally satisfied with the high-lumen output of the lamps when they were placed outside or sometimes in a shaded fixture like a table lamp. However, when installed indoors in un-shaded fixtures, such as a ceiling fan, participants sometimes felt the lamps were too bright or harmful to the eyes. Customers uniformly preferred the brightness of LEDs to other types of lamps, especially CFLs, which they felt lost their brightness over time.

- **Notably, customers confuse brightness with space illumination and this should be considered when advising on design.** Most referred to this as "brightness" not beam angle because it lit a larger area. As a result, many are disappointed if they select the wrong angle for their intended application.

- **Customers preferred LED lamp color that ranged from soft and warm white to stark white** as opposed to "yellowish" colored lamps**,** and were generally pleased with the color quality of the LEDs. When compared to CFLs, respondents unanimously preferred the color of the LEDs as CFLs were often viewed as "artificial."
- **Customers are looking for smooth, gradual dimming.** Customers reported dissatisfaction with Reflectors that did not work properly with 3-stage dimming fixtures (Hi-Med-Low) or did not dim at all. Dim-ability was the only attribute for which customers felt other types of lamps (particularly Incandescent) were superior to LEDs. These problems were not attributable to a specific brand, and are more related to LEDs not fitting correctly into fixtures.
- **Lack of brightness may present a significant barrier to LED adoption in the short term.** Based on our IDIs, brightness is a critical factor to customer satisfaction with LEDs at home. When asked what they liked and disliked about the LEDs they received, half of respondents mentioned brightness. However, our online channel review (see Appendix H) revealed that typical LED A-Lines are significantly less bright than other lamps. Nonetheless, this barrier should eventually be overcome as LEDs further penetrate the market. The Department of Energy expects LEDs with higher brightness ranges to surface between now and 2013.[11]

Notably, Reflectors face greater barriers to satisfaction directly related to their design. Our IDIs indicate that SCE faces several distinct challenges when promoting adoption of LED Reflectors in particular.

- **Because Reflectors have more attributes to consider, customers do not understand how to shop for them.** Interview respondents provided much less detail on what they liked and disliked about the A-Lines than they did about Reflectors, likely due to more observable variation in the Reflector lamps provided.[12] Appropriate lamp size for fixtures and beam angle are the two most confusing areas where the customer requires more education. (Note: this finding is not specific to LEDs)
- **Customers prefer wide beam angles but do not purchase on beam angles.** The most salient issue for Reflectors was beam angle. Respondents overwhelmingly preferred wider beam angles (approximately 115 degrees) because they felt they did a better job of illuminating rooms or workspaces. Most respondents expressed strong dissatisfaction with the Reflector with the narrowest beam angle, stating that it did not properly illuminate the intended space. This was noted in particular for applications such as use in hallways and closets and above staircases. Many customers saw narrow beam angles as useless in everyday use, such as illuminating a room. The few customers who did like the narrow beam Reflector had used it or imagined using it for the purposes of illuminating a specific part of the room (such as the sink or artwork).

[11] KEMA June 2012. Pages 34-35, 43-47

[12] Three different Reflector lamps were provided. Each was a different brand and had different specifications, making it easier to make comparisons between the three. The four A-Lines provided were identical.

> *"The wide angled [Reflector]…I really like that one…it lights up [the hallway] really, really nice. That would be a premium there. I think I'm going to put another of those in my office."*

- **LED Reflector beam angles tend to be much narrower than other technologies, presenting another challenge for LED adoption.** Our online channel review (see Appendix H) indicates that LEDs tend to be of the "spotlight" variety (narrow beam angles between 16 and 20 degrees). Other technologies however, are typically of the "floodlight" variety (wide beam angles between 30 and 40 degrees). This presents a challenge for LED adoption, IDI respondents indicated that they much preferred wider beam angles.

4.4 RECOMMENDATIONS

Based on our findings, we make the following recommendations.

Incented LEDs should be the Gold Standard of Lighting Quality

- **SCE should be viewed as the arbiter of quality by influencing design and incenting only high quality products.** Customers are very sensitive to lighting quality and skeptical of LEDs due to bad experiences with CFLs. For this reason, SCE should use its incentives to foster and "approve" higher quality products that will satisfy customers' expectations.
- **SCE should stock and incent more wide-angled Reflector lamps and consider in-store education on beam angle and applications.** Most customers did not/do not consider beam angle when purchasing lighting; however, their satisfaction with LED Reflector technology was *highly* affected by the beam angle of the lamps. Overall, customers preferred wide beam angles, but do cite situat*ions whe*re narrow angles are preferred. SCE should provide in-store signage or demonstrations to communicate the differences between the two technologies.
- **Minimum standards should be placed on dimming quality for incentives.** SCE should work with manufacturers to improve dimming quality of Reflector lamps and/or incent those that meet a minimum dim-ability standard.

Provide Customers with insight into Both the Positive Observable and Unobservable Attributes of LEDs

- **SCE should use comparative displays and in-store demonstrations to demonstrate the enhanced quality of LEDs compared to CFLs.** To demonstrate the technological advancements and differences in key attributes between LEDs and CFLs, we recommend that SCE create in-store experiences to encourage customers to explore and compare the lighting technologies. Such demonstrations can convey differences in observable light quality, brightness, and color temperature.

- **Promote the convenience benefits of LEDs generally and for Reflectors in particular.** Our research shows that customers found convenience to be one of the major selling points for LEDs, particularly for Reflectors, which can be difficult and troublesome to replace in ceiling fixtures.

Educate Customers on LED Attributes and Applications

Our findings have shown that customer satisfaction is largely driven by customers' direct experience with lighting in home. In addition to educating on energy-saving and longevity benefits, customers would benefit from more general lighting education. In this way, SCE can serve as the lighting expert that helps customers navigate diverse product offerings at the shelf to ensure satisfaction in the home. To do this, we recommend:

- **Educate on the monetary value of LEDs.** Focus group respondents indicated that they can adjust to other factors that differ about LEDs (such as their look and technology) once they are familiar with them; however, if they consider the bulbs too expensive, customers simply will not buy them.
- **Consider providing retailers with point-of-purchase communication materials or general training for sales associates on LEDs.** Customers are going to want information about LEDs and how they differ from CFLs. Even with the planned buy-down of customer purchase costs, it is not certain that SCE can bring down the point-of-purchase cost of LEDs to the point where no additional information would be necessary. Respondents in the focus groups and IDIs were willing to pay more for LEDs, but they would have to consider them a worthwhile investment (see next section for more detail).
    - **Information must particularly address LED lamp disposal, safety, and functional quality.** Focus group respondents were concerned that LEDs might also be hazardous or require special disposal the way that CFLs do. Information on LEDs must address these concerns, as well as emphasize the superiority of LEDs in terms of lifetime, long-term value and functional quality (color, dimming, noise).
    - **Information must carefully address longevity claims given past experience with CFLs that failed to deliver longevity.** Customers noted that longevity claims cannot be trusted due to past experiences with CFLs. This is important to call out because customers must believe in longevity claims in order to factor this into total cost estimates. With LED's first cost significantly above market, a lack of trust in longevity claims may present an additional barrier to purchase.
- **Educate on fixtures and application at home improvement stores.** Customers indicated a clear preference for purchasing application-specific lighting at home improvement stores. Given this insight, SCE should consider developing more in-depth educational materials and displays for these particular channels where customers go to make educated purchases.
    - **Because Reflectors have more attributes to consider, be sure to focus on educating customers on the appropriate fixtures and beam angles to meet their ambient lighting goals.** Customers seemed to have the greatest difficulty

selecting appropriate Reflectors for their application and fixtures. While this issue may not be specific to LEDs, SCE should consider ways to better educate customers on fixture sizes, lamp fit, and applications for different beam angle.

5. CUSTOMER PURCHASER GROUPS

In this section, we discuss the findings from our Latent Class Discrete Choice survey. The LCDC survey used purchase preferences for A-Lines and Reflectors to develop shopper groups for each of the two product categories. In this section, we detail the shopper groups that emerged from this study. See Appendix A for an example of the shopping exercise completed by customers.

Notably, customers make different choices when shopping for A-Lines vs. Reflectors, resulting in two distinct shopper groups for each category. Based on the results of the LCDC, we found that customers make different trade-offs when shopping for A-Lines versus Reflectors, which resulted in two different sets of purchaser groups, one for each category. While the A-Line and Reflector group sets share some similarities, they do not overlap in a systematic way. For instance, both sets have a early adopter group (Tech Seekers and Product Explorers), but customers in the A-Line early adopter group do not typically appear in the Reflector early adopter group, indicating that customers will take different risks at the shelf based on the product they are considering.

Table 19 and

Table 20 below present each A-Line and Reflector shopper group, giving a brief overview of relative marketing opportunity rank (based on the percentage that preferred LEDS), each group's needs, and potential marketing approaches.

Table 19. A-Line Purchaser Group Snapshot

LED Rating	A-Line Segment	Needs. . .	Messaging Approach
★★★★ % Preferred LEDs: 84%	Tech Seekers (25%)	➢ The latest technology ➢ To feel confident they are getting the cutting-edge ➢ An opportunity to explore	Focus on the innovative elements of LEDs and what LED's "do" to advance the state-of-the-art. Highlight longevity and ENERGY STAR®.
★★★ % Preferred LEDs: 15%	Practical Shoppers (30%)	➢ Clear information ➢ Reasonable price ➢ Believable longevity claims	Provide these shoppers with concise information at the shelf. Offer savings calculators and demonstrate overall value.
★★ % Preferred LEDs: 16%	Convenience-Focused (14%)	➢ Easy purchase decisions at places they already shop	This segment cannot be "bought" with messaging. Product placement is key to getting uptake with this segment. Place lamps in impulse purchase locations.
★ % Preferred LEDs: 2%	Thrifty DIY-ers (31%)	➢ A clear understanding of how LEDs save money and improve the home ➢ Reasonable price	Communicate how LEDs are a home investment. Promote the "Change it once" longevity of LEDs. Indicate that DIY-ers choose smarter lighting for their home.

★ Opportunity Rank for Marketing LEDs

Table 20. Reflector Purchaser Group Snapshot

LED Rating	Reflector Segment	Needs. . .	Messaging Approach
★★★★ % Preferred LEDs: 48%	Product Explorers (24%)	➢ Demonstrations ➢ Accessible, online information ➢ Trusted reviews	Focus marketing dollars on in-store displays and demonstrations. Promote lighting on consumer review sites, such as CNET, Consumer Reports, online reviews.
★★★ % Preferred LEDs: 82%	Energy Investors[13] (49%)	➢ Efficiency without a cost premium, will not likely consider LEDs until prices drop dramatically ➢ Clear information on energy and lifetime cost savings	This group is interested in energy efficiency but will not pay a premium for it. If all things are equal, they will always go for LEDs. Advertise at the shelf, but bring the cost down first.
★★ % Preferred LEDs: 21%	Value-Focused (14%)	➢ Bang for their buck ➢ At the shelf information promoting product savings	This group considers their purchases. They will read labels to find value and calculate overall savings.
★ % Preferred LEDs: 59%	Deal-Sleuths (13%)	➢ To feel like they're getting a "steal" ➢ To save the most they can with every purchase	This group is going to be receptive to obvious promotional events, coupons, and sales. Give them freebies to get them comfortable with the product.

★ Opportunity Rank for Marketing LEDs

The same set of shoppers make different choices at the shelf when considering A-Lines and Reflectors. Based on the results of this exercise, we found that customers make different trade-offs when shopping for A-Lines versus Reflectors, which resulted in two different sets of purchaser groups, one for each category. However, while the A-Line and Reflector group sets share some similarities, they do not overlap in a systematic way. Table 21 provides an overview of the overlap between A-Line and Reflector groups. The percentages indicate the proportion of each A-Line group within each Reflector group.

[13] We note that this group was placed lower on the opportunity hierarchy because of their extreme price sensitivity despite high interest in LEDs.

Table 21. A-Lines and Reflector Groups Overlap

A-Line Purchaser Groups (below)	Reflector Purchaser Groups			
	Energy Investors	Product Explorers	Value-Focused Browsers	Deal-Sleuths
Practical Shoppers	27%	38%	24%	11%
Thrifty-DIYers	69%	10%	12%	9%
Tech Seekers	54%	25%	8%	13%
Convenience-Focused	23%	6%	23%	48%

Note: Sums to 100% across rows.

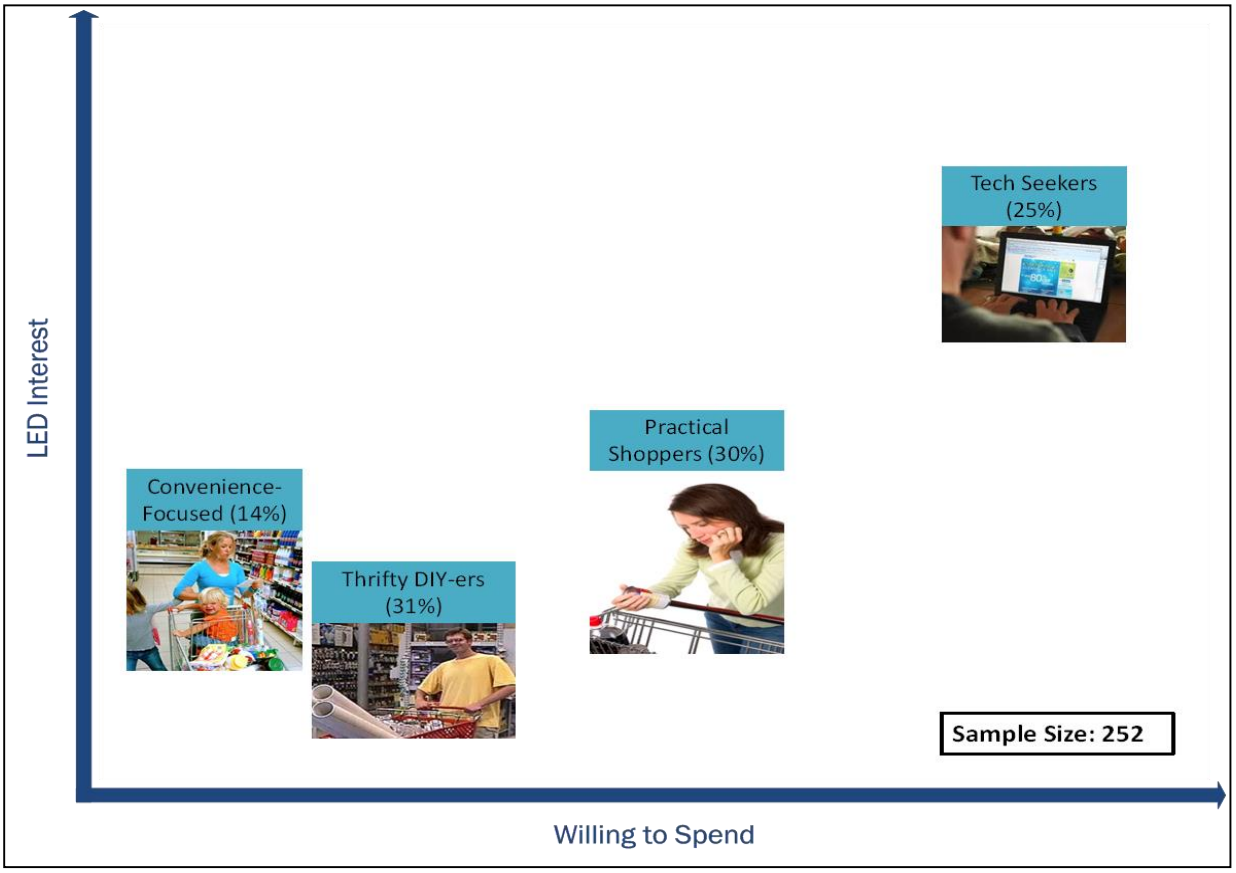
For instance, as can be seen in the table above, both A-Line and Reflector shoppers have an early adopter group (Tech Seekers and Product Explorers), but only a quarter of customers in the A-Line early adopter group are Reflector early adopters. Furthermore, both sets of shoppers have a value-driven group (Thrifty DIY-ers and Value-Focused Browsers). However, only 12% of value-driven A-Line shoppers are value-driven Reflector shoppers.

5.1 A-Line Purchaser Groups

In this section, we provide an over-arching comparison of A-Line purchaser groups. We then provide descriptive detail for each group.

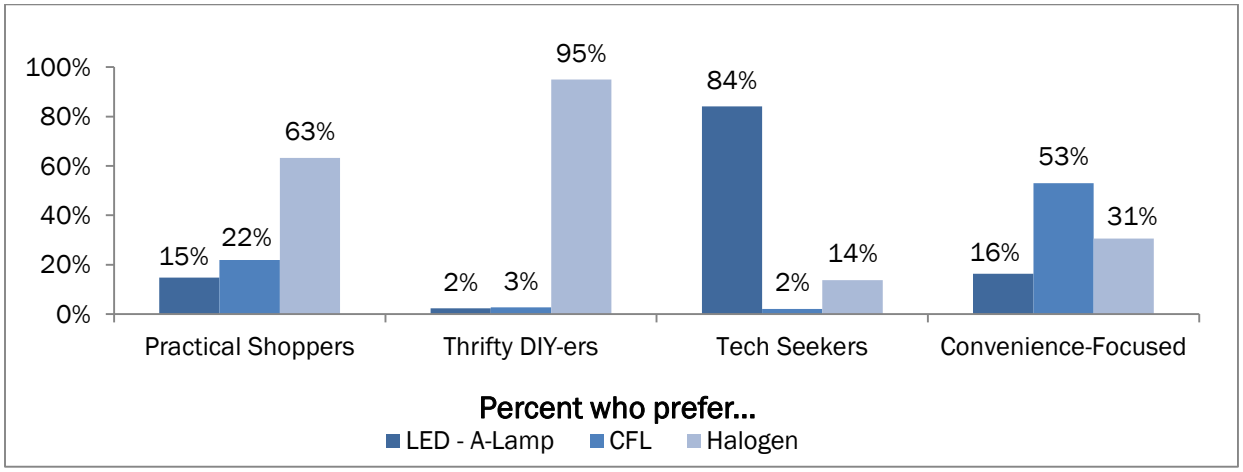
When shopping for A-Lines, customers are less interested in LEDs than the Reflector groups and tend to be cost-sensitive. A-Line shoppers fall into four purchaser groups, which are arranged in Figure 7 below according to their interest in LEDs and willingness to spend on lighting products. Three of the four A-Line groups (representing a cumulative 75% of customers) fall in the low range of interest in LEDs, and Reflector groups generally rank much higher. Nearly half of A-Line shoppers (45%), represented by Thrifty DIY-ers and the Convenience-Focused, are also extremely unwilling to spend on lighting products (though not as unwilling as when shopping for Reflectors).

Figure 7. A-Line Purchaser Groups



Note: Groups may not sum to 100% due to rounding.

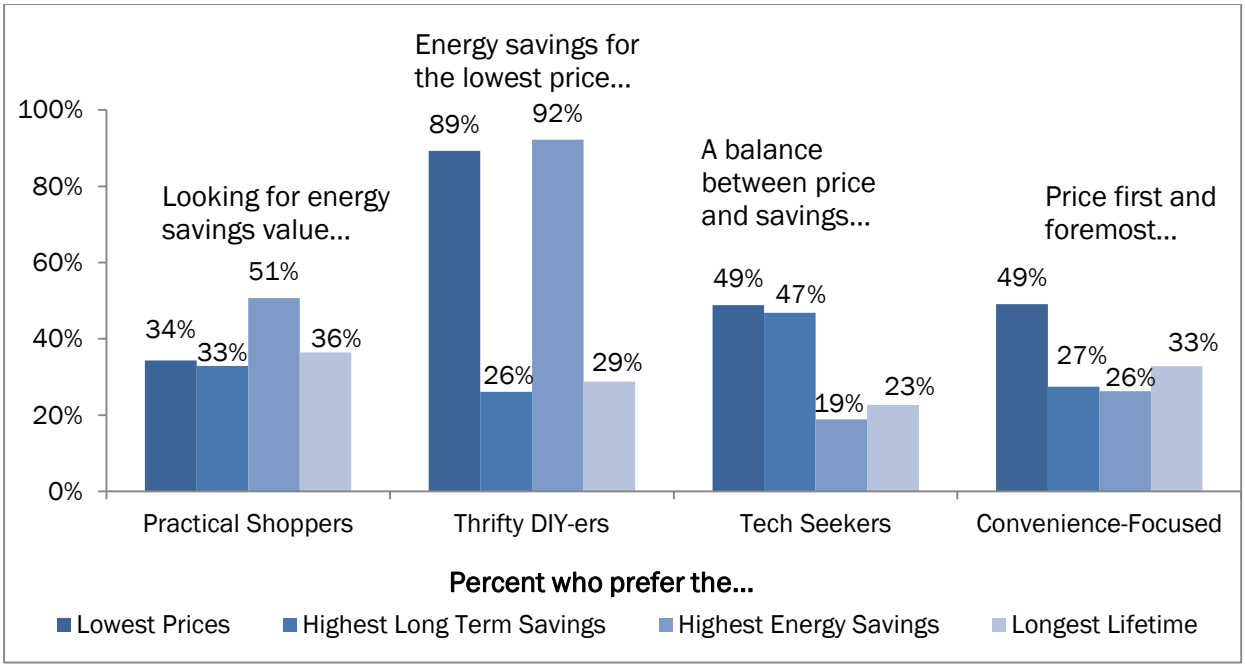
Figure 8. Technology Considerations (A-Lines)



When selecting A-Lines, customers are less interested in LEDs. As can be seen in the figure above, most of the A-Line groups are generally uninterested in LEDs. The one important exception is the early adopter Tech Seeker group, who are far more likely to select LEDs than

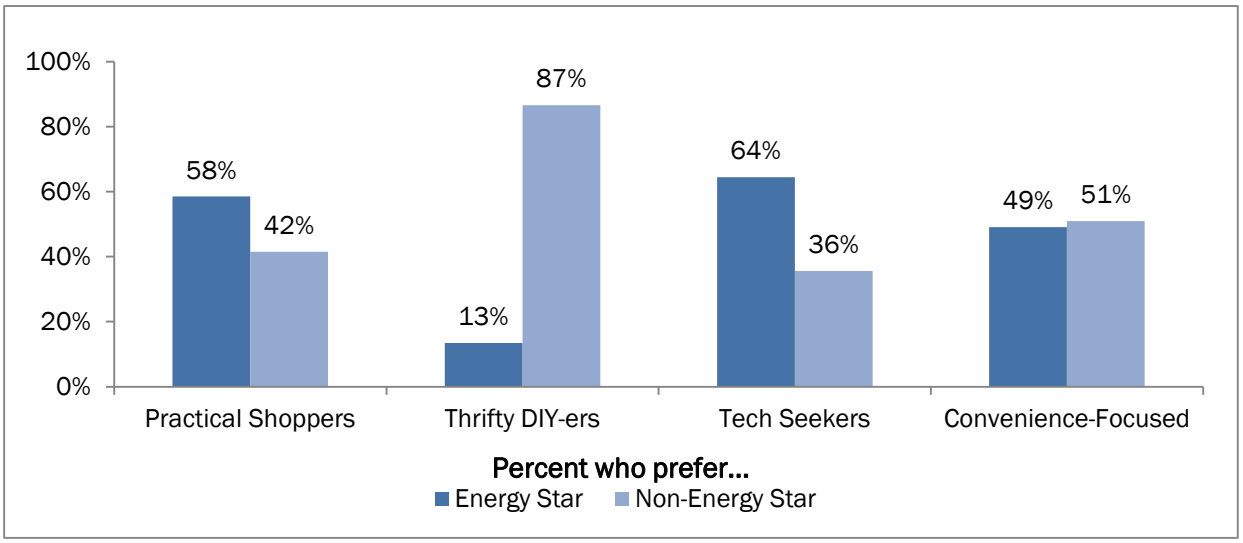
any other technology type. Halogen A-Line lamps are especially popular among Practical Shoppers and Thrifty DIY-ers, who may be confusing Halogen lamps for energy efficient alternatives to Incandescent. More than half (53%) of Convenience-Focused shoppers prefer CFLs because they have tried them before and feel they are an easy purchase decision.

Figure 9. Price and Savings Considerations (A-Lines)



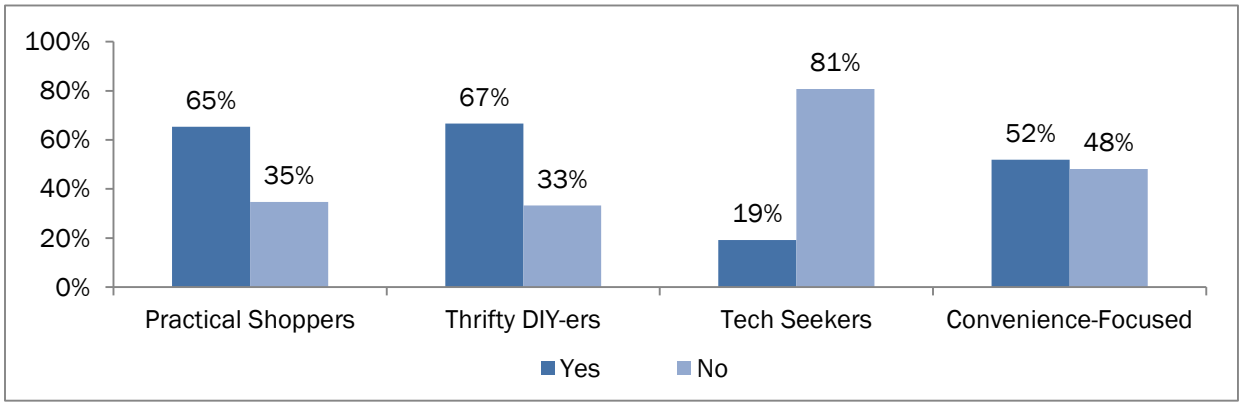
Price is more important than long-term savings across all A-Line groups, but the importance of energy savings varies widely across segments. Thrifty-DIY-ers are the most price-sensitive, but give nearly equal importance to saving on their energy bill. Tech Seekers are the least price sensitive (and willing to spend more to experiment with LEDs), and have very low concern for saving on their energy bill. Overall, the percent of purchaser groups that look for the highest energy savings ranges from 19% (Tech Seekers) to 92% (Thrifty DIY-ers).Concern for lifetime is fairly even across all groups, and most consider it of equal importance to long-term savings.

Figure 10. ENERGY STAR® Considerations (A-Lines)



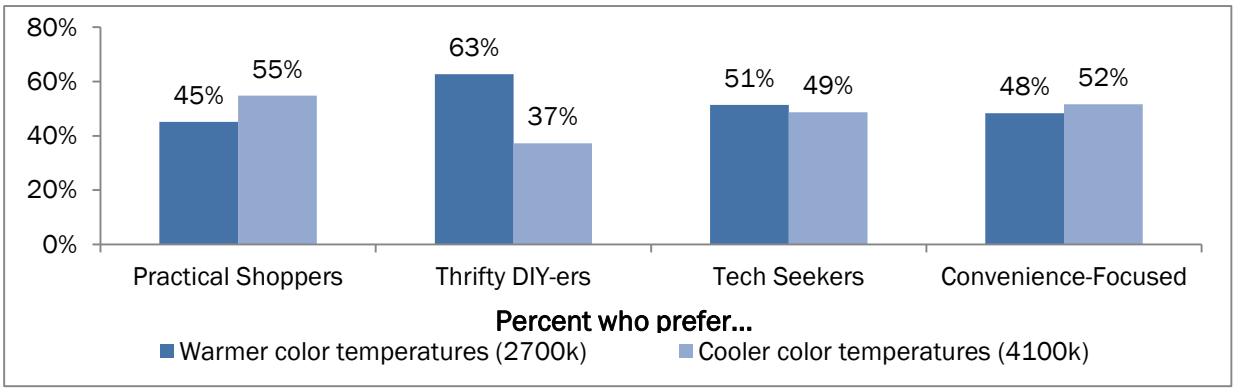
When shopping for A-Lines, customers tend towards ENERGY STAR® labeling. All else equal, Practical Shoppers and Tech Seekers would prefer familiar ENERGY STAR® labeled products. Tech Seekers are especially interested in this attributes when they experiment with new technologies. Thrifty DIY-ers are likely to go with non-ENERGY STAR® products to save on price. The Convenience-Focused are indifferent to the ENERGY STAR® label.

Figure 11. Plans to Purchase CFLs in the Future (A-Lines)



Most customers plan to continue purchasing CFL A-Lines in the future. Excluding Tech Seekers, more than half of shoppers in each A-Line group has plans to purchase CFLs in the next six months. Tech Seekers, however, have soured on CFLs. Along with their strong interest in LEDs, this makes them more likely to enter the LED market in the near future.

Figure 12.Color Temperature Consideration (A-Lines)



When shopping for A-Lines, only certain groups have clear preferences regarding color temperature. Tech Seekers and the Convenience-Focused are nearly evenly split on color temperature, though they have a slight preference for warmer and cooler colors, respectively. Practical Shoppers have a preference for cooler colors. Thrifty DIY-ers have the strongest preference for color, with nearly two-thirds preferring warmer colors.

Table 22. Top Three Outlets by A-Line Purchaser Groups*

Purchaser Group	First Preference	Second Preference	Third Preference
Practical Shoppers	Big-box mass retailers (19%)	Online lighting only stores (17%)	Grocery stores (12%)
Thrifty DIY-ers	Big-box building supplies retailers (27%)	Lighting stores (22%)	Grocery stores (21%)
Tech Seekers	Big-box building supplies retailers (17%)	Online lighting only stores (17%)	Lighting store (15%)
Convenience-Focused	Big-box mass retailers (22%)	Grocery stores (17%)	Big-box building supplies retailers (15%)

*Percentages reflect percent of the purchaser group who prefer the outlet

Customers do not have a strong preference for where they purchase A-Lines, but building supply stores are popular across all groups. Big-box building supply stores appear in the top three outlets for all A-Line purchaser groups. Grocery stores are also a favorite shopping location for all A-Lines groups except Tech Seekers, who prefer to buy their products at brick-and-mortar or online lighting specialty stores.

5.1.1 Detailed A-Line Purchaser Group Descriptions

Who Are Tech Seekers?

"I would buy [LEDs] in an instant if the price was reasonable…and I'm expecting to pay a little bit more."

Tech Seekers are the early adopters, representing approximately 25% of SCE's customers. This group comprises mostly higher-income males.

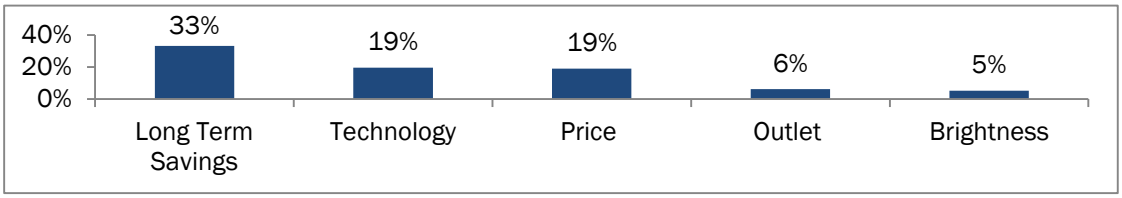
Tech Seekers have traditionally favored CFL spirals ("twisty-shape") over other lighting technologies. While this group is sold on the idea of LEDs (84% indicate a preference for them, more than five times more likely than any other group), only 23% have tried them before.

Few customers in this group have tried LEDs. When looking for lighting products, they are more likely than any other segment to seek out reputable brands and ENERGY STAR® labeling. This suggests that Tech Seekers seek comfort in reputation and like to be informed when they shop. They also prefer warmer color temperatures.

Where costs are concerned, Tech Seekers are willing to pay a little bit more to try out a new product. They are sophisticated customers who focus on a lamp's total life-cycle economics more than features or the up-front price. However, lifetime and saving on their energy bill are of little importance compared to other attributes.

While this group has been more likely to use CFLs in the past over LEDs, the majority of Tech Seekers do not plan to purchase them in the future, suggesting their negative experiences with CFLs have soured them to that technology. This makes Tech Seekers the most likely of all other groups to enter the LED market in the future. SCE can win these customers over by appealing to their desire to try products by making them more affordable. This segment may respond positively to in-store demonstrations that introduce them to this "cutting edge" technology. You can find this group shopping at home improvement and online stores.

Figure 13. Top Five Purchase Considerations for Tech Seekers



Who Are Practical Shoppers?

"I might buy. I'd have to know more about it. I mean what are the features? What's it gonna do? I'd have to have more information."

Practical Shoppers have to be confident in what they buy and reassured that they are making a good investment. Representing 30% of SCE's customer base, this group is mostly female and middle-income.

Customers in this group have experimented with Halogens and CFLs before, and many indicate dthey have tried LEDs in the past.[14] However, their need for savings, reasonable prices, and believable longevity claims is far more important than specific technologies.

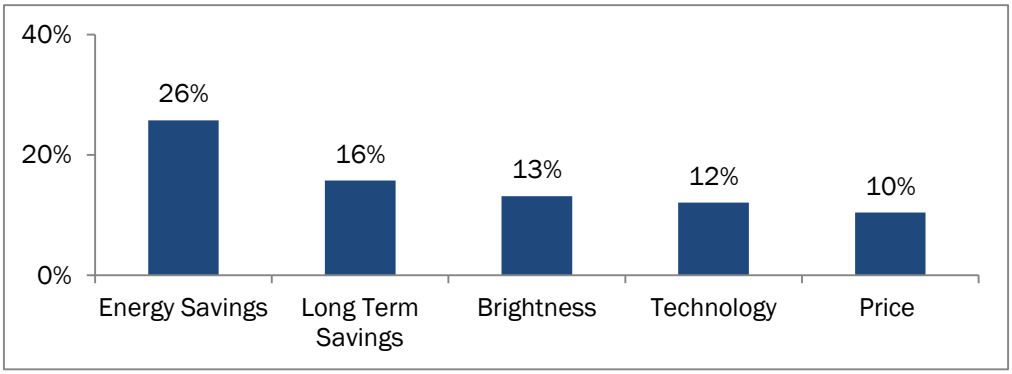
At the shelf, Practical Shoppers look for low prices, but might budge if they can be convinced that they will save in the long run (more than a third look for the highest lifetime). More than half (51%) look for the highest possible energy savings when purchasing lighting products. They also look for cooler color temperatures and ENERGY STAR® ratings.

In the future, this group is likely to continue to purchase CFLs (65% have plans for future CFL purchases). However, Practical Shoppers can become LED converts if the product offer is balanced: affordable price, trust-worthy lifetime savings.

Win Practical Shoppers over by clearly showing the long-term savings gained by spending a little more now. Provide them with concise information at the shelf. Offer savings calculators and demonstrate overall value and especially savings on energy bills. Most importantly, get on the shopping list for trips to big-box building supplies or mass merchandise retailers on Saturday afternoon.

[14] We note here that customers may be referring to other LED technologies and not ambient lighting.

Figure 14. Top Five Purchase Considerations for Practical Shoppers



Who Are Thrifty DIY-ers?

"[For $5 per bulb] I'd do the whole house. … If they would still last 10 years."

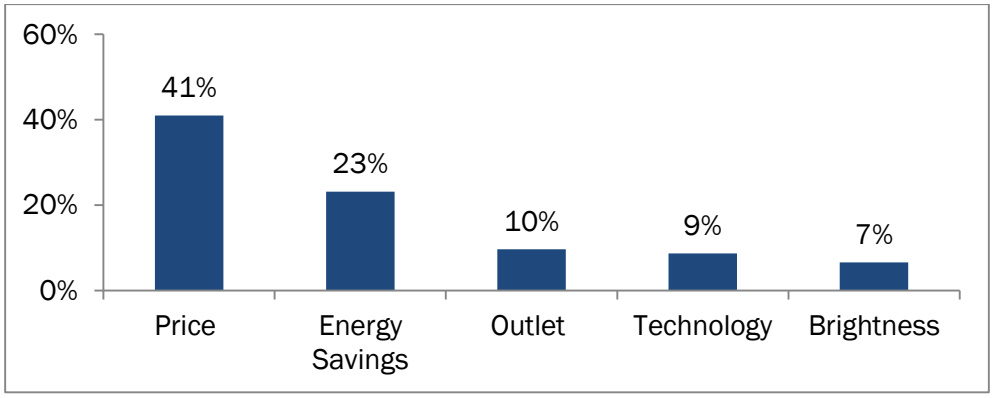
Thrifty DIY-ers are looking for new solutions to home renovation projects, but only if they can get them at the right price and where they shop. Consisting of the largest proportion of SCE's customers (31%), these customers are mostly male and of all income levels.

Almost all of these customers (95%) prefer Halogens, and have tried CFLs before. However, while they may have purchased LEDs before, of all the segments, they are the least inclined to purchase them now (2% prefer LEDs).

Price comes first at the shelf for this group, which is more price-sensitive than any other. They will forgo familiar brands and ENERGY STAR® certification to save money, but at the same time seek solutions for saving on their energy bill. They also look for long-lasting lamps and generally prefer warmer color temperatures.

Because they are seeking the cheapest solution to saving energy, Thrifty DIY-ers are likely to continue to purchase CFLs in the future. However, this segment may be won over by bringing the costs of LEDs down. Thrifty DIY-ers may also respond well to messaging. Appeal to their desire for home improvement solutions by demonstrating the practicality of LEDs and how they are the "light of choice" for DIY homeowners. This group, more than any other, is particular about where they shop for lighting products. Target this group by profiling products at home improvement and hardware stores.

Figure 15. Top Five Purchase Considerations for Thrifty DIY-ers



Who Are the Convenience-Focused?

"If I am there (at the grocery store) I am going to buy what I need."

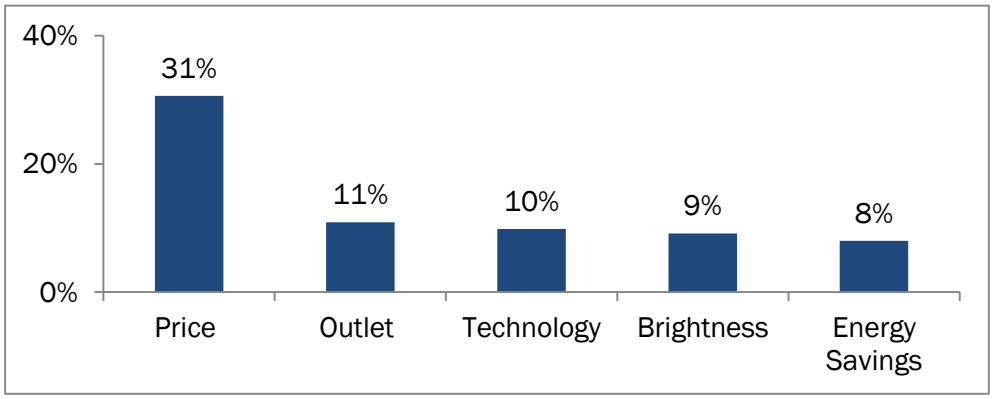
The Convenience-Focused will purchase only what they absolutely must and only if it makes obvious sense. This is the smallest of the A-Line groups, representing 14% of SCE's customers. They are mostly female in higher-income areas.

This group prefers to buy nothing at all. However, if they have to choose, over half (53%) prefer CFLs because they have tried them in the past. They have possibly purchased LEDs before , but are deterred by the price. In the future, they are likely to purchase more CFLs.

When shopping, the Convenience-Focused generally prefer low prices, but are willing to spend more if it is right in front of them and if they are convinced that the product lasts longer and saves on their energy bill. They also prefer cooler color temperatures.

For this group to adopt LEDs, they must be made to be an obvious and easy purchase decision. This group may not respond well to messaging, but might pick up LEDs as they are checking out at the store. Therefore, product placement is key. Target this group in-store with end caps and place products in impulse purchase areas. This group shops all over and should be targeted at all outlets.

Figure 16. Top Five Purchase Considerations for the Convenience-Focused

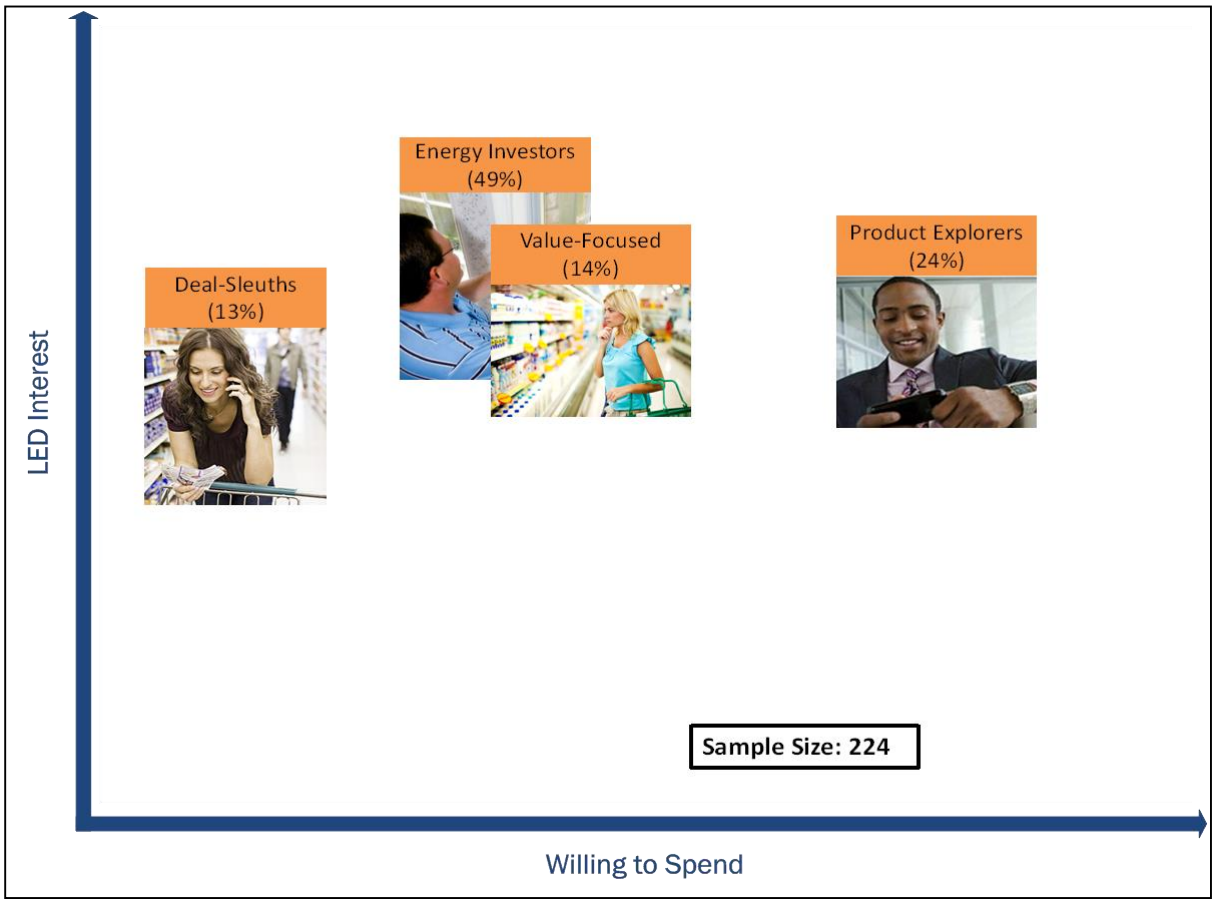


5.2 REFLECTOR PURCHASER GROUPS

In this section, we provide an over-arching comparison of Reflector purchaser groups. We then provide descriptive detail for each group.

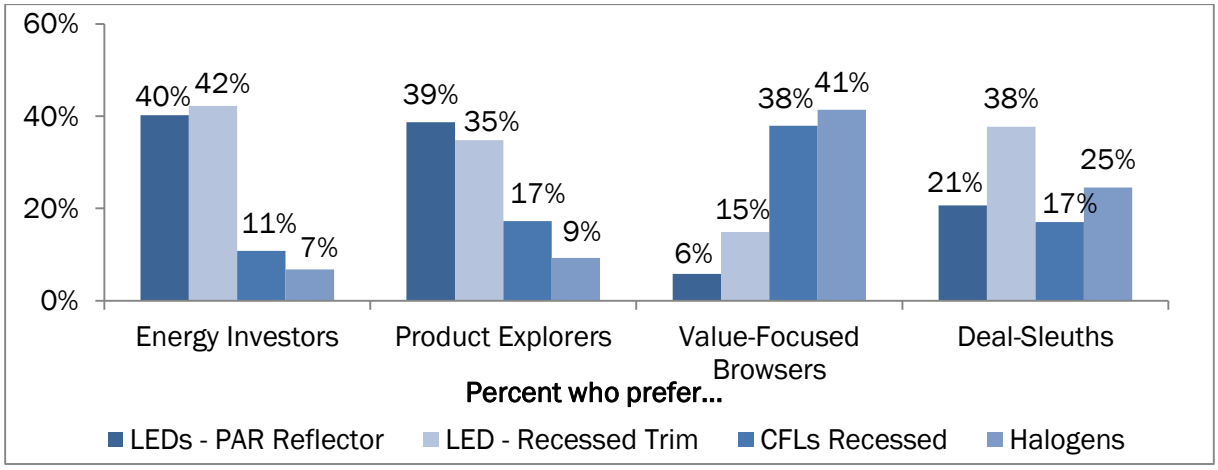
When shopping for Reflectors, customers are much more interested in LEDs but more cost sensitive than the A-Line groups. Reflector shoppers fall into four purchaser groups, which are arranged in Figure 17 below according to their interest in LEDs and willingness to spend on lighting products. In contrast to the A-Line groups (who are disinterested in LEDs, as shown in Figure 7 above), all of the Reflector groups have moderate to high interest in LEDs. However, with the exception of Product Explorers (the early adopter group), customers are not willing to spend a great deal more on LED Reflectors. Nearly two thirds of Reflector shoppers (62%) fall at the low end of willingness to pay, and an additional 14% (the Value-Focused) are only willing to pay a bit more if they can be convinced of the long-term savings.

Figure 17. Reflector Purchaser Groups



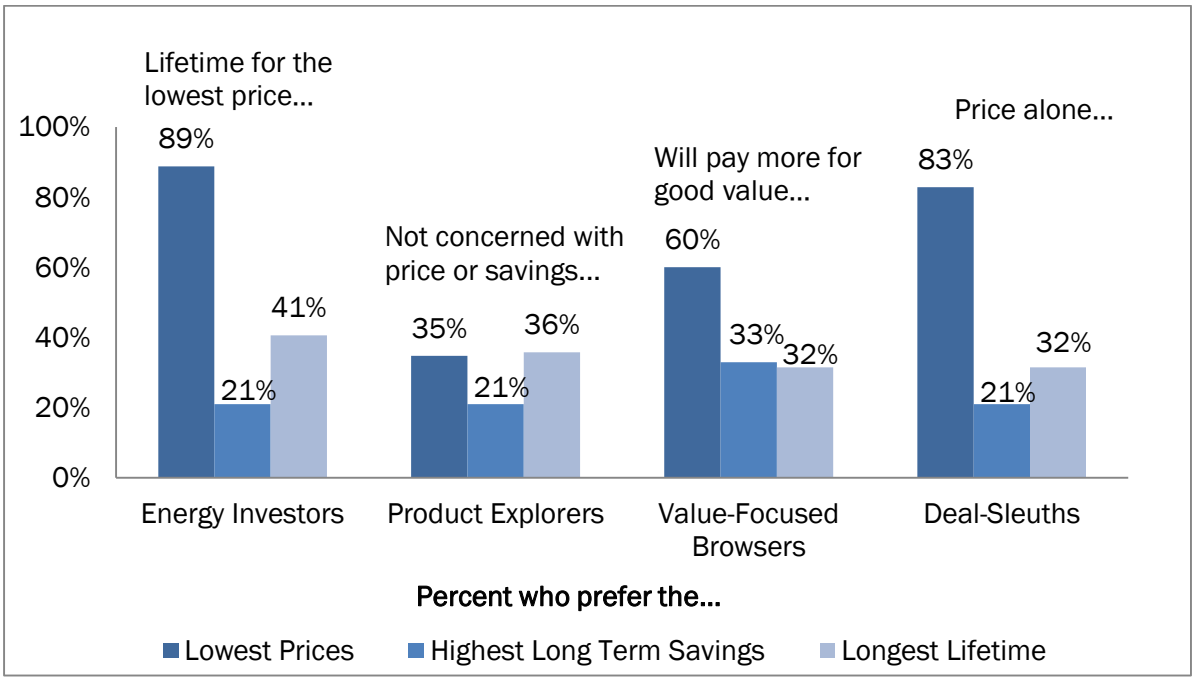
Note: Groups may not sum to 100% due to rounding.

Figure 18. Technology Considerations (Reflectors)



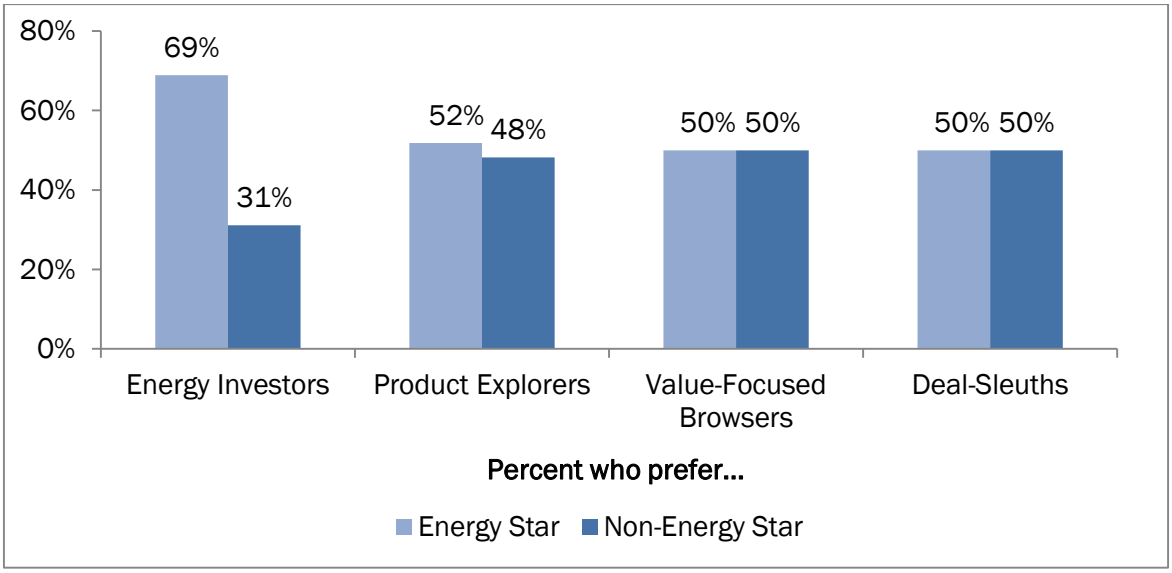
When shopping for Reflectors, customers have a strong preference for LEDs. With the exception of Value-Focused Browsers, more than half of each Reflector purchaser group prefers LEDs (either the PAR Reflector or recessed trim type). Value-Focused Browsers, however, are more likely to prefer CFLs for their balance of affordability and long-term value.

Figure 19. Cost Considerations (Reflectors)



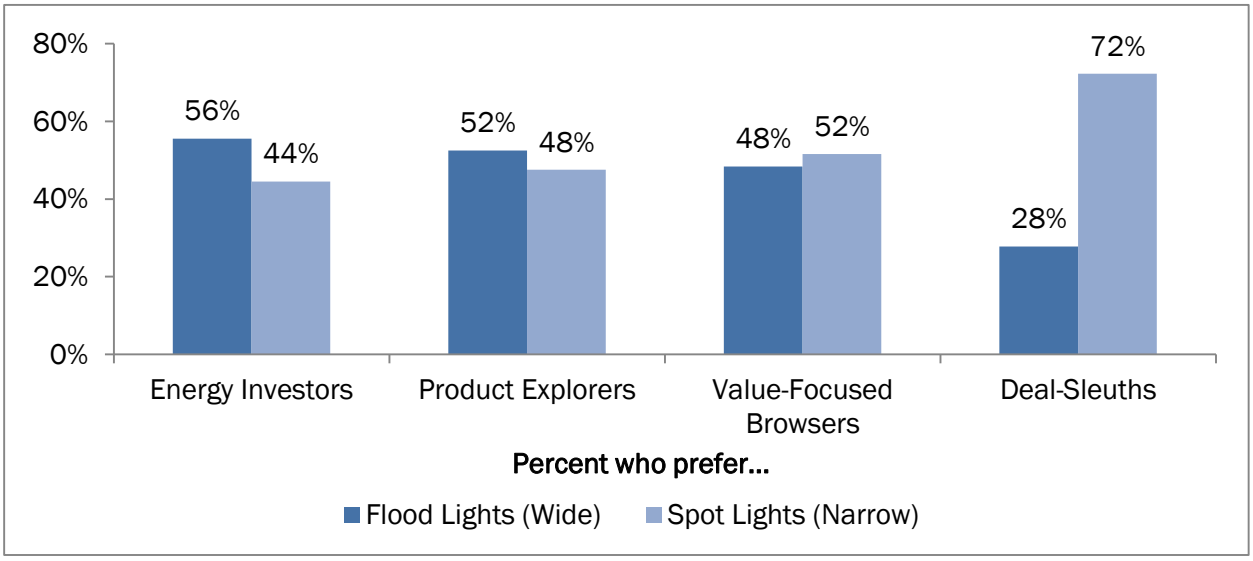
Price is the dominant cost consideration across all Reflector groups. Reflector groups shop primarily on price, and long-term savings and lifetime are of relatively lower concern. Of all the groups, Product Explorers are the most balanced, willing to sacrifice a little on price to get more lifetime. Energy savings alone is not a consideration for any of the Reflector segments.

Figure 20. ENERGY STAR® Considerations (Reflectors)



Customers are generally indifferent to ENERGY STAR® labeling when shopping for Reflectors. Most Reflector groups do not have a clear preference for the ENERGY STAR® label. The key exception is Energy Investors, whose enthusiasm for energy savings leads them to look for the ENERGY STAR® label more than any other group.

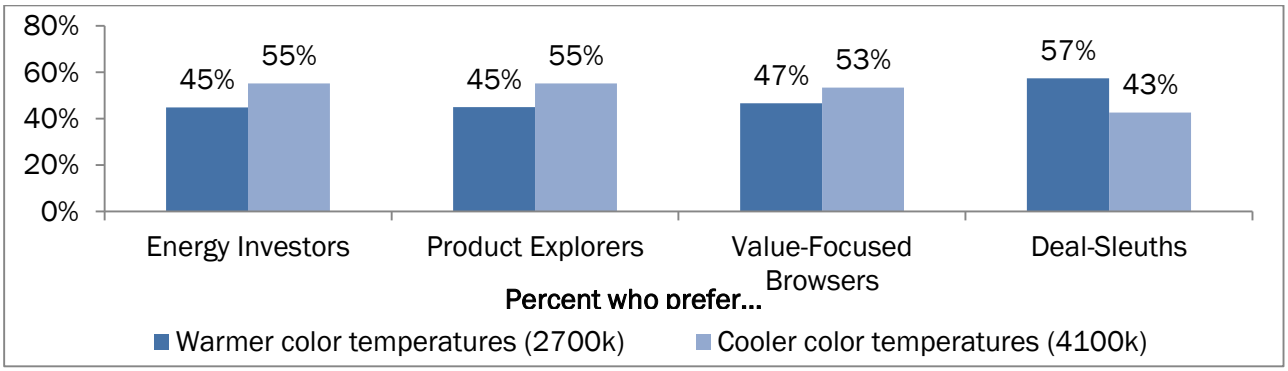
Figure 21. Beam Angle Considerations (Reflectors)



Customer's beam angle preferences depend on the application. While Deal-Sleuths do have a strong preference for narrow beam angles, most Reflector shoppers are fairly balanced. Whether they look for wide angle "flood" lights or narrow "spot" lights likely depends on the application for which they are shopping, which we also found to be an important consideration

among customers during our focus group sessions (see the "Customer Purchase Preferences" section above).

Figure 22. Color Temperature Considerations (Reflectors)



Reflector shoppers generally prefer cooler color temperatures. With the exception of Deal-Sleuths, each of the Reflector groups has a clear preference for coolor colors. However, the Deal-Sleuths have the strongest preference across the Reflector groups, and prefer warmer colors.

Table 23. Top Three Outlets by Reflector Purchaser Groups*

Purchaser Group	First Preference	Second Preference	Third Preference
Product Explorers	Online retail stores (17%)	Drug stores (14%)	Lighting stores (12%)
Energy Investors	Grocery stores (20%)	Online retail stores (16%)	Drug stores (16%)
Value-Focused Browsers	Grocery stores (22%)	Big-box mass retailers (15%)	Lighting store (14%)
Deal-Sleuths	Big-box mass retailers (20%)	Big-box building supplies retailers (19%)	Online retail stores (18%)

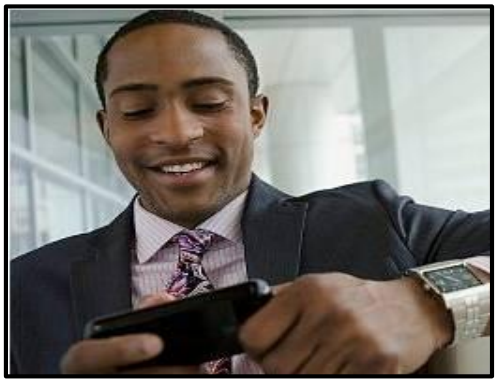
*Percentages reflect percent of the purchaser group who prefer the outlet

Customers do not have strong preferences for where they purchase Reflectors. None of the Reflector groups have strong outlet preferences, and Deal-Sleuths are especially indifferent, likely preferring to shop where they can get the best deals or lowest prices. Energy Investors and Value-Focused Browsers are slightly more likely than other groups to shop for Reflectors at grocery stores. Product Explorers are more likely to shop online than anywhere else.

5.2.1 Detailed Reflector Purchaser Group Descriptions

Who Are Product Explorers?

"I'm interested. Now I want to go Google it and find out more about it."



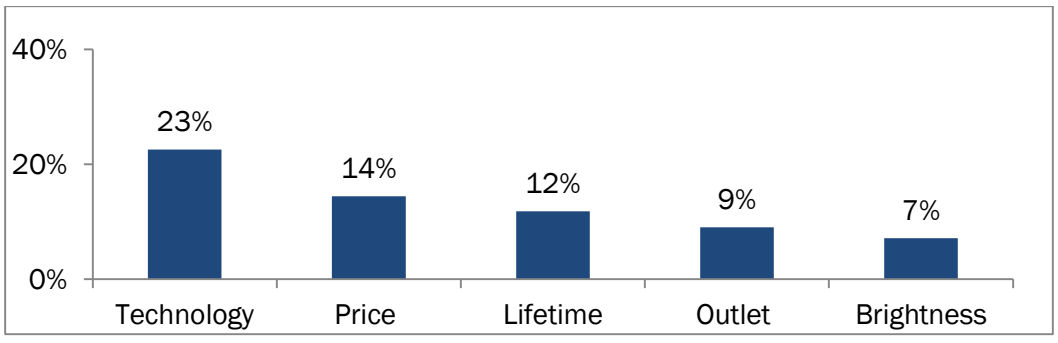
Product Explorers are willing to spend more to test out new technologies. These are the early adopters among the Reflector groups. Product Explorers tend to be males in middle-income areas, and are more likely than any other group to be fully employed. While not the largest of the Reflector groups (24% of SCE's customers), they represent the greatest opportunity for marketing LEDs.

As with most Reflector groups, these customers have a strong preference for LEDs—all else equal, 48% prefer them. However, Product Explorers are inexperienced with LEDs, with only some having tried them in the past. While they will likely purchase more CFLs in the future, they are ready to jump at the chance to make the switch to LEDs (74% of Product Explorers prefer LEDs over other lighting technologies).

Product Explorers are not as intimidated by LED prices as other groups, which makes them potential adopters today. Seeking the latest and greatest product, these customers may be willing to go with up-and-coming, unfamiliar brands (this group is about evenly split in their preferences for familiar or unfamiliar brands). They also seek out long-lasting lighting products with cooler color temperatures and high levels of brightness (75 watt equivalent and up).

Their strong preference for LEDs suggests these customers are looking for any opportunity to experiment. Appeal to their curiosities by inviting them to special demonstration events. Approach where they shop (mostly online) and convince them to switch through credible review sites (such as CNET and Consumer Reports) and technology presses. Lead them to in-store demonstrations.

Figure 23. Top Five Purchase Considerations for Product Explorers



Who Are Energy Investors?

"I'd want to go with the most efficient one. So yeah when I see the ENERGY STAR notice on things I … it's a good thing."

Energy Investors are interested in energy efficiency but will not pay a premium for it. Nearly half of SCE's customer population (49%), this group is mostly males in high-income areas.

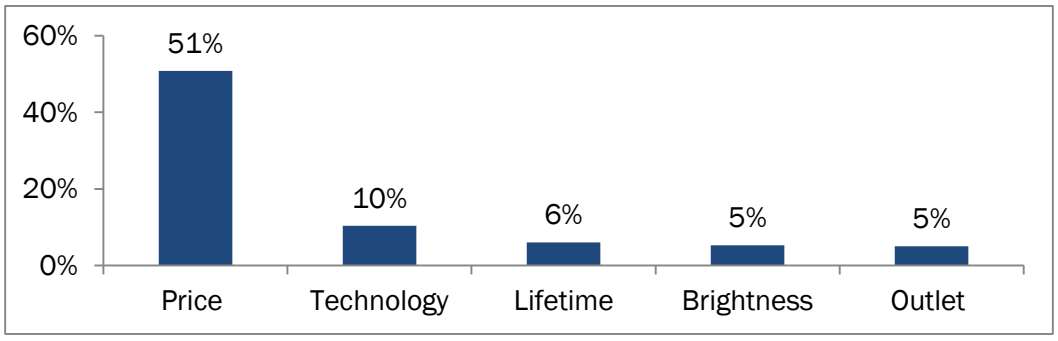
These customers are attracted to the potential energy savings of LEDs (82% would choose them, all else equal) However, the cost of LEDs has deterred them, and few have tried them in the past.

At the shelf, Energy Investors are interested in energy efficiency, having the highest preference for ENERGY STAR® products among the Reflector groups, but aren't willing to compromise on cost. They will only consider low-priced lamps that are long lasting (they have the strongest preference for long lifetime), and generally prefer unfamiliar brands if they save money. They also have a preference for cooler color temperatures and dim-able lamps.

Because they like energy efficiency, but won't pay more for it, these customers are likely to continue buying CFLs in the future. However, they may try LEDs if the price comes down and if they can be convinced of their superior energy and lifetime benefits compared to CFLs.

Win over Energy Investors by conveying the value of energy efficient lamps for Reflector applications. Provide them with clear information on energy and lifetime cost savings. Advertise at the shelf, but most importantly bring the cost down first. Energy Investors can often be found at grocery stores and drug stores, and sometimes online.

Figure 24. Top 5 Purchase Considerations for Energy Investors



Who Are the Value-Focused?

"We are all looking for the label. You know . . . anything that will cut costs."

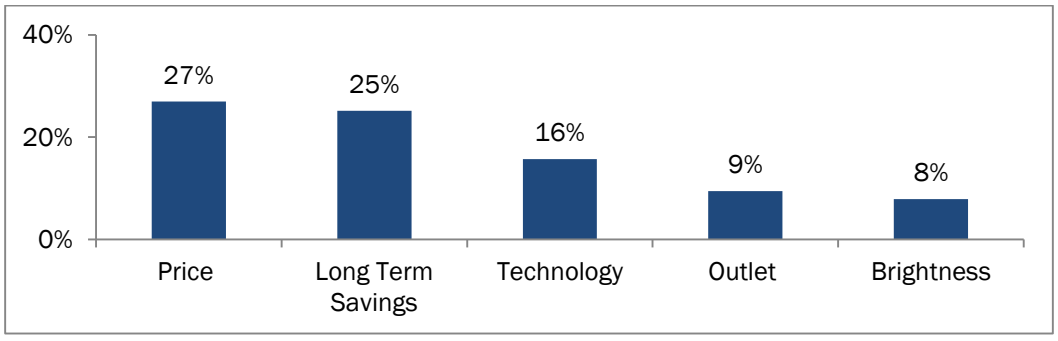
The Value-Focused are always looking for more "bang for their buck". Representing 14% of SCE's customers, they can be found among women in higher-income areas.

These customers are more likely than any other group to have tried LEDs before, but not many (21%) prefer them now. The Value-Focused are interested in long-term savings, but will only consider low-cost lamps. Thus, these customers prefer Halogens (41%) and CFLs (38%), willing to compromise on energy efficiency for what they consider a more reasonable price.

At the shelf, this group's strong preference for long-term savings suggests that they consider their purchases very carefully. They may read labels to find value and calculate overall savings. They also look for familiar brands and cooler color temperatures. In the future, they will likely continue to purchase CFLs because they have tried them before and it is an easy purchase decision. However, these customers are first and foremost interested in value and convenience.

The Value-Focused may respond well to messaging that promotes value (lifetime and long-term savings). Clearly convey how LEDs are a "smart" and "sensible" choice for the home. Indulge their need for convenience by making promotional spaces easy to find in grocery stores or mass merchandisers. Appeal to their tendency to evaluate products by providing them with information at the shelf that promotes total cost and energy savings. They can be found at most outlets, but typically shop at grocery stores.

Figure 25. Top Five Purchase Considerations for the Value-Focused



Who Are the Deal-Sleuths?

"If it was a product I was already using, I would look for deeper discounts."

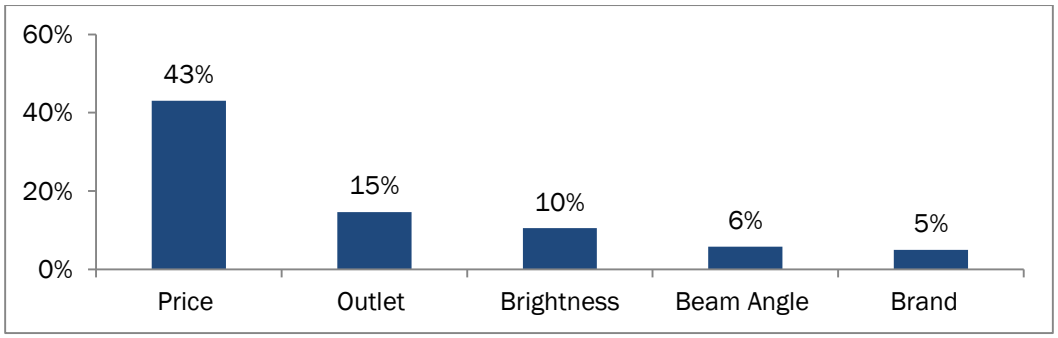
Deal-Sleuths need to feel like they are getting a "steal." They represent the smallest portion of SCE's customers (13%). This group is mostly female, living in lower to middle-income areas.

They have likely tried both CFLs (86%) and LEDs (40%) in the past. Most Deal-Sleuths (59%) would prefer LEDs if the price was right, as they are attracted to long-lasting lamps. However, in the short-term, these customers will likely continue to purchase cheaper CFLs.

At the shelf, Deal-Sleuths will only consider low-priced lamps. They also have stronger physical attribute preferences than any other group, seeking warm color temperatures, extremely bright lamps (90 wattage equivalent or higher), and narrow, "spot" beam angles.

This group will not likely be loyal to a single technology unless it is cost-competitive. However, their need for a good deal makes them receptive to obvious promotional events, coupons, and sales. Give them freebies to get them comfortable with the product. Offer direct installs to sweeten the deal. Deal-Sleuths can be seen shopping almost anywhere. However, they are most likely found at big-box retailers where they can take advantage of steep discounts.

Figure 26. Top Five Purchase Considerations for Deal Sleuths



5.3 RECOMMENDATIONS

Based on our findings from the LCDC segmentation exercise, we recommend the following strategies for marketing LEDs to SCE's customers:

- **Merchandise differently by product category:** The LCDC suggests that customers make very different decisions at shelf for Reflectors and A-Lines. Consider developing different marketing strategies for each product category, targeting the key selling points unique to each product category.

- **Target Early-Adopting segments first through online channels:** SCE should consider targeting early-adopting segments through online channels in the short term before prices drop enough to entice other segments. These segments (Tech Seekers and Product Explorers) are willing to pay more for new technologies, express high interest in LEDs, and look to make their purchases online.
- **Target the Reflector market first to gain LED market penetration:** Customers are substantially more receptive to LEDs when shopping for Reflectors. Our focus group and IDIs suggest that customers are willing to pay more for longevity for this product category to reduce the number of times they have to replace lamps in hard-to-reach locations. For this reason, the Reflector market may be an ideal market in which to gain consumer acceptance of LEDs.
- **Develop incentives and mechanisms to drive interest in LEDs for A-Line purchases:** Customers are less willing pay for A-Line lamps. For this reason, give-aways may be necessary to gain consumer buy-in to new LED lighting in this product category.

6. DETAILED LCDC FINDINGS

In this section of the report, we offer a detailed analysis of the Latent Class Discrete Choice (LCDC) findings presented earlier in our segment and purchase preference sections of this report. We begin with a technical discussion of the model and then provide detailed summary tables on the model findings.

6.1 TECHNICAL DISCUSSION OF THE MODEL

Using the procedure described in our methodology, a model specification including all these variables was run over a range of classes, from 1 to 5. The Bayesian Interaction Criterion (BIC) statistic guided the selection of the optimum number of segments. The BIC balances the increase in number of parameters (Npar) with the goodness of fit (reduction in log likelihood LL), in essence weighing fit against parsimony.

6.1.1 DETAILED FINDINGS – A-LINES

For the A-Line model, the BIC criterion reached a minimum at 6,950, so the 4-class model was selected for subsequent analysis. Key statistics for model selection are presented in Table 24.

Table 24. Key Diagnostics for the A-Line LCDC Model

	LL	BIC(LL)	Npar	L^2	df	p-value	Class.Err.	$R^2(0)$	R^2
1-Class Choice	-3,641	7,398	21	6,022	231	1.8e-1097	0	0.1211	0.1136
2-Class Choice	-3,427	7,126	49	5,595	203	3.5e-1028	0.0487	0.1846	0.1772
3-Class Choice	-3,298	7,016	76	5,335	176	1.7e-993	0.041	0.2355	0.2281
4-Class Choice	**-3,187**	**6,950**	**104**	**5,115**	**148**	**3.1e-968**	**0.0395**	**0.2628**	**0.2557**
5-Class Choice	-3,125	6,975	131	4,991	121	2.6e-963	0.0449	0.2884	0.2815

Notice that the p-value for the model is close to zero, indicating the model passed an overall significance test, and the value for R^2 (not to be confused with the ordinary least squares R^2), is 0.2557, an acceptable value. Information on how this R^2 is calculated appears in a following section.

Figure 27 graphically illustrates the relationship between the BIC and the identification of the correct number of classes.

Figure 27. Relationship of BIC to Identification of Correct Number of Classes A-Line Model

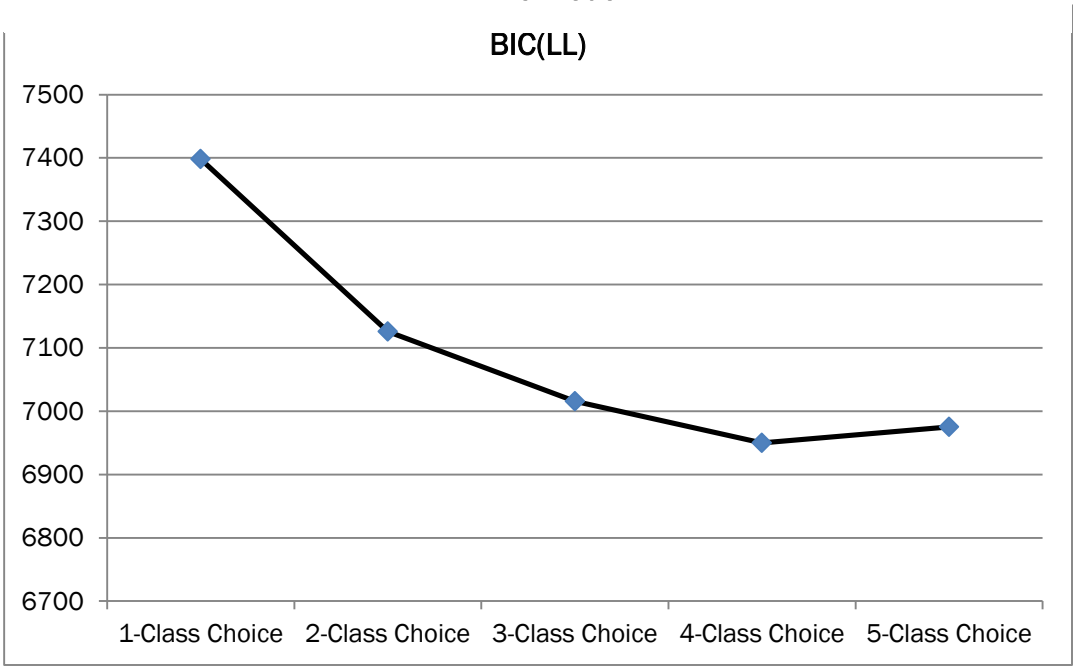


Table 25 displays parameter estimates along with significance tests for the 4-class model. The first column in this table lists the variables used in the model; detailed descriptions for these variables appeared earlier in Table 8. The next four columns contain parameter estimates for the conditional logit models associated with the eight classes (i.e., segments) in the model.

Table 25. Parameter Estimates and Significance Tests for Four-Class A-Line Model

Parameters	*Practical Shoppers*	*Thrifty DIY-ers*	*Tech Seekers*	*Convenience-focused*						
Model for Choices										
	Class1	Class2	Class3	Class4	Overall		High			
R^2	0.077	0.4173	0.2511	0.0963	0.2557		Low			
$R^2(0)$	0.0943	0.451	0.2677	0.2045	0.2628		Above avg.			
Attributes	**Class1**	**Class2**	**Class3**	**Class4**	**Wald**	**p-value**	**Wald(=)**	**p-value**	**Mean**	**Std.Dev.**
None										
	0.4624	0.4557	0.8264	2.1174	5.8197	0.21	1.745	0.63	0.8752	0.6449
Type										
LED - A-Lamp	-0.6133	-1.2979	1.839	-0.5984	124.472	3.90E-23	109.387	2.70E-21	-0.2784	1.1391
CFL	-0.2239	-1.121	-1.8717	0.5753					-0.6606	0.8605
Halogen	0.8372	2.4189	0.0327	0.0231					0.939	0.978
Brand										
Familiar brand	0.1107	-0.6717	0.4471	0.2416	43.6618	7.50E-09	21.9017	6.80E-05	-0.0081	0.4281
Unfamiliar brand	-0.1107	0.6717	-0.4471	-0.2416					0.0081	0.4281
Outlet										
Lighting store	-0.1296	1.3072	0.2577	-0.09	86.5558	6.80E-08	56.2541	4.60E-05	0.3595	0.6048
Drug store	-0.0096	-0.534	-0.7489	-0.0713					-0.325	0.3064
Hardware store	-0.1436	1.1926	-0.3063	-0.1056					0.2002	0.6189
Online lighting-only s	0.3302	-2.6716	0.376	-0.3923					-0.6401	1.2904
Big-box mass retaile	0.425	-1.8837	0.2267	0.6473					-0.2124	1.0445
Grocery store	0.0072	1.2576	-0.4588	0.4092					0.3369	0.6358
Big-box building sup	-0.2893	1.4797	0.4045	0.2518					0.4594	0.6854
Online retail store	-0.1904	-0.1478	0.249	-0.6492					-0.1786	0.2904
BrWtEqv										
40	0.6798	1.2677	0.3083	0.4648	36.796	0.00024	22.5272	0.0073	0.7201	0.3648
60	0.2448	0.2789	-0.6668	-0.6282					-0.1176	0.4484
75	-0.025	-0.0011	0.2618	-0.1034					0.0266	0.1274
100	-0.8996	-1.5455	0.0967	0.2668					-0.6291	0.7287
ClrTemp										
2700K (warm white	-0.0965	0.2608	0.0267	-0.0325	11.7405	0.019	11.7396	0.0083	0.0419	0.1426
4100k (cool white)	0.0965	-0.2608	-0.0267	0.0325					-0.0419	0.1426
EnrStar										
	0.3425	-1.8638	0.5936	-0.0364	32.6429	1.40E-06	19.9146	0.00018	-0.2934	0.9944
Dim-able										
	0.0201	-0.2912	0.532	0.1321	6.7975	0.15	6.2912	0.098	0.0655	0.2883
LifeYrs										
	0.0282	0.0098	-0.0064	0.0197	34.8557	5.00E-07	9.8272	0.02	0.014	0.0127
TotSvngs										
	0.0044	0	0.0146	0.0008	15.9053	0.0012	15.9053	0.0012	0.0046	0.0055
EngSvngs										
	0.0336	0.108	0.0027	0.0106	20.5271	0.00039	8.6675	0.034	0.043	0.0419
Price										
	-0.0169	-0.2376	-0.0487	-0.0494	222.426	5.60E-47	130.331	4.60E-28	-0.0915	0.0915

Model for Classes										
Intercept	Class1	Class2	Class3	Class4	Wald	p-value				
	0.55	0.5182	-1.3962	0.3279	2.0875	0.55				
Covariates	Class1	Class2	Class3	Class4	Wald	p-value				
Educated										
	-0.2266	0.7184	1.5659	-2.0577	24.2084	2.30E-05				
PchLED12										
Yes	0.014	-0.3073	0.3889	-0.0956	18.1629	0.033				
No	0.0167	-0.8348	0.9631	-0.145						
Other	-0.3099	0.0295	-0.2944	0.5748						
Don't know	0.2792	1.1126	-1.0576	-0.3342						
PchCFL6m										
Yes	0.2597	0.4057	-0.5797	-0.0857	18.2762	0.00039				
No	-0.2597	-0.4057	0.5797	0.0857						
Gender										
Male	-0.2283	0.0693	0.4481	-0.2891	10.0528	0.018				
Female	0.2283	-0.0693	-0.4481	0.2891						

Turning to rows, the first few repeat names we assigned to each latent class. The next two rows are pseudo-R^2 measures: R^2 and $R^2(0)$. These terms measure reduction of error compared to baseline models, such that

$$R_k^2 = \frac{Error(baseline) - Error(model)}{Error(baseline)} \qquad \text{Eq.11.}$$

where k indexes the two measures. The baseline for R^2 is an average-probability model; the baseline for $R^2(0)$ is a constants-only model.

The remaining rows display parameter values along with significance tests. As a visual aid, the highest value for each parameter estimate in a row (i.e., across classes) is shaded orange; the lowest value, green; and above average values yellow. What represents high, above average, and low values varies from parameter to parameter. Employing this scheme allows the distinctive nature of each segment to become apparent.

Columns 6 through 9 contain Wald significance tests. The first Wald / p-value combination tests whether the parameter set across classes equals 0, whereas the second pair (Wald(=) and p-value) tests the hypothesis that the true values of the parameters across all classes are equal. The low p values indicate that all coefficient estimates differ significantly from zero and from each other across classes. Columns 10 and 11 contain the means and standard deviations of coefficients in each row, weighted by class sizes.

Weights by size for each class are shown in Table 26. Note that class proportions equal the marginal latent class probabilities for each segment.

Table 26. Weights by Class Size for A-Line Model

Class #	Characterization	Percentage
Class 1	Practical Shoppers	30.6%
Class 2	Thrifty DIY-ers	27.7%
Class 3	Tech Seekers	21.3%
Class 4	Convenience-focused	20.4%

Segment descriptions come from a careful analysis of the unique characteristics of each segment. A number of tables helped us develop these characterizations. We will discuss three of these: an importance table (Table 27), profile table (Table 28) and ProbMeans table (Table 29).

Importance as used here represents the maximum effect for attribute variables listed in Table 27 within each latent class. The following table displays a relative importance measure, defined as

$$releff_{xp} = \frac{maxeff_{xp}}{\sum_p maxeff_{xp}} \qquad \text{Eq.12}$$

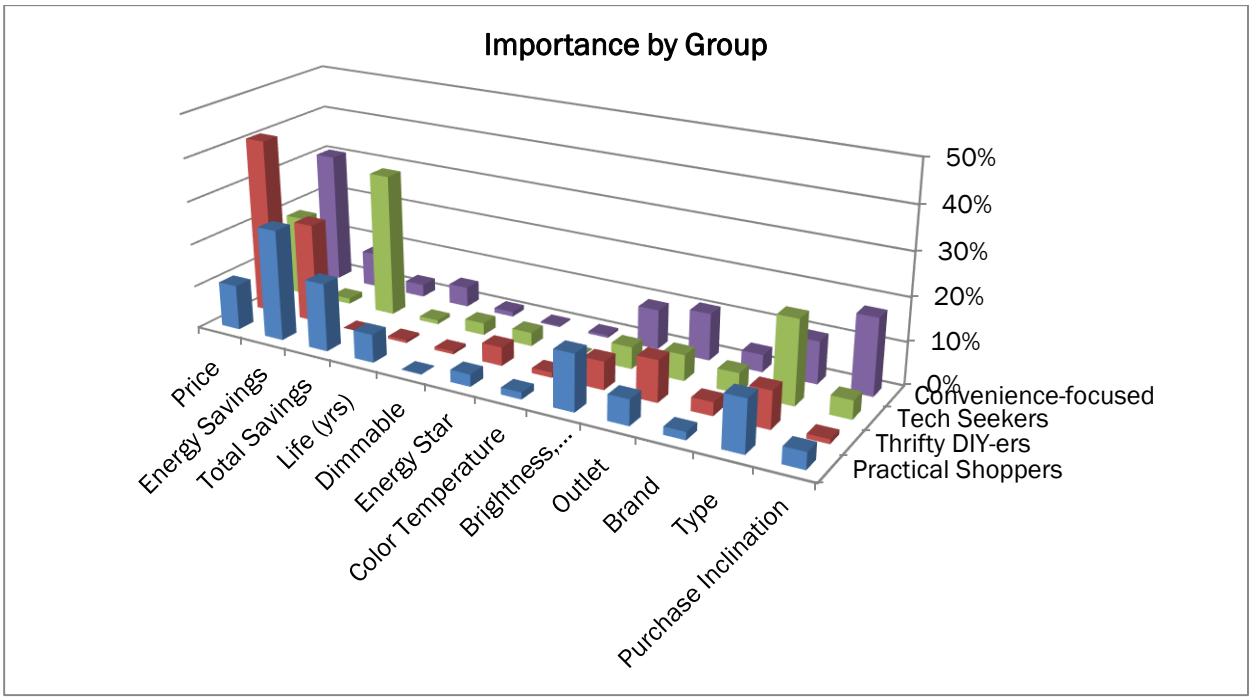
For each latent class x and attribute p. The *maximum effect* for attribute p is the difference in utility U_{max} - U_{min}, where U_{max} is the utility for the level that generates the maximum value for attribute A, and U_{min} is the utility for the level that generates the minimum value for attribute A. Table 27 presents the relative importance scores (values of $releff_{xp}$) for each attribute by class. The higher the value the more important the attribute for a class.

Table 27. Relative Importance Table for A-Line Model

	Practical Shoppers	Thrifty DIY-ers	Tech Seekers	Convenience-focused	Overall
Purchase Inclination	3.9%	1.1%	4.3%	17.8%	3.3%
Type	12.1%	8.7%	19.4%	9.8%	11.5%
Brand	1.8%	3.1%	4.7%	4.1%	3.3%
Outlet	6.0%	9.7%	6.0%	10.9%	8.4%
Brightness, Wattage Equiv	13.2%	6.6%	5.1%	9.2%	7.5%
Color Temperature	1.6%	1.2%	0.3%	0.6%	1.0%
Energy Star	2.9%	4.3%	3.1%	0.3%	3.6%
Dim-able	0.2%	0.7%	2.8%	1.1%	1.1%
Life (yrs)	6.6%	0.6%	0.9%	4.6%	1.9%
Total Savings	15.8%		33.2%	2.9%	9.5%
Energy Savings	25.8%	23.1%	1.3%	8.2%	18.0%
Price	10.4%	40.9%	18.9%	30.6%	30.9%

Figure 28, based on the table above, makes the relationships easier to see.

Figure 28. Importance by Group A-Line Model



A simple example illustrates how to read this chart. Notice that the most important attribute by far for Class 2, the "Thrifty DIY-ers" segment, is the bulb price. This pronounced characteristic gave rise to this particular segment's name. In this respect, importance resembles its English connotation.

We now take up two related tables that are helpful in characterizing segments, Profiles and ProbMeans, terms we will explain momentarily. The profile table (Table 28) displays a special kind of choice probability that varies only with respect to the attribute concerned. These values are calculated as follows. If a is a level of attribute p, where A_p is the total number of levels, and U is the utility associated with level a for latent class x, then the isolated choice probabilities for attribute p are

$$\hat{P}_p(a|x) = \frac{\exp(U_{a|xp})}{\sum_{a=1}^{A} \exp(U_{a|xp})} \qquad \text{Eq. 13.}$$

For every attribute, taking "Type" on the Table 28 as an example, the vertical probabilities associated with the levels a of attribute p within class x sum to 1. In those cases where the attribute takes on numeric values rather than discrete categories, the mean of the probabilities for that attribute is also displayed.

Color-coding helps interpret this table. For each p attribute within a class, the largest probability is colored orange; the smallest, green. Above average probabilities are colored yellow. What represents high, above average, and low values varies from parameter to parameter.

We see, for example, that the conditional probability for a respondent in class 3 to buy an LED A-lamp is 84%. That's a contributing reason why this was branded the "Tech Seekers" segment. Conversely, respondents in Class 2 ("Thrifty DIY-ers") chose the same LED's at a rate of only 2%.

Table 28. Profile Table for A-Line Model

Profile	Practical Shoppers	Thrifty DIY-ers	Tech Seekers	Convenience-focused
	Class1	Class2	Class3	Class4
Class Size	30.6%	27.7%	21.3%	20.4%
Attributes				
None	**Purchase Inclination**			
Buy	0.3864	0.388	0.3044	0.1074
No buy	0.6136	0.612	0.6956	0.8926
Mean	0.6136	0.612	0.6956	0.8926
Type	**Type**			
LED - A-Lamp	0.1483	0.0231	0.8412	0.1641
CFL	0.219	0.0275	0.0206	0.5305
Halogen	0.6327	0.9494	0.1382	0.3054
Brand	**Brand**			
Familiar brand	0.5551	0.207	0.7098	0.6185
Unfamiliar brand	0.4449	0.793	0.2902	0.3815
Outlet	**Outlet**			
Lighting store	0.1066	0.223	0.15	0.1057
Drug store	0.1202	0.0354	0.0548	0.1077
Hardware store	0.1051	0.1989	0.0853	0.1041
Online lighting-only store	0.1689	0.0042	0.1688	0.0781
Big-box mass retailer	0.1857	0.0092	0.1454	0.221
Grocery store	0.1223	0.2122	0.0733	0.1742
Big-box building supplies retailer	0.0909	0.265	0.1737	0.1488
Online retail store	0.1003	0.0521	0.1487	0.0604
BrWtEqv	**Brightness, Wattage Equiv**			
40	0.426	0.5837	0.3184	0.3674
60	0.2757	0.2171	0.1201	0.1231
75	0.2105	0.1641	0.3039	0.2081
100	0.0878	0.035	0.2577	0.3014
ClrTemp	**Color Temperature**			
2700K (warm white)	0.4519	0.6275	0.5134	0.4837
4100k (cool white)	0.5481	0.3725	0.4866	0.5163
EnrStar	**Energy Star**			
	0.4152	0.8657	0.3558	0.5091
Energy Star	0.5848	0.1343	0.6442	0.4909
Mean	0.5848	0.1343	0.6442	0.4909
Dim-able				
	0.495	0.5723	0.37	0.467

High
Low
Above avg.

Profile	Practical Shoppers	Thrifty DIY-ers	Tech Seekers	Convenience-focused
Dim-able	0.505	0.4277	0.63	0.533
Mean	0.505	0.4277	0.63	0.533
LifeYrs	Life (yrs)			
2	0.1655	0.2188	0.2709	0.1891
8	0.1959	0.2321	0.2608	0.2129
20	0.2747	0.2611	0.2416	0.2696
30	0.364	0.288	0.2267	0.3284
Mean	18.3105	16.1556	14.2623	17.3255
TotSvngs	Total Savings			
1-11	0.1553	0.2391	0.0655	0.2197
12-15	0.0786	0.087	0.0509	0.086
16 - 23	0.1731	0.1739	0.141	0.175
24 - 34	0.2643	0.2391	0.2746	0.2453
35 - 46	0.3286	0.2609	0.4679	0.2741
Mean	47.0855	27.1522	65.8754	32.1245
EngSvngs	Energy Savings			
1-3	0.0447	0.0002	0.2259	0.1611
4-6	0.091	0.0017	0.2388	0.2009
7-8	0.1359	0.0131	0.17	0.1735
9-10	0.2215	0.063	0.1767	0.2023
11-12	0.5069	0.9221	0.1886	0.2623
Mean	80.0308	98.7163	54.8279	62.049
Price	Price			
1-2	0.343	0.8932	0.4885	0.491
3-3	0.1522	0.0759	0.1728	0.1729
4-5	0.2684	0.0302	0.2416	0.2406
6-6	0.1085	0.0007	0.0652	0.0644
7-8	0.1279	0	0.0319	0.031
Mean	18.1137	3.1571	10.9867	10.8989

The ProbMeans table (Table 29) resembles the Profile table in interpretation, the only difference being that ProbMeans probabilities sum to 1 across classes rather than attributes. The calculation is:

$$\hat{P}_p(x|a) = \frac{\hat{P}(x)\hat{P}_p(a|x)}{\sum_{x'=1}^{K} \hat{P}(x')\hat{P}_p\left(a\middle|x'\right)} \quad \text{Eq.14.}$$

In this context, the value can be interpreted as the probability of being in class x given choice of attribute level a on attribute set p. For example, Row 9 shows us that if a customer selects a CFL lamp they are most likely (58% likelihood) to belong to Class 4 (the "Convenience-Focused"), but very unlikely (2% likelihood) to belong to Class 3 ("Tech Seekers"). The color-coding scheme is similar to the profile table. The highest probability for each parameter estimate in a row (i.e., across classes) is shaded orange; the lowest value, green; and above average values yellow. What represents high, above average, and low probabilities varies from parameter to parameter.

Table 29. ProbMeans Table for A-Line Model

ProbMeans	Practical Shoppers	Thrifty DIY-ers	Tech Seekers	Convenience-focused
	Class1	Class2	Class3	Class4
Overall	30.6%	27.7%	21.3%	20.4%
Attributes				
None	**Purchase Inclination**			
Buy	0.3783	0.3444	0.2072	0.07
No buy	0.2731	0.247	0.2153	0.2646
Type	**Type**			
LED - A-Lamp	0.1718	0.0242	0.6774	0.1265
CFL	0.3581	0.0408	0.0234	0.5777
Halogen	0.3529	0.4801	0.0536	0.1134
Brand	**Brand**			
Familiar brand	0.3368	0.1138	0.2994	0.2499
Unfamiliar brand	0.2747	0.4439	0.1246	0.1568
Outlet	**Outlet**			
Lighting store	0.2205	0.4182	0.2157	0.1456
Drug store	0.4586	0.1224	0.1454	0.2736
Hardware store	0.2539	0.4354	0.1433	0.1674
Online lighting-only store	0.4937	0.0111	0.3432	0.1521
Big-box mass retailer	0.4198	0.0188	0.2286	0.3327
Grocery store	0.2539	0.3996	0.1058	0.2408
Big-box building supplies retailer	0.1649	0.4361	0.2192	0.1798
Online retail store	0.3446	0.1621	0.3551	0.1382
BrWtEqv	**Brightness, Wattage Equiv**			
40	0.2997	0.3724	0.1558	0.1721
60	0.4321	0.3085	0.1308	0.1285
75	0.2968	0.2098	0.2979	0.1954
100	0.1758	0.0636	0.3588	0.4018
ClrTemp	**Color Temperature**			
2700K (warm white)	0.2658	0.3347	0.21	0.1895
4100k (cool white)	0.3496	0.2154	0.2158	0.2192
EnrStar	**Energy Star**			
	0.2324	0.4393	0.1385	0.1898
Energy Star	0.3948	0.0822	0.3024	0.2207
Dim-able				
	0.3129	0.3279	0.1626	0.1966
Dim-able	0.2996	0.23	0.2598	0.2105
LifeYrs	**Life (yrs)**			
2	0.244	0.2926	0.2777	0.1857
8	0.2686	0.2885	0.2486	0.1943
20	0.3198	0.2756	0.1956	0.209
30	0.3635	0.2607	0.1574	0.2184
TotSvngs	**Total Savings**			
1-11	0.2698	0.3911	0.0775	0.2615

High
Low
Above avg.

ProbMeans	Practical Shoppers	Thrifty DIY-ers	Tech Seekers	Convenience-focused
12-15	0.3145	0.3149	0.1419	0.2287
16 - 22	0.3172	0.2927	0.1743	0.2158
23 - 33	0.3168	0.2635	0.2216	0.198
34 - 45	0.3085	0.2274	0.2894	0.1747
107	0.2989	0.2011	0.3429	0.1571
EngSvngs	**Energy Savings**			
1-3	0.144	0.0005	0.5086	0.3469
4-5	0.2162	0.0029	0.4376	0.3433
6-7	0.2877	0.013	0.3725	0.3267
8-9	0.3775	0.0536	0.2827	0.2862
10-11	0.3918	0.223	0.1797	0.2056
103	0.2835	0.5578	0.0672	0.0916
Price	**Price**			
1-1	0.1573	0.5181	0.1653	0.1593
2-3	0.2865	0.2385	0.2424	0.2326
4-4	0.4054	0.0608	0.273	0.2608
5-6	0.5052	0.013	0.2472	0.2346
7-7	0.7003	0	0.155	0.1447
75	0.8391	0	0.0839	0.0771

High
Low
Above avg.

6.1.2 Detailed Findings – Reflectors

Similar tables (*i.e.,* "b" tables) for the Reflector models follow. We present them without comment because they share the same methodology with the A-Line ("a") tables, and their interpretation is identical.

Table 30. Key Diagnostics for the Reflector LCDC Model

	LL	BIC(LL)	Npar	L^2	df	p-value	Class.Err.	$R^2(0)$	R^2
1-Class Choice	-3,109	6,331	21	4,876	203	3.8e-878	0	0.1518	0.1354
2-Class Choice	-2,876	6,007	47	4,411	177	2.2e-799	0.0557	0.2171	0.2013
3-Class Choice	-2,698	5,796	74	4,054	150	7.9e-744	0.0429	0.2895	0.2746
4-Class Choice	**-2,614**	5,754	**97**	**3,888**	**127**	**8.8e-726**	**0.047**	**0.318**	**0.3036**
5-Class Choice	-2,561	5,787	123	3,780	101	5.9e-723	0.0462	0.3544	0.3409

Figure 29. Relationship of BIC to Identification of Correct Number of Classes Reflector Model

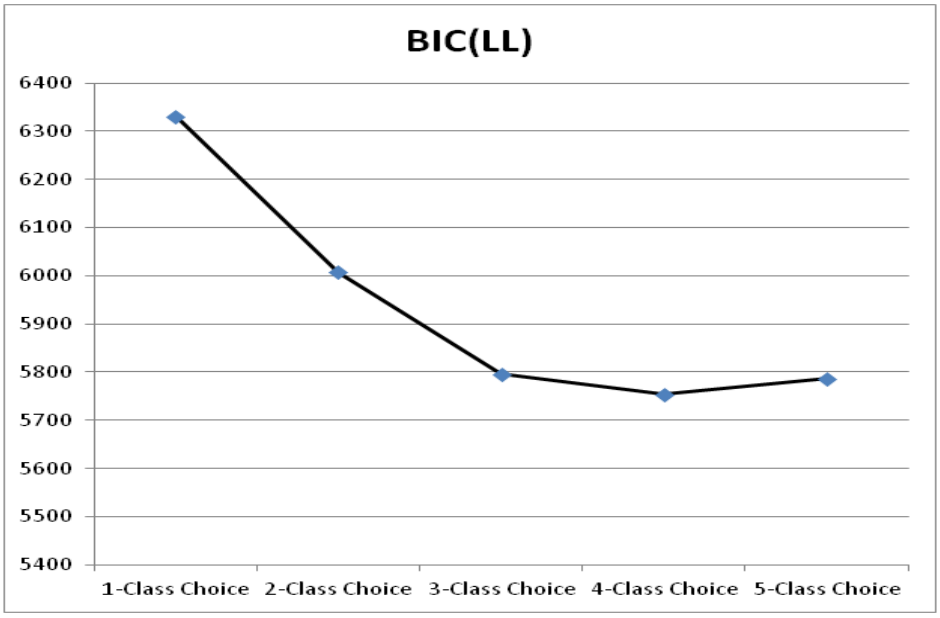


Table 31. Parameter Estimates and Significance Tests for Four-Class Reflector Model

Parameters	Energy Investors	Product Explorers	Value-Focused Browsers	Deal Sleuths	
Model for Choices					
	Class1	Class2	Class3	Class4	Overall
R^2	0.3889	0.0523	0.1567	0.1281	0.3036
$R^2(0)$	0.404	0.0698	0.174	0.5057	0.318

High
Low
Above avg.

Attributes	Class1	Class2	Class3	Class4	Wald	p-value	Wald(=)	p-value	Mean	Std.Dev.
None										
	-1.6489	-1.7521	-0.2123	1.699	85.0889	1.50E-17	67.0473	1.80E-14	-0.9007	1.2547
Type										
LED - PAR Reflector	0.7639	0.5849	-1.1919	-0.1455	244.859	1.60E-45	147.929	2.40E-27	0.2557	0.7149
CFL Recess	-0.553	-0.223	0.6802	-0.3367					-0.2402	0.4299
Halogen	-1.0231	-0.8425	0.768	0.0262					-0.5193	0.6766
LED - Recessed Trim	0.8122	0.4806	-0.2563	0.4559					0.5038	0.3717
Brand										
Familiar brand	-0.2888	0.0452	0.3102	0.4089	31.7931	2.10E-06	29.5935	1.70E-06	-0.0025	0.2835
Unfamiliar brand	0.2888	-0.0452	-0.3102	-0.4089					0.0025	0.2835
Outlet										
Lighting store	-0.0041	0	0.1831	-0.0781	39.1048	0.079	26.982	0.17	0.0158	0.0791
Drug store	0.282	0.1323	-0.3984	-1.7278					-0.1854	0.7132
Hardware store	-0.1758	-0.2353	0.1187	-0.6894					-0.223	0.2346
Online lighting-only store	-0.2413	-0.0045	-0.5293	0.2913					-0.1496	0.2517
Big-box mass retailer	-0.3848	-0.1302	0.2808	0.678					-0.0473	0.3929
Grocery store	0.4937	-0.035	0.6496	0.3056					0.3688	0.2403
Big-box building supplies retailer	-0.2717	-0.0612	-0.2952	0.6157					-0.0857	0.3186
Online retail store	0.302	0.334	-0.0094	0.6048					0.3064	0.1756

BrWtEqv										
40	-0.601	-0.1695	0.3818	0.2667	42.2859	3.00E-05	22.7194	0.0069	-0.2021	0.4034
60	0.1076	-0.2402	-0.0907	-0.435					-0.0911	0.2041
75	0.1585	0.2099	-0.6025	-0.7808					-0.1052	0.4092
90	0.3349	0.1998	0.3114	0.9492					0.3984	0.246
ClrTemp										
2700K (warm white)	-0.1036	-0.1021	-0.0672	0.1485	4.7517	0.31	0.8897	0.83	-0.057	0.0906
4100k (cool white)	0.1036	0.1021	0.0672	-0.1485					0.057	0.0906
EnrStar										
	0.7961	0.0736	0	0	20.0836	4.40E-05	20.0836	4.40E-05	0.3731	0.3817
BmAngle										
Flood	0.111	0.0497	-0.032	-0.4777	4.1454	0.39	3.8206	0.28	-0.0206	0.2057
Spot	-0.111	-0.0497	0.032	0.4777					0.0206	0.2057
Dim-able										
	0.5633	0	0.358	0.2355	19.7698	0.00019	19.7698	0.00019	0.3487	0.2245
LifeYrs										
	0.038	0.0266	0.0165	0.0165	83.4521	3.20E-17	4.3243	0.23	0.0284	0.0094
TotSvngs										
	0	0	0.0055	0	5.9199	0.015	5.9199	0.015	0.0009	0.002
Price										
	-0.0948	-0.0096	-0.0354	-0.0747	392.541	1.10E-83	300.666	7.10E-65	-0.0624	0.0354

Table 32. Weights by Class Size for Reflector Model

Class #	Characterization	Percentage
Class 1	Energy Investors	44,8%
Class 2	Product Explorers	22.8%
Class 3	Value-Focused Browsers	16.4%
Class 4	Deal Sleuths	16.0%

Table 33. Relative Importance for Reflector Model

	Energy Investors	Product Explorers	Value-Focused Browsers	Deal Sleuths	Overall
Purchase Inclination	9.3%	27.7%	1.7%	10.3%	10.5%
Type	10.4%	22.6%	15.7%	4.8%	11.5%
Brand	3.3%	1.4%	5.0%	5.0%	3.5%
Outlet	5.0%	9.0%	9.4%	14.6%	7.4%
Brightness, wattage equiv.	5.3%	7.1%	7.9%	10.5%	6.6%
Color Temperature	1.2%	3.2%	1.1%	1.8%	1.5%
Energy Star	4.5%	1.2%			2.9%
Beam angle	1.3%	1.6%	0.5%	5.8%	1.9%
Dim-able	3.2%		2.9%	1.4%	2.5%
Life (yrs)	6.0%	11.8%	3.7%	2.8%	5.9%
Total Savings Over 10 Years			25.2%		3.1%
Price	50.8%	14.4%	27.0%	43.0%	42.8%

Figure 30. Importance by Group, Reflector Model

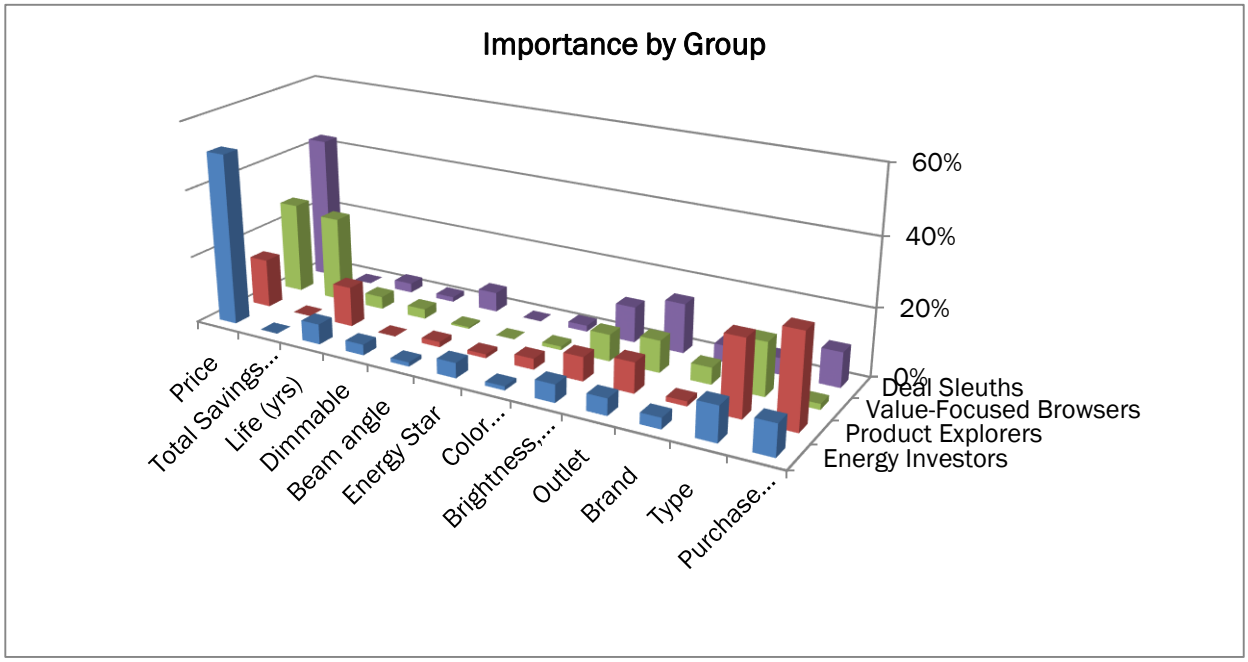


Table 34. Profile for Reflector Model

Profile	Energy Investors	Product Explorers	Value-Focused Browsers	Deal Sleuths
	Class1	Class2	Class3	Class4
Class Size	44.76%	22.79%	16.46%	15.99%
Attributes				
None	Purchase Inclination			
Buy	0.8387	0.8522	0.5529	0.1546
No buy	0.1613	0.1478	0.4471	0.8454
Mean	0.1613	0.1478	0.4471	0.8454
Type	Type			
LED - PAR Reflector	0.4024	0.3866	0.0583	0.2067
CFL Recess	0.1078	0.1723	0.3791	0.1707
Halogen	0.0674	0.0928	0.4139	0.2454
LED - Recessed Trim	0.4224	0.3483	0.1486	0.3772
Brand	Brand			
Familiar brand	0.3595	0.5226	0.6503	0.6938
Unfamiliar brand	0.6405	0.4774	0.3497	0.3062
Outlet	Outlet			
Lighting store	0.1188	0.1233	0.1403	0.0929
Drug store	0.1582	0.1408	0.0784	0.0179
Hardware store	0.1001	0.0975	0.1315	0.0504
Online lighting-only store	0.0938	0.1228	0.0688	0.1345
Big-box mass retailer	0.0812	0.1083	0.1547	0.1979
Grocery store	0.1955	0.1191	0.2237	0.1364
Big-box building supplies retailer	0.0909	0.116	0.0869	0.186
Online retail store	0.1614	0.1722	0.1157	0.184

High
Low
Above avg.

Profile	Energy Investors	Product Explorers	Value-Focused Browsers	Deal Sleuths
BrWtEqv	Brightness, wattage equiv.			
40	0.1296	0.2066	0.3414	0.2614
60	0.2632	0.1925	0.2128	0.1296
75	0.2769	0.302	0.1276	0.0917
90	0.3303	0.2989	0.3182	0.5173
ClrTemp	Color Temperature			
2700K (warm white)	0.4484	0.4491	0.4664	0.5737
4100k (cool white)	0.5516	0.5509	0.5336	0.4263
EnrStar	Energy Star			
	0.3109	0.4816	0.5	0.5
Energy Star	0.6891	0.5184	0.5	0.5
Mean	0.6891	0.5184	0.5	0.5
BmAngle	Beam angle			
Flood	0.5553	0.5248	0.484	0.2778
Spot	0.4447	0.4752	0.516	0.7222
Dim-able				
	0.3628	0.5	0.4115	0.4414
Dim-able	0.6372	0.5	0.5885	0.5586
Mean	0.6372	0.5	0.5885	0.5586
LifeYrs	Life (yrs)			
2	0.1402	0.1697	0.1984	0.1986
8	0.1761	0.199	0.2191	0.2192
20	0.2777	0.2739	0.2672	0.2672
30	0.406	0.3574	0.3152	0.3151
Mean	19.4245	18.131	16.9507	16.9458
TotSvngs	Total Savings, 10 Years			
1-12	0.1935	0.1935	0.0629	0.1935
13 - 25	0.2097	0.2097	0.1694	0.2097
26 - 37	0.1935	0.1935	0.195	0.1935
38 - 49	0.1935	0.1935	0.243	0.1935
50 - 62	0.2097	0.2097	0.3297	0.2097
Mean	51.2244	51.2244	102.3874	51.2244
Price	Price			
1-2	0.8878	0.3476	0.6007	0.8282
3-3	0.0821	0.1469	0.1609	0.1102
4-5	0.0275	0.2428	0.1609	0.053
6-6	0.0018	0.1001	0.039	0.0056
7-8	0.0008	0.1625	0.0386	0.003
Mean	9.5501	37.6136	21.202	11.4736

High
Low
Above avg.

Table 35. ProbMeans Table for Reflector Model

ProbMeans	Energy Investors	Product Explorers	Value-Focused Browsers	Deal Sleuths
	Class1	Class2	Class3	Class4

ProbMeans	Energy Investors	Product Explorers	Value-Focused Browsers	Deal Sleuths
Overall	44.8%	22.8%	16.5%	16.0%
Attributes				
None	**Purchase Inclination**			
Buy	0.5478	0.2833	0.1328	0.0361
No buy	0.2294	0.107	0.234	0.4296
Type	**Type**			
LED - PAR Reflector	0.5794	0.2834	0.0309	0.1063
CFL Recess	0.2723	0.2215	0.3522	0.154
Halogen	0.1901	0.1332	0.4295	0.2472
LED - Recessed Trim	0.5353	0.2247	0.0693	0.1707
Brand	**Brand**			
Familiar brand	0.3232	0.2391	0.215	0.2227
Unfamiliar brand	0.5711	0.2167	0.1147	0.0975
Outlet	**Outlet**			
Lighting store	0.4461	0.2357	0.1937	0.1246
Drug store	0.5968	0.2703	0.1088	0.0241
Hardware store	0.4632	0.2296	0.2238	0.0833
Online lighting-only store	0.4084	0.2722	0.1102	0.2092
Big-box mass retailer	0.3077	0.2088	0.2156	0.2679
Grocery store	0.5051	0.1566	0.2125	0.1258
Big-box building supplies retailer	0.3661	0.2377	0.1287	0.2674
Online retail store	0.4517	0.2454	0.1191	0.1839
BrWtEqv	**Brightness, wattage equiv.**			
40	0.2856	0.2318	0.2768	0.2058
60	0.5418	0.2017	0.1612	0.0953
75	0.5427	0.3012	0.092	0.0642
90	0.4212	0.194	0.1492	0.2356
ClrTemp	**Color Temperature**			
2700K (warm white)	0.4256	0.217	0.1629	0.1945
4100k (cool white)	0.4673	0.2375	0.1662	0.129
EnrStar	**Energy Star**			
	0.3384	0.2669	0.2002	0.1944
Energy Star	0.5239	0.2006	0.1398	0.1357
BmAngle	**Beam angle**			
Flood	0.5049	0.2429	0.1619	0.0902
Spot	0.3921	0.2132	0.1673	0.2274
Dim-able				
	0.3917	0.2748	0.1634	0.1702
Dim-able	0.4873	0.1946	0.1655	0.1526
LifeYrs	**Life (yrs)**			
2	0.3784	0.2331	0.197	0.1914
8	0.4036	0.2322	0.1847	0.1795
20	0.4547	0.2282	0.1609	0.1562
30	0.4973	0.2228	0.142	0.1378
TotSvngs	**Total Savings, 10 Years**			
1-12	0.5042	0.2567	0.059	0.1801
13 - 25	0.4623	0.2353	0.1373	0.1651
26 - 37	0.4477	0.2279	0.1645	0.1599
38 - 49	0.4303	0.219	0.1969	0.1537
50 - 61	0.4101	0.2088	0.2346	0.1465
184.2	0.398	0.2026	0.2572	0.1421

High
Low
Above avg.

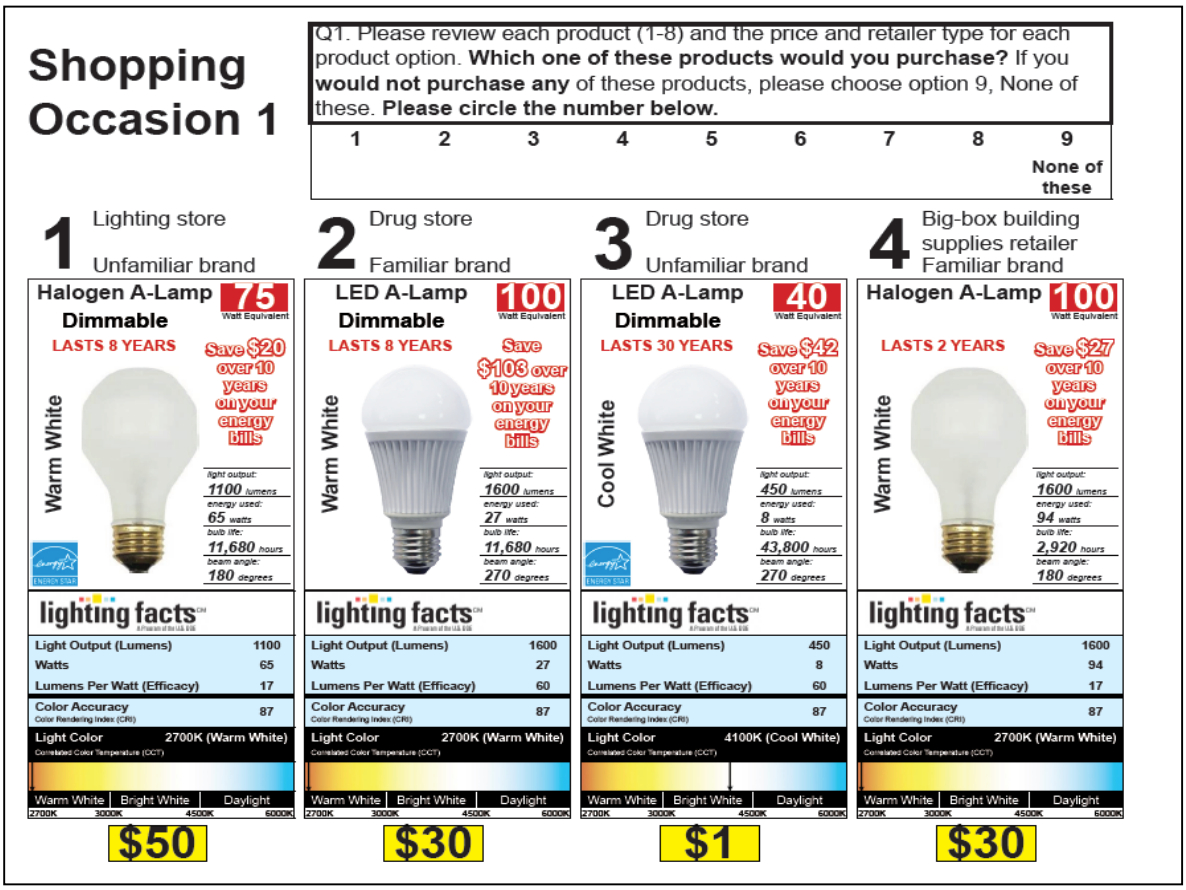
ProbMeans	Energy Investors	Product Explorers	Value-Focused Browsers	Deal Sleuths
Price	**Price**			
1-1	0.5864	0.0971	0.1288	0.1877
2-3	0.4234	0.213	0.1935	0.1701
4-4	0.1498	0.49	0.2631	0.0971
5-6	0.0529	0.6719	0.2294	0.0457
7-7	0.0123	0.7981	0.1733	0.0162
100	0.0016	0.8932	0.1016	0.0036

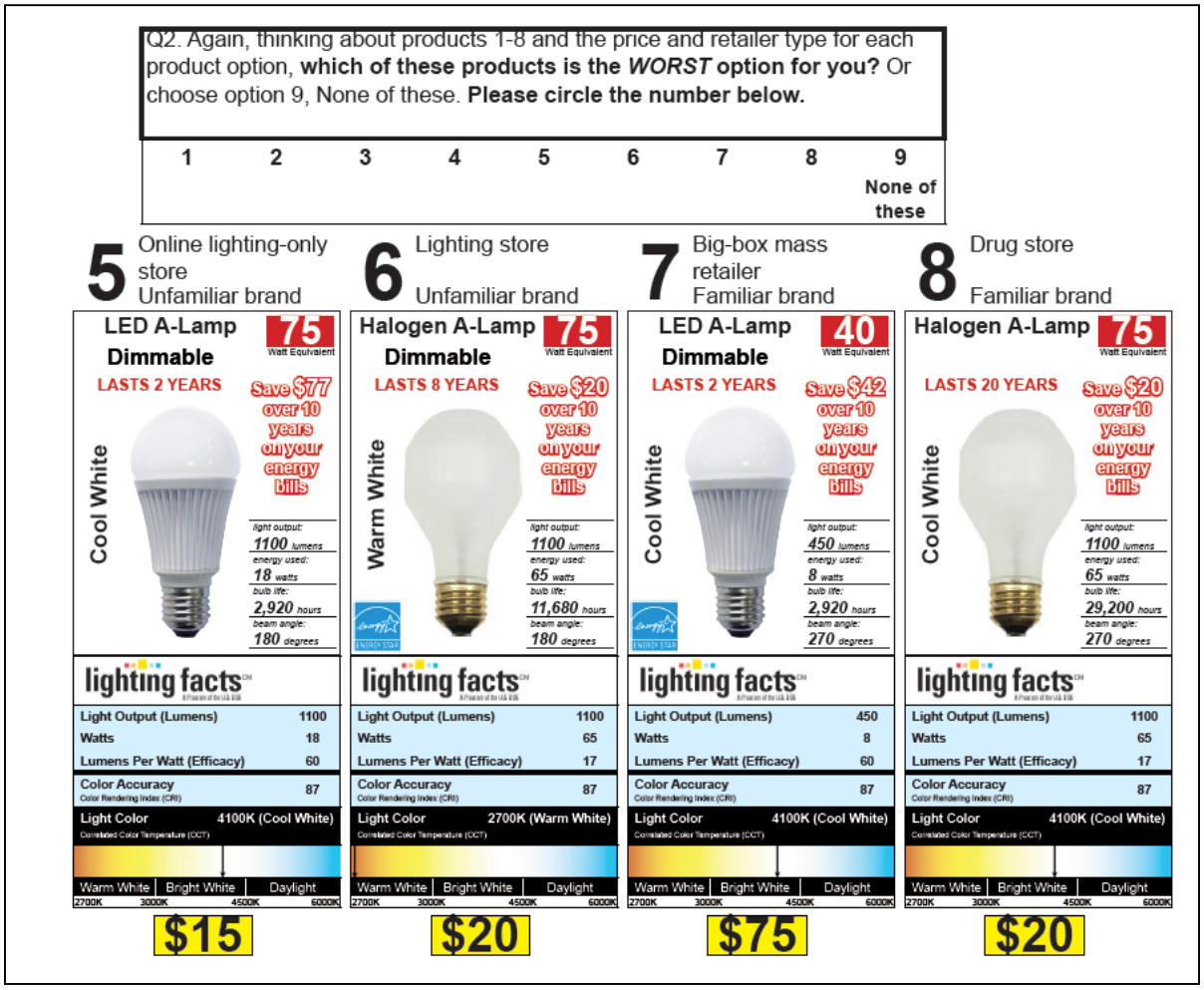
APPENDIX A: LCDC FINAL INSTRUMENT

Please click the link below for the full version of the Final LCDC Instrument. We also include in this appendix examples of the shopping exercises completed by customers.

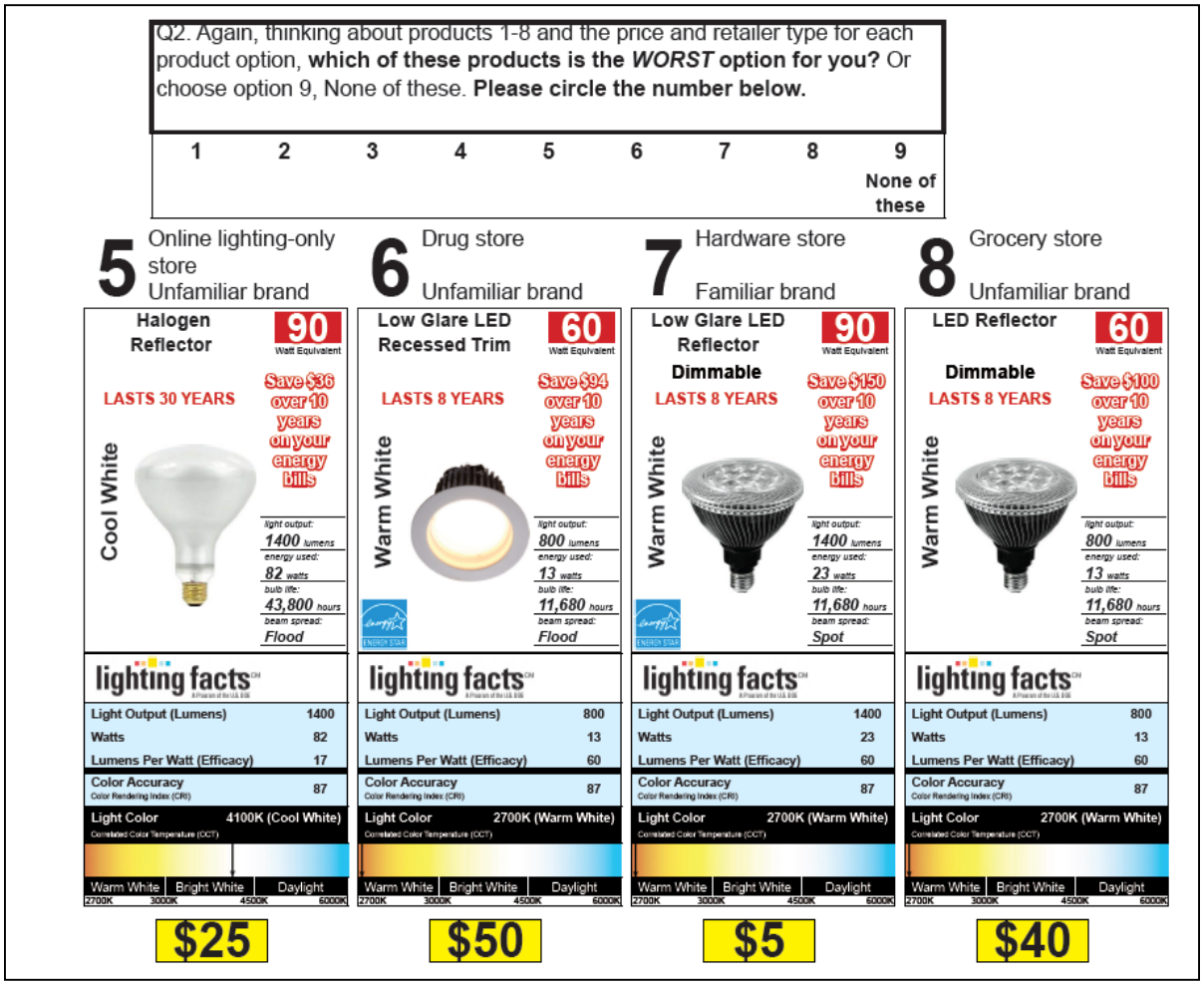
LCDC Final Instrument

A-Line Shopping Exercise Example




Q2. Again, thinking about products 1-8 and the price and retailer type for each product option, which of these products is the WORST option for you? Or choose option 9, None of these. Please circle the number below.
1 2 3 4 5 6 7 8 9
None of these
5 Online lighting-only store Unfamiliar brand
6 Lighting store Unfamiliar brand
7 Big-box mass retailer Familiar brand
8 Drug store Familiar brand
LED A-Lamp Dimmable 75 Watt Equivalent LASTS 2 YEARS Save $77 over 10 years on your energy bills Cool White light output: 1100 lumens energy used: 18 watts bulb life: 2,920 hours beam angle: 180 degrees
Halogen A-Lamp Dimmable 75 Watt Equivalent LASTS 8 YEARS Save $20 over 10 years on your energy bills Warm White light output: 1100 lumens energy used: 65 watts bulb life: 11,680 hours beam angle: 180 degrees
LED A-Lamp Dimmable 40 Watt Equivalent LASTS 2 YEARS Save $42 over 10 years on your energy bills Cool White light output: 450 lumens energy used: 8 watts bulb life: 2,920 hours beam angle: 270 degrees
Halogen A-Lamp 75 Watt Equivalent LASTS 20 YEARS Save $20 over 10 years on your energy bills Cool White light output: 1100 lumens energy used: 65 watts bulb life: 29,200 hours beam angle: 270 degrees
lighting facts
Light Output (Lumens) 1100
Watts 18
Lumens Per Watt (Efficacy) 60
Color Accuracy 87
Light Color 4100K (Cool White)
Warm White Bright White Daylight
2700K 3000K 4500K 6000K
lighting facts
Light Output (Lumens) 1100
Watts 65
Lumens Per Watt (Efficacy) 17
Color Accuracy 87
Light Color 2700K (Warm White)
Warm White Bright White Daylight
2700K 3000K 4500K 6000K
lighting facts
Light Output (Lumens) 450
Watts 8
Lumens Per Watt (Efficacy) 60
Color Accuracy 87
Light Color 4100K (Cool White)
Warm White Bright White Daylight
2700K 3000K 4500K 6000K
lighting facts
Light Output (Lumens) 1100
Watts 65
Lumens Per Watt (Efficacy) 17
Color Accuracy 87
Light Color 4100K (Cool White)
Warm White Bright White Daylight
2700K 3000K 4500K 6000K
$15
$20
$75
$20

Reflector Shopping Exercise Example


Q2. Again, thinking about products 1-8 and the price and retailer type for each product option, **which of these products is the *WORST* option for you?** Or choose option 9, None of these. **Please circle the number below.**
1 2 3 4 5 6 7 8 9
None of these
5 Online lighting-only store
Unfamiliar brand
Halogen Reflector
90 Watt Equivalent
LASTS 30 YEARS
Save $36 over 10 years on your energy bills
Cool White
light output: 1400 lumens
energy used: 82 watts
bulb life: 43,800 hours
beam spread: Flood
lighting facts
Light Output (Lumens) 1400
Watts 82
Lumens Per Watt (Efficacy) 17
Color Accuracy 87
Light Color 4100K (Cool White)
Warm White Bright White Daylight
2700K 3000K 4500K 6000K
$25
6 Drug store
Unfamiliar brand
Low Glare LED Recessed Trim
60 Watt Equivalent
LASTS 8 YEARS
Save $94 over 10 years on your energy bills
Warm White
light output: 800 lumens
energy used: 13 watts
bulb life: 11,680 hours
beam spread: Flood
lighting facts
Light Output (Lumens) 800
Watts 13
Lumens Per Watt (Efficacy) 60
Color Accuracy 87
Light Color 2700K (Warm White)
Warm White Bright White Daylight
2700K 3000K 4500K 6000K
$50
7 Hardware store
Familiar brand
Low Glare LED Reflector Dimmable
90 Watt Equivalent
LASTS 8 YEARS
Save $150 over 10 years on your energy bills
Warm White
light output: 1400 lumens
energy used: 23 watts
bulb life: 11,680 hours
beam spread: Spot
lighting facts
Light Output (Lumens) 1400
Watts 23
Lumens Per Watt (Efficacy) 60
Color Accuracy 87
Light Color 2700K (Warm White)
Warm White Bright White Daylight
2700K 3000K 4500K 6000K
$5
8 Grocery store
Unfamiliar brand
LED Reflector Dimmable
60 Watt Equivalent
LASTS 8 YEARS
Save $100 over 10 years on your energy bills
Warm White
light output: 800 lumens
energy used: 13 watts
bulb life: 11,680 hours
beam spread: Spot
lighting facts
Light Output (Lumens) 800
Watts 13
Lumens Per Watt (Efficacy) 60
Color Accuracy 87
Light Color 2700K (Warm White)
Warm White Bright White Daylight
2700K 3000K 4500K 6000K
$40

APPENDIX B: IN-HOME LAMP TRIAL STUDY INSTRUCTIONS

Thank you for your participation in this study

In this package you will find the following:

- 4 LED Standard A-Lamp Light Bulbs
- 3 LED Reflector Light Bulbs
- Description Sheets for the Light Bulbs
- Instruction Sheet
- Lighting Facts
- Types of Light Bulbs and Fixtures (This will help you in filling out the installation sheet)
- LED Light Bulb Installation Sheet
- Pre-stamped Envelope

Meet Your New LED Light Bulbs

Retail price $15

Feit LED A-Line Light Bulb

Quantity in package: 4
Specifications:
- Omni-directional, 300 degree beam spread
- 60 Watt Equivalent
- 800 Lumens (13.5 Watts)
- 25,000 hours Average life (22.8 years)
- Soft white light
- Dim-able

Recommended for Use in the following fixtures:
- Ceiling Fixtures
- Wall Fixtures
- Lamps

Model number # A19/OM800/LED

Retail price $27

Feit LED Reflector Light Bulb

Quantity in package: 1
Specifications:
- 6 total LEDs within Bulb
- 75 Watt Equivalent
- 650 Lumens (13.5 Watts)
- 25,000 hours Average life (22.8 years)
- Soft white light
- Dim-able
- 30 degrees Beam Spread
- Base Type – E26 (Medium)

Recommended for Use in the following fixtures:
- Recessed lighting fixture
- Track lighting fixture

Model number #13PAR30L/DM/LED

Please note that we are only interested in learning about your opinions and at no point will you be asked to buy anything from Opinion Dynamics Corporation or from Southern California Edison (SCE or Edison)

Philips LED Reflector Light Bulb

Retail price $27

Quantity in package: 1
Specifications:

- 10 total LEDs within Bulb
- 60 Watt Equivalent
- 630 Lumens (12 Watts)
- 25,000 hours Average life (22.8 years)
- White light
- Dim-able
- 25 degrees Beam Spread
- Base Type – E26 (Medium)

Recommended for Use in the following fixtures:

- Recessed lighting fixture
- Track lighting fixture

Model number #12E26PAR30L-E2

Nexxus LED Reflector Light Bulb

Retail price $50

Quantity in package: 1
Specifications:

- 11 total LEDs within Bulb
- 45 Watt Equivalent
- 465 Lumens (9.5 Watts)
- 25,000 hours Average life (22.8 years)
- Soft white light
- Dim-able
- 115 degrees Beam Spread
- Base Type – E26 (Medium)

Recommended for Use in the following fixtures:

- Recessed lighting fixture
- Track lighting fixture

Model number #AE26PAR30112760

Thank you once again for your participation in this study. Please read the following instructions:

1. Please install ALL the LEDs in this package within FIVE days of receipt (4 LED standard A-lamp light bulbs and 3 reflector light bulbs). You will also receive a follow-up phone call from us to confirm receipt of the light bulbs.

2. Please make a note of WHERE you have installed these light bulbs and what was REPLACED by these light bulbs by filling out the 'LED Light Bulb Installation' Sheet.

3. Please mail the completed 'LED Light Bulb Installation' Sheet to Opinion Dynamics in the pre-stamped envelope

4. After 4 weeks of usage, you will be asked to fill out an online survey (the survey instructions will be sent to you via email)

5. After completing the survey, the LEDs are yours to keep and do not have to be returned to us

Lighting Facts

Specifications	Definitions	Halogens	CFLs	LEDs
Average Rated Life	How long it takes for the light bulbs to fail.	1.5 years	7 years	22 years
Life Span	Time in which bulb needs to be replaced	Medium	Long	Very Long
Watts	A unit of electrical power. Lamps are rated in watts to indicate the rate at which they consume energy.	5-500	3-120	2.5-16
Lumens per Watt (LPW)	Measures efficiency - the higher the number, the more efficient the product	15 - 25 LPW	50 - 75 LPW	50 - 100 LPW
Costs to Operate	Cost of running a light bulb for 24 hours	Medium	Low	Low
Average Price	Average price of a light bulb	$5 - $7	$4 - $10	$25 - $45
Turns on Instantly	Time for bulb to reach full brightness	Yes	Slight Delay	Yes
Durability	If bulb can break easily	Durable	Fragile	Durable

Type of Light Bulbs

Incandescent light bulbs are the most commonly used light bulbs. Below are some pictures of incandescent light bulbs.

Standard A-lamp ***Spot/Flood*** ***Globe*** ***Candelabra***

e simil bs with the main differen
gas ca n bulbs tend to be smalle
glass ne pictures of Halogen lig

Standard A-lamp ***Spot/Flood*** ***Globe*** ***Candelabra***

CFLs look different than standard incandescent bulbs and are made out of thin tubes of glass bent into loop. Below are some pictures of CFL light bulbs.

Twist/Spiral ***Spot/Flood*** ***Globe*** ***Candelabra*** ***Standard***

A

-la

A-Lamp

An **LED** is a device that emits light when an electric current passes through it, much like a light bulb. You can typically identify LEDs by a series of small lights that make up a larger display. For example, if you look closely at a flashlight, you can tell it is an LED light if you can see multiple circles with dots. Below are some pictures of LED light bulbs.

Standard A-lamp ***Reflector*** ***Recessed***

…age" for the bulbs

The wattage for a bulb can be either found on the base of the light bulb (See image A) or on top of the light bulb (See image B). The wattage is usually following by a "W" or "Watt"

Image A ***Image B***

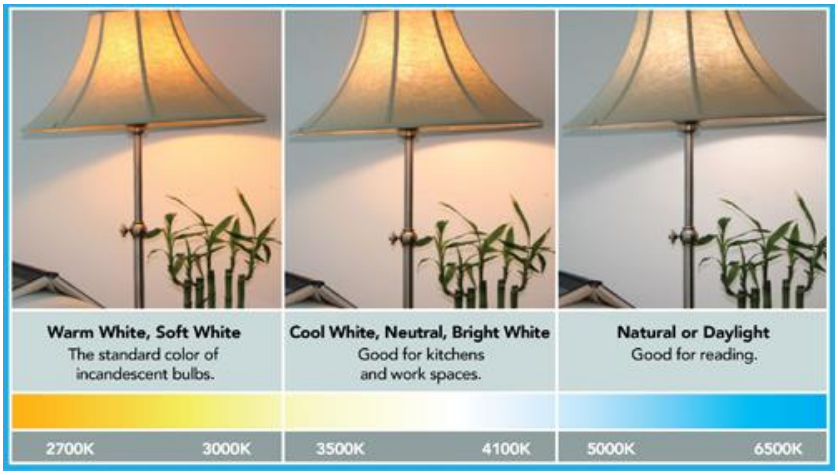
13W Bulb *100W bulb*

Beam Angle/Beam Spread for the Reflector Bulbs

The beam angle/beam spread is degree of width that the light spreads from the light bulb. This information can be found on the base of the bulb or on the packaging. The beam angle/spread is usually following by "°" or "Degree". See examples for two different beam angles.

60 Degrees *120 Degrees*

Different Types of Light Colors



Type of Fixtures

Recessed ceiling fixture ***Flush mounted ceiling fixture***

Track fixture

Wall Fixture

Table lamp

Floor lamp

Vanity fixture

Exterior Wall fixture

Exterior Flood fixture

APPENDIX C: SAMPLE INSTALLATION SHEET

LED LIGHT BULB INSTALLATION

NAME:_____

PHONE: _____

ADDRESS: _____

_____

Please fill out the following information

Thank you for your participation in this important study!

We sincerely appreciate your time and assistance. We would like to get to know more about your usage of the LED light bulbs that you received. We will use your feedback to help improve products and service to customers like you.

Please take your time to thoughtfully completely this sheet and answer the questions to the best of your ability.

You have received **4 Standard A-Lamp LEDs** and **3 Reflector LEDs** – we would like to know where you have installed **EACH** of these bulbs

BULB 1 (Standard A-Lamp)

A1. Where Did you Install this Bulb?	
Not Installed	⊂⊃ 0
Bedroom (regularly used)	⊂⊃ 1
Guest Bedroom (not regularly used)	⊂⊃ 2
Bathroom	⊂⊃ 3
Living Room	⊂⊃ 4
Kitchen	⊂⊃ 5
Hallway	⊂⊃ 6
Closet	⊂⊃ 7
Garage	⊂⊃ 8
Outside Front Door	⊂⊃ 9
Outside Back Door	⊂⊃10
Front Yard	⊂⊃11
Back Yard	⊂⊃12
Other (specify)	(Specify)_____

A2. What type of lighting fixture is the LED installed into?	
Not Installed	⊂⊃ 0
Recessed Ceiling fixture	⊂⊃ 1
Flush Mounted Ceiling fixture	⊂⊃ 2
Wall fixture	⊂⊃ 3
Table lamp	⊂⊃ 4
Floor lamp	⊂⊃ 5
Other (specify)	(Specify)_____

A3. Did this bulb replace an existing light bulb?		
Not Installed	⊂⊃ 0	
Yes	⊂⊃ 1	If you answer Yes, please answer QA4-QA5
No	⊂⊃ 2	If you answer No, please skip to Bulb 2

A4. Please write down the details of the bulb replaced	
Not Installed	⊂⊃ 0
A. Kind of Bulb (example, incandescent, Halogen, CFL etc)	
B. Specific bulb type (example, A-Lamp, spot/flood, globe, candelabra etc	
C. Wattage of bulb (example, 10 watts, 40 watts, 60 watts, etc.)	

A5. How do you use the fixture in which you installed the LED? (Please check all that apply)	
Not Installed	⊂⊃ 0
Reading	⊂⊃ 1
Ambient Light	⊂⊃ 2
Illuminating a work space	⊂⊃ 3
Illuminating a kitchen or bathroom sink	⊂⊃ 4
Creating a design effect (such as mood lighting)	⊂⊃ 5
Security	⊂⊃ 6
Other (specify)	(Specify)_____

BULB 2 (Standard A-Lamp)

B1. Where Did you Install this Bulb?	
Not Installed	⊂⊃ 0
Bedroom (regularly used)	⊂⊃ 1
Guest Bedroom (not regularly used)	⊂⊃ 2
Bathroom	⊂⊃ 3
Living Room	⊂⊃ 4
Kitchen	⊂⊃ 5
Hallway	⊂⊃ 6
Closet	⊂⊃ 7
Garage	⊂⊃ 8
Outside Front Door	⊂⊃ 9
Outside Back Door	⊂⊃10
Front Yard	⊂⊃11
Back Yard	⊂⊃12
Other (specify)	(Specify)_____

B2. What type of lighting fixture is the LED installed into?	
Not Installed	⊂⊃ 0
Recessed Ceiling fixture	⊂⊃ 1
Flush Mounted Ceiling fixture	⊂⊃ 2
Wall fixture	⊂⊃ 3
Table lamp	⊂⊃ 4
Floor lamp	⊂⊃ 5
Other (specify)	(Specify)_____

B3. Did this bulb replace an existing light bulb?		
Not Installed	⊂⊃ 0	
Yes	⊂⊃ 1	If you answer Yes, please answer QB4-QB5
No	⊂⊃ 2	If you answer No, please skip to Bulb 3

B4. Please write down the details of the bulb replaced	
Not Installed	⊂⊃ 0
A. Kind of Bulb (example, incandescent, Halogen, CFL etc)	
B. Specific bulb type (example, A-Lamp, spot/flood, globe, candelabra etc	
C. Wattage of bulb (example, 10 watts, 40 watts, 60 watts, etc.)	

B5. How do you use the fixture is which you installed the LED? (Please check all that apply)	
Not Installed	⊂⊃ 0
Reading	⊂⊃ 1
Ambient Light	⊂⊃ 2
Illuminating a work space	⊂⊃ 3
Illuminating a kitchen or bathroom sink	⊂⊃ 4
Creating a design effect (such as mood lighting)	⊂⊃ 5
Security	⊂⊃ 6
Other (specify)	(Specify)_____

BULB 3 (Standard A-Lamp)

C1. Where Did you Install this Bulb?	
Not Installed	⊂⊃ 0
Bedroom (regularly used)	⊂⊃ 1
Guest Bedroom (not regularly used)	⊂⊃ 2
Bathroom	⊂⊃ 3
Living Room	⊂⊃ 4
Kitchen	⊂⊃ 5
Hallway	⊂⊃ 6
Closet	⊂⊃ 7
Garage	⊂⊃ 8
Outside Front Door	⊂⊃ 9
Outside Back Door	⊂⊃10
Front Yard	⊂⊃11
Back Yard	⊂⊃12
Other (specify)	(Specify)_____

C2. What type of lighting fixture is the LED installed into?	
Not Installed	⊂⊃ 0
Recessed Ceiling fixture	⊂⊃ 1
Flush Mounted Ceiling fixture	⊂⊃ 2
Wall fixture	⊂⊃ 3
Table lamp	⊂⊃ 4
Floor lamp	⊂⊃ 5
Other (specify)	(Specify)_____

C3. Did this bulb replace an existing light bulb?		
Not Installed	⊂⊃ 0	
Yes	⊂⊃ 1	If you answer Yes, please answer QC4-QC5
No	⊂⊃ 2	If you answer No, please skip to Bulb 4

C4. Please write down the details of the bulb replaced	
Not Installed	⊂⊃ 0
A. Kind of Bulb (example, incandescent, Halogen, CFL etc)	
B. Specific bulb type (example, A-Lamp, spot/flood, globe, candelabra etc	
C. Wattage of bulb (example, 10 watts, 40 watts, 60 watts, etc.)	

C5. How do you use the fixture in which you installed the LED? (Please check all that apply)	
Not Installed	⊂⊃ 0
Reading	⊂⊃ 1
Ambient Light	⊂⊃ 2
Illuminating a work space	⊂⊃ 3
Illuminating a kitchen or bathroom sink	⊂⊃ 4
Creating a design effect (such as mood lighting)	⊂⊃ 5
Security	⊂⊃ 6
Other (specify)	(Specify)_____

BULB 4 (Standard A-Lamp)

D1. Where Did you Install this Bulb?	
Not Installed	⊂⊃ 0
Bedroom (regularly used)	⊂⊃ 1
Guest Bedroom (not regularly used)	⊂⊃ 2
Bathroom	⊂⊃ 3
Living Room	⊂⊃ 4
Kitchen	⊂⊃ 5
Hallway	⊂⊃ 6
Closet	⊂⊃ 7
Garage	⊂⊃ 8
Outside Front Door	⊂⊃ 9
Outside Back Door	⊂⊃10
Front Yard	⊂⊃11
Back Yard	⊂⊃12
Other (specify)	(Specify)_____

D2. What type of lighting fixture is the LED installed into?	
Not Installed	⊂⊃ 0
Recessed Ceiling fixture	⊂⊃ 1
Flush Mounted Ceiling fixture	⊂⊃ 2
Wall fixture	⊂⊃ 3
Table lamp	⊂⊃ 4
Floor lamp	⊂⊃ 5
Other (specify)	(Specify)_____

D3. Did this bulb replace an existing light bulb?		
Not Installed	⊂⊃ 0	
Yes	⊂⊃ 1	If you answer Yes, please answer QD4-QD5
No	⊂⊃ 2	If you answer No, please skip to Bulb 5

D4. Please write down the details of the bulb replaced	
Not Installed	⊂⊃ 0
A. Kind of Bulb (example, incandescent, Halogen, CFL etc)	
B. Specific bulb type (example, A-Lamp, spot/flood, globe, candelabra etc	
C. Wattage of bulb (example, 10 watts, 40 watts, 60 watts, etc.)	

D5. How do you use the fixture in which you installed the LED? (Please check all that apply)	
Not Installed	⊂⊃ 0
Reading	⊂⊃ 1
Ambient Light	⊂⊃ 2
Illuminating a work space	⊂⊃ 3
Illuminating a kitchen or bathroom sink	⊂⊃ 4
Creating a design effect (such as mood lighting)	⊂⊃ 5
Security	⊂⊃ 6
Other (specify)	(Specify)_____

BULB 5 (Reflector)

E1. Where Did you Install this Bulb?	
Not Installed	⊂⊃ 0
Bedroom (regularly used)	⊂⊃ 1
Guest Bedroom (not regularly used)	⊂⊃ 2
Bathroom	⊂⊃ 3
Living Room	⊂⊃ 4
Kitchen	⊂⊃ 5
Hallway	⊂⊃ 6
Closet	⊂⊃ 7
Garage	⊂⊃ 8
Outside Front Door	⊂⊃ 9
Outside Back Door	⊂⊃10
Front Yard	⊂⊃11
Back Yard	⊂⊃12
Other (specify)	(Specify)_____

E2. What type of lighting fixture is the LED installed into?	
Not Installed	⊂⊃ 0
Recessed Ceiling fixture	⊂⊃ 1
Wall fixture	⊂⊃ 2
Flood lighting fixture	⊂⊃ 3
Track lighting fixture	⊂⊃ 4
Other (specify)	(Specify)_____

E3. Did this bulb replace an existing light bulb?		
Not Installed	⊂⊃ 0	
Yes	⊂⊃ 1	If you answer Yes, please answer QE4-QE5
No	⊂⊃ 2	If you answer No, please skip to Bulb 6

E4. Please write down the details of the bulb replaced	
Not Installed	⊂⊃ 0
A. Kind of Bulb (example, incandescent, Halogen, CFL etc)	
B. Beam angle of bulb (example, 60 degrees, 120 degrees)	
C. Wattage of bulb (example, 10 watts, 40 watts, 60 watts, etc.)	

E5. How do you use the fixture in which you installed the LED? (Please check all that apply)	
Not Installed	⊂⊃ 0
Reading	⊂⊃ 1
Ambient Light	⊂⊃ 2
Illuminating a work space	⊂⊃ 3
Illuminating a kitchen or bathroom sink	⊂⊃ 4
Creating a design effect (such as mood lighting)	⊂⊃ 5
Security	⊂⊃ 6
Other (specify)	(Specify)_____

BULB 6 (Reflector)

F1. Where Did you Install this Bulb?	
Not Installed	⊂⊃ 0
Bedroom (regularly used)	⊂⊃ 1
Guest Bedroom (not regularly used)	⊂⊃ 2
Bathroom	⊂⊃ 3
Living Room	⊂⊃ 4
Kitchen	⊂⊃ 5
Hallway	⊂⊃ 6
Closet	⊂⊃ 7
Garage	⊂⊃ 8
Outside Front Door	⊂⊃ 9
Outside Back Door	⊂⊃10
Front Yard	⊂⊃11
Back Yard	⊂⊃12
Other (specify)	(Specify)_____

F2. What type of lighting fixture is the LED installed into?	
Not Installed	⊂⊃ 0
Recessed Ceiling fixture	⊂⊃ 1
Wall fixture	⊂⊃ 2
Flood lighting fixture	⊂⊃ 3
Track lighting fixture	⊂⊃ 4
Other (specify)	(Specify)_____

F3. Did this bulb replace an existing light bulb?		
Not Installed	⊂⊃ 0	
Yes	⊂⊃ 1	If you answer Yes, please answer QF4-QF5
No	⊂⊃ 2	If you answer No, please skip to Bulb 7

F4. Please write down the details of the bulb replaced	
Not Installed	⊂⊃ 0
A. Kind of Bulb (example, incandescent, Halogen, CFL etc)	
B. Beam angle of bulb (example, 60 degrees, 120 degrees)	
C. Wattage of bulb (example, 10 watts, 40 watts, 60 watts, etc.)	

F5. How do you use the fixture in which you installed the LED? (Please check all that apply)	
Not Installed	⊂⊃ 0
Reading	⊂⊃ 1
Ambient Light	⊂⊃ 2
Illuminating a work space	⊂⊃ 3
Illuminating a kitchen or bathroom sink	⊂⊃ 4
Creating a design effect (such as mood lighting)	⊂⊃ 5
Security	⊂⊃ 6
Other (specify)	(Specify)_____

BULB 7 (Reflector)

G1. Where Did you Install this Bulb?	
Not Installed	⊂⊃ 0
Bedroom (regularly used)	⊂⊃ 1
Guest Bedroom (not regularly used)	⊂⊃ 2
Bathroom	⊂⊃ 3
Living Room	⊂⊃ 4
Kitchen	⊂⊃ 5
Hallway	⊂⊃ 6
Closet	⊂⊃ 7
Garage	⊂⊃ 8
Outside Front Door	⊂⊃ 9
Outside Back Door	⊂⊃10
Front Yard	⊂⊃11
Back Yard	⊂⊃12
Other (specify)	(Specify)_____

G2. What type of lighting fixture is the LED installed into?	
Not Installed	⊂⊃ 0
Recessed Ceiling fixture	⊂⊃ 1
Wall fixture	⊂⊃ 2
Flood lighting fixture	⊂⊃ 3
Track lighting fixture	⊂⊃ 4
Other (specify)	(Specify)_____

G3. Did this bulb replace an existing light bulb?		
Not Installed	⊂⊃ 0	
Yes	⊂⊃ 1	If you answer Yes, please answer QG4-QG5
No	⊂⊃ 2	

G4. Please write down the details of the bulb replaced	
Not Installed	⊂⊃ 0
A. Kind of Bulb (example, incandescent, Halogen, CFL etc)	
B. Beam angle of bulb (example, 60 degrees, 120 degrees)	
C. Wattage of bulb (example, 10 watts, 40 watts, 60 watts etc)	

G5. How do you use the fixture is which you installed the LED? (Please check all that apply)	
Not Installed	⊂⊃ 0
Reading	⊂⊃ 1
Ambient Light	⊂⊃ 2
Illuminating a work space	⊂⊃ 3
Illuminating a kitchen or bathroom sink	⊂⊃ 4
Creating a design effect (such as mood lighting)	⊂⊃ 5
Security	⊂⊃ 6
Other (specify)	(Specify)_____

Thank you for filling this out. Please mail these sheets back to Opinion Dynamics in the pre-stamped envelope.

APPENDIX D: EXPERIENCED SURVEY

Thank you for your participating in this important study!

We sincerely appreciate your time and assistance. We would like to get your opinion on the LED light bulbs that you received. We care very much about your thoughts and ideas. We will use your feedback to help improve products and services to customers like you.

Please take your time to thoughtfully completely the survey and answer the questions to the best of your ability.

PART 1: PRE-SHOPPING

Q1. Have you purchased a screw-in LED light bulb in the past 12 months?

1. Yes, I have purchased a screw-in LED light bulb
2. No LED Lighting Products
3. No Screw-In LED bulbs, but other LED products (Rope/Holiday LEDs)

[ASK IF Q1 = 1]

Q1a. What kinds of LEDs have you purchased? (Check all that apply)

1. A-Lamp (Standard Bulb Shape)

2. Spot/Flood

3. Recessed Trim

4. Other (specify)

[ASK IF Q1 = 1]

Q1b. How many total LED bulbs did you buy in the past 12 months?

1. 1
2. 2
3. 3
4. 4
5. 5
6. 6
7. 7
8. 8
9. 9
10. 10
11. More than 10

[ASK IF Q1b=11]

Q1c. Please write down the total number of LED bulbs you bought in the past 12 months. [OPEN END]

Compact Florescent Lights (CFLs) are made out of thin tubes of glass bent into loops. These look different than standard incandescent bulbs, but can be used in the same way. Below are pictures of screw-in CFL light bulbs that can be used in your home or business.

Q2. Have you ever purchased a CFL?

1. Yes
2. No

[ASK IF Q2 = 1]

Q2a. What kinds of CFLs have you purchased? (Check all that apply)

1. Twist/Spiral

2. Spot/Flood

3. Globe

4. Candelabra

5. A-Lamp (Standard Bulb Shape)

6. Other (specify)

[ASK IF Q2 = 1]
Q2b. How many total CFL bulbs did you buy in the past 12 months?

1. 1
2. 2
3. 3
4. 4
5. 5
6. 6
7. 7
8. 8
9. 9
10. 10
11. More than 10
12. None

[ASK IF Q2b=11]
Q2c. Please write down the total number of CFL bulbs you bought in the past 12 months. [OPEN END]

[ASK IF Q2=1]
Q3. Approximately what percentage of all the standard light sockets in your home have CFLs installed in them?

1. 10%
2. 20%
3. 30%
4. 40%
5. 50%
6. 60%
7. 70%
8. 80%
9. 90%
10. 100%
11. None

Q4. Where do you usually shop for light bulbs (of any type)? (Store name or type of store, such as "drug store" or "home improvement store") (Check all that apply)

1. Drug Store [For example CVS]
2. Home Improvement Store [For example Home Depot]
3. Grocery Store [For example Safeway]
4. Supermarket [For example Wal-Mart]
5. Warehouse Store [For example Costco]
6. Mass Merchandiser [For example Target]
7. Other (Specify)_____

Q5. Do you plan on purchasing additional light bulbs (of any type) in the next six months?

1. Yes
2. No

[ASK IF Q5 = 2]

Q5a. How many months from now do you think you will purchase new light bulbs?

1. 7 month
2. 8 months
3. 9 months
4. 10 months
5. 11 months
6. 1 Year
7. More than a year
8. Other (specify)_____
98. Don't Know

Q6 - Do you plan on purchasing CFLs in the next six months?

1. Yes
2. No

[ASK IF Q6 = 2]

Q6a. How many months from now do you think you will purchase new CFLs?

1. 7 month
2. 8 months
3. 9 months
4. 10 months
5. 11 months
6. 1 Year
7. More than a year
00. Other (specify)_____
98. Don't Know

Q7. When you shop for light bulbs, do you shop for a particular wattage (or wattage equivalent)?

1. Yes
2. No

[ASK IF Q7 = 1]

Q7a. If you found a light bulb that had features you liked (such as color, shape, or price) but *was not* the wattage (or wattage equivalent) you were looking for, would you buy it?

1. Yes
2. No

On the following screens, imagine that you are shopping for one or more light bulbs. In today's market there are number of different choices available, different in terms of price, wattage, brightness, and color.

In each "virtual shop", you will have a choice of types of bulbs including halogen, LED's and CFL's. Each bulb type has a number of characteristics associated with it. In each shop, you can choose any one of the products that are on offer or, if you don't see anything you like on a particular screen, you can always choose the 'none' option. A description of each type of bulb is included before the shopping screens.

IMPORTANT NOTES:

1. Don't comparison-shop between screens. You are starting over on each screen, and you should make your decision **only** on what is offered on that screen.
2. Don't feel you have to buy anything if you don't want to. Every shop has a "none" option.

This is strictly imaginary shopping – you are not actually purchasing such a product – but we would like you to consider the choices as realistically as possible, given your needs, interests, and budget.

[INSERT Shopping exercises from the 'General Population Survey']

Now please think about the free LED light bulbs that you received.

SO1. In the time since you received the free LEDs have you purchased and installed any additional energy efficient light bulbs?

1. Yes
2. No **[SKIP TO SO4]**

SO2. How many additional energy efficient light bulbs did you purchase on your own?

1. 1
2. 2
3. 3
4. 4
5. 5
6. 6
7. 7
8. 8
9. 9

10. 10
11. More than 10

[ASK IF SO2=11]
Q2c. Please write down the total number of energy efficient light bulbs you bought on your own. [OPEN END]

SO3. For the following statement, please indicate if you strongly disagree, somewhat disagree, neutral, somewhat agree, or strongly agree.

	1 Strongly Disagree	2 Somewhat Disagree	3 Neutral	4 Somewhat Agree	5 Strongly Agree
My experience with the free LEDs influenced my decision to install more efficient lighting products on my own.					

SO4. Following are a list of reasons that keep some people from installing LEDs. For each one, please indicate if you strongly agree, somewhat agree, neutral, somewhat disagree or strongly disagree.

	1 Strongly Disagree	2 Somewhat Disagree	3 Neutral	4 Somewhat Agree	5 Strongly Agree
LEDs are too expensive					
I prefer the way other light bulbs (such as incandescent bulbs/CFLs) look in a fixture compared to the LED					
I prefer the quality of light of other light bulbs (such as incandescent bulbs/CFLs) compared to the LED					
I am unsure of which wattage to buy for an LED					
LEDs are not bright enough					
The energy savings you get is not worth the cost of the bulb					

[SCREEN BREAK]

Process and LED User Section

For the following statement, please indicate if you are not at all satisfied, somewhat not satisfied, neutral, somewhat satisfied, or extremely satisfied.

	1 Not at All Satisfied	2 Somewhat Not Satisfied	3 Neutral	4 Somewhat Satisfied	5 Extremely Satisfied
P1. How satisfied are you overall with the **Standard A-lamp LEDs** currently installed in your home.					

P1a. Why did you give it that score? [OPEN END]

	1 Not at All Satisfied	2 Somewhat Not Satisfied	3 Neutral	4 Somewhat Satisfied	5 Extremely Satisfied
P2. How satisfied are you overall with the **Reflector LEDs** currently installed in your home.					

P2a. Why did you give it that score? [OPEN END]

P3. Is your level of satisfaction different depending on where the LED is installed (interior or exterior fixture, room type, fixture type or type of bulb replaced)?
1. Yes
2. No

[ASK IF P3 = 1]
P3a. Why is your level of satisfaction different? [OPEN END]

P4. Thinking about the recessed reflector LEDs installed in an **INTERIOR FIXTURE** of your home, which beam angle were you **MOST** satisfied with?
1. 25 degrees (Narrow beam angle)
2. 30 degrees (Medium beam angle)
3. 115 degrees (Wide beam angle)
4. None

P5. Thinking about the recessed reflector LEDs installed in an **INTERIOR FIXTURE** of your home, which beam angle were you **LEAST** satisfied with?
1. 25 degrees (Narrow beam angle)
2. 30 degrees (Medium beam angle)
3. 115 degrees (Wide beam angle)
4. None

P6. Thinking about the recessed reflector LEDs installed in an **EXTERIOR FIXTURE** of your home, which beam angle were you **MOST** satisfied with?
1. 25 degrees (Narrow beam angle)
2. 30 degrees (Medium beam angle)
3. 115 degrees (Wide beam angle)

4. None

P7. Thinking about the recessed reflector LEDs installed in an **EXTERIOR FIXTURE** of your home, which beam angle were you **LEAST** satisfied with?

1. 25 degrees (Narrow beam angle)
2. 30 degrees (Medium beam angle)
3. 115 degrees (Wide beam angle)
4. None

[SCREEN BREAK]

We would like to know more about your household to make sure we talk to a representative sample of SCE customers.

D1. What is your gender?

1. Male
2. Female

D2. Is English the primary language spoken in your home?

1. Yes
2. No

D3. Are you currently employed?

1. Employed Full Time
2. Employed Part Time
3. Not Currently Employed
4. Student
5. Self-Employed
6. Retired
7. Homemaker
9. Refused

[ASK IF D3 = 1, 2, 5]

D4. Which of the following categories best describes your current line of employment?

1. Business / Financial / Banking / Management
2. Computer / Science / Research / Engineering / Architecture
3. Health Care & Related Services
4. Education / Training / Library Services
5. Food Services / Hospitality / Personal Care Services
6. Sales / Retail
7. Construction / Maintenance / Repair Services
8. Legal & Related Services
9. Community and Social Services / Police / Fire / Military Service
10. Manufacturing / Goods Production / Transportation
11. Arts / Design / Entertainment / Sports / Media
12. Other (Please Describe)_____

D5. Which category best describes your total household income in 2011 before taxes?

1. Less than $15,000
2. $15,000 to less than $30,000
3. $30,000 to less than $50,000
4. $50,000 to less than $75,000
5. $75,000 to less than $100,000
6. $100,000 to $150,000
7. $150,000 or more
9. Refused

H1. Do you or members of your household own your home or do you rent?

1. Own
2. Rent
3. Other (specify)_____

H2. In which Zip Code is your residence located? [OPEN END]

H3. What type of house do you live in?

1. Single family home (ranch)
2. Single family home (2 or more stories)
3. Two-family duplex or flat
4. Condominium (apartment style)
5. Condominium (townhouse style)
6. Condominium (ranch style)
7. Mobile home
8. Apartment (3 or more living units in building)
9. Townhouse (attached)
10. Cottage or cabin
11. Other (specify)_____

This completes the survey. SCE appreciates your participation. Thank you for your time.

APPENDIX E: IN-DEPTH INTERVIEW GUIDE

We would like to get a more in-depth understanding of your opinion on the LED light bulbs that you received. Please give your honest opinions and respond freely to our questions. All answers will be kept strictly confidential.

[NOTE TO INTERVIEWER – FOR EACH QUESTION PROBE FOR ANSWERS FOR BOTH STANDARD A-LAMP AND REFLECTOR BULBS]

Q1. What are the things you look for in a lighting product? [PROBE FOR- watt, color, price]

Q2. Where do you usually shop for lighting products?

Q3. Why did you choose to participate in this trial?

Q4. What were your expectations of the light bulbs prior to receiving then? [PROBE FOR differences by bulb type]

Q5. Where did you install the LEDs that you received? [PROBE FOR interior/exterior, specific area, fixture types]

Q6. Why did you choose to install the LEDs in those areas/fixtures?

Q7. Did you move or remove any of the LEDs after you installed them? If yes, why were they uninstalled? Were they moved to a different part of the house – where and why?

Q8. After having used the LEDs, would you purchase them in the future? Why/ why not? [If respondent answers "don't like them" or "they wouldn't work", probe for more specific reasons]

Q9. Could you go into a little more detail about what you liked or disliked about the LEDs?

Q10. What are the qualities in an LED that you favor over other types of light bulbs?

Q11. If these LEDs were available at your local store, how much would you pay for them? What is the maximum that you would pay? Why?

Q12. Overall, how do the LEDs compare to other light bulbs in your home?

Q13. What would you do to improve the LEDs? [PROBE FOR changes in terms of wattage, price, way light bulb looks in a fixture, brightness, light quality, beam angle]

Q14. Is there anything else that you would like to tell me about your experience with the LED Standard A-lamps or LED reflectors?

This completes the survey. SCE appreciates your participation. Thank you for your time.

APPENDIX F: SEGMENT SLIDES

A-Line Segments

Tech Seekers (25%)

"I would buy [LEDs] in an instant if the price was reasonable…and I'm expecting to pay a little bit more."

This segment is sold on LEDs. While they have yet to purchase them, they are generally not satisfied with CFLs and are looking for a better solution. Demonstrate the "cutting-edge" technology. Appeal to their curiosities with interactive displays. Find them online too.

- All things equal, I prefer to buy:
  - LEDs (84%)
  - A familiar brand if I am going to experiment
  - Energy Star products
  - Warmer color temperatures
- Where costs are concerned, I:
  - Am willing to pay more to try it out
  - Don't care much about lifetime
  - Am not concerned with saving on my energy bill
- In the past I have:
  - Replaced up to 80-90% of sockets with CFLs
  - Favor of CFLs over LEDs
  - Not likely purchased LEDs before (23%)
- In the future I will:
  - Most likely enter the LED market
  - Will avoid purchasing CFLs because I can do better
- Find me:
  - In big box building and online stores with other men
  - In higher income areas
  - Browsing new products and product review sites
- Win me over by:
  - Appealing to my desire to try new products
  - Showing me affordable "cutting-edge" technologies

Practical Shoppers (30%) ✧

"I might buy. I'd have to know more about it. I mean what are the features? What's it gonna do? I'd have to have more information."

Target this segment with clear and concise education at the shelf. Practical Shoppers can be LED converts if the product offer is balanced: reasonable price, trust-worthy lifetime savings. Target this segment on the Saturday Big-Box trips. Get on the shopping list.

- All things equal, I prefer to buy:
  - Halogens (63%) and CFLs (22%)
  - LEDs (15%)
  - Any brand that meets my needs
  - Cooler color temperatures
  - ENERGY STAR®
- Where costs are concerned, I:
  - Prefer low prices, but might budge
  - Look for long lasting lamps
  - Would like to save on my energy bill
- In the past I have:
  - Replaced up to 80-90% of sockets with CFLs
  - Possibly purchased LEDs before (41%)
- In the future I will:
  - Mostl likely purchase more CFLs (65%)
- Find me:
  - At big box, mass merchandisers
  - In moderate-income regions
  - On Saturdays with female sshopping for other goods
- Win me over by:
  - Clearly showing me the long-term savings gained by spending a little more now
  - Showing me how much I can save on my energy bills

Thrifty DIY-ers (31%)

"[For $5 per bulb] I'd do the whole house. … If they would still last 10 years."

This segment is price focused but receptive to trying new products. Target this segment by profiling products at home improvement and hardware stores. Make sure they view LEDs as the practical , home renovation and upgrade solution.

- All things equal, I prefer to buy:
  - Halogens (95%)
  - LEDs (2%)
  - An unfamiliar brand to save money
  - Any lamp, regardless of Energy Star certification
  - Warmer color temperatures
- Where costs are concerned, I:
  - Will only consider low priced lamps
  - Look for long lasting lamps
  - Need to save on my energy bill
- In the past I have:
  - Replaced up to 80-90% of sockets with CFLs
  - Possibly purchased LEDs before (38%)
- In the future I will:
  - Most likely purchase more CFLs
- Find me:
  - In big box building, hardware, and light stores
  - Across all regions, regardless of income
  - With all the other men at Lowes or Home Depot
- Win me over by:
  - Bringing the costs of LEDs down and demonstrating how they are the "light of choice" for DIY homeowners
  - Making sure I see the value of LEDs over *Halogens*

Convenience-Focused (14%) ✧

"If I am there (at the grocery store) I am going to buy what I need."

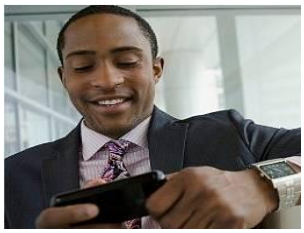
This segment will purchase only what they absolutely must and will pick up products at stores last minute. They buy CFLs because they know them, but will try LEDs. Target this segment in-store with end caps and place in impulse purchase areas (checkout).

- All things equal, I prefer to buy:
  - Nothing at all
  - CFLs (53%) if I have to choose
  - LEDs (16%)
  - Cooler color temperatures
- Where costs are concerned, I:
  - Prefer low and must be convinced to spend more
  - Could be persuaded to pay a premium for long lasting lamps
  - Feel energy savings is a plus, but not necessary
- In the past I have:
  - Avoided adopting CFLs more than others segments
  - Possibly purchased LEDs before (38%), but not committed
- In the future I will:
  - Likely purchase some CFLs
- Find me:
  - At big-box mass merchandisers and building stores
  - I might also shop lamps at grocery stores
  - Among women in higher-income areas
- Win me over by:
  - Making LEDs an obvious and easy purchase decision
  - Placing LEDs at low prices near checkout where I shop

Reflector Segments

Product Explorers (24%) ✧

"I'm interested. Now I want to go Google it and find out more about it."



This segment is interested in new technologies (seen in their willingness to convert to LEDs and past CFL purchases). Appeal to their curiosities through online review sites and technology presses. Lead them to in-store demonstrations.

- All things equal, I prefer to buy:
  - LEDs (48%)
  - Any brand that meets my needs
  - Cool color temperatures
  - Bright lamps (75 wattage equivalent and up)
- When costs are concerned, I:
  - Prefer low prices, but might budge
  - Look for long lasting lamps
- In the past I have:
  - Replaced up to 80-90% of sockets with CFLs
  - Possibly purchased LEDs before (34%)
- In the future I will:
  - Likely purchase CFLs
  - Possibly try LEDs
- Find me:
  - Online shopping for the latest technologies
  - Among males in middle-income areas
- Win me over by:
  - Inviting me to special demonstration events and interactive displays
  - Providing me with online reviews at credible sites

Energy Investors (49%) ✧

"I'd want to go with the most efficient one. So yeah when I see the ENERGY STAR notice on things I … it's a good thing."

This segment is technology, not brand, focused. Energy-minded and price sensitive, this segment wants to purchase LEDs but will do so only if the price is right and the lamp will last a long time. This segments wants efficiency, but won't pay a premium to get it.

- All things equal, I prefer to buy:
  - LEDs (82%)
  - Unfamiliar brands if they save me money
  - Energy Star products
  - Cooler color temperatures
  - Dimmable lamps
- When costs are concerned, I:
  - Will only consider low priced lamps
  - Look for long lasting lamps
- In the past I have:
  - Replaced up to 80-90% of sockets with CFLs
  - Not likely purchased LEDs before (28%)
- In the future I will:
  - Likely purchase CFLs
  - Possibly try LEDs
- Find me:
  - At grocery stores and drug stores, and maybe online
  - Among males in high-income areas
- Win me over by:
  - Bring prices down and convey the energy and lifetime benefits
  - Convey the value of EE lamps for Reflector applications

Value-Focused (14%)

"We are all looking for the label. You know . . . anything that will cut costs."

This segment is interested in value and convenience. They will not purchase unless the price is reasonable, but will take into account lifetime savings. This segment is dominated by women who purchase lighting "along the way" with few clear preferences

- All things equal, I prefer to buy:
  - Halogens (41%) or CFLs (38%) LEDs (21%)
  - Familiar brands
  - Cooler color temperatures
- When costs are concerned, I:
  - Will only consider low priced lamps
  - Look for long lasting lamps
  - Want long-term savings
- In the past I have:
  - Replaced up to 80-90% of sockets with CFLs
  - Tried LEDs, but generally preferred CFLs
- In the future I will:
  - Likely purchase CFLs
  - Purchased LEDs before (57%)
- Find me:
  - At most outlets, but usually in grocery stores
  - Definitely not online
  - Among females in higher-income areas
- Win me over by:
  - Clearly conveying how LEDs are a "smart" and "sensible Choice for my home.
  - Placing lamps in easy-to-find promotional spaces in grocery stores or mass merchandisers.

Deal-Sleuths (13%)

"If it was a product I was already using, I would look for deeper discounts."

This segment is loyal only to prices and deals. To gain penetration with this segment, run promotional events, give-aways, and direct installs. This segment will never be loyal to a single technology unless it is cost-competitive.

- All things equal, I prefer to buy:
  - LEDs (59%)
  - Any lamp if the price is right
  - Familiar brands
  - Warm color temperatures
  - Extremely bright lamps (90 wattage equivalent or higher)
  - Narrow-beamed "spot" lamps
- When costs are concerned:
  - Will only consider low priced lamps
  - Look for long lasting lamps
- In the past I have:
  - Purchased CFLs
  - Possibly purchased LEDs (40%)
- In the future I will:
  - Most likely buy CFLs
  - Buy LEDs if the price is right
- Find me:
  - Almost anywhere, but especially at big-box retailers
  - Among females in lower to middle-income areas
- Win me over by:
  - Running promotional events at mass merchandisers and club stores
  - Giving me a freebie or "taste" of LEDs

APPENDIX G: MARKET OVERVIEW

Our secondary market overview in the first section below presents the current state of the residential lighting market and builds a foundational context for our online channel review. The findings from our retail overview in the next section are used as inputs into the market simulators to project potential market share for each of the major lighting technologies. Based on the attributes of the most popular product offered at four online retailers, we construct "typical" lighting products of each technology. The preferences of the eight purchaser groups developed from our LCDC survey are then combined with these findings to project market share for each of these "typical" lighting products. Market share can be projected across SCE's customer population, within a purchaser group, or within a subsection of a group.

We note that our findings in this section are limited by several factors. Most importantly, we reviewed only four online retailers and have constructed out "average" lamps based on the top three to most popular lamps of each technology and product category. More detail on the limitations of this effort is included in Appendix H.

Literature Review Findings

We provide a brief overview of our findings in this section based on review of inventory and shelf data from market studies completed by Navigant, KEMA, and D&R International.

Market Penetration: Shelf Inventory

LEDs are a new entrant into the residential lighting market and have achieved less than 1% of market share nationally in 2010, as measured by the percentage of shelf space in retail channels reviewed by Navigant Consulting in their study for the DOE, "2010 U.S. Lighting Market Characterization."[15]

LEDs represent much more of the residential lighting market in California compared to the national market, with approximately 4% of retail shelf space in California by 2011. KEMA's shelf-survey across 184 California retail stores, as presented in their "California LED Lamp Market Characterization Report," shows that A-Lines are the dominant product category among LEDs. Approximately 65% of all LEDs are A-Lines compared to 29% being Reflectors.[16]

[15]January 2012. U.S. Department of Energy. "2010 U.S. Lighting Market Characterization". Prepared by Navigant Consulting. Page 22.

[16]June 2012. DNV KEMA Energy & Sustainability. "California LED Lamp Market Characterization Report". Prepared for the CA Public Utilities Commission (CPUC). Page 12. The remaining 25% of inventory includes "other shapes"

Market Penetration: Residential Installation

According to Navigant's survey of approximately 13,000 homes, about 0.2% of installed lamps nationally are LEDs (approximately the same as Navigant's estimate of LED inventory). Incandescent are the most common technology in the home (62% of sockets) followed by CFLs (23%) and Halogens (4%).[17]

In California, D&R International's market saturation study, "ENERGY STAR® CFL Market Profile," shows that while Incandescent lamps still remain the dominant technology (55% of sockets), energy efficient lighting is beginning to grow in market share. However, this growth is not driven by CFLs (20% of sockets, less than nationally), but rather by Halogens (8%) and "other" lighting products including LEDS (13%).[18]

Online Channel Review Findings

We reviewed the most popular products in each lighting category across four retail channels. Average lifetime is listed in years and is based on three hours per day use (a common convention among manufacturers). When the purchased item included two or more lamps, the price listed is the price per lamp.

Table 36 and Table 37 below are the aggregate findings, listing the typical attributes of each lamp technology and product category that are demanded by consumers.

Table 36. Typical A-Line Attributes by Technology

Attributes	A-Line LED	A-Line CFL	A-Line Halogen	A-Line Incandescent
Wattage (Watts)	8 W	14 W	50 W	60 W
Brightness (Lumens)	450 lms	900 lms	1050 lms	860 lms
Efficiency (Watt Equiv.)	40 W	60 W	-	-
Color	Soft White	Soft White	Bright White	Soft White
Temperature (Kelvin)	2700 K	2700 K	2900 K	2850 K
Average Lifetime (Years)	22.8	9.1	1-2	1.5
Dim-able?	Yes	No	No	Yes
ENERGY STAR®/UL Cert?	Yes	Yes	No	No
Average Price	$17.98	$1.82	$3.88	$0.94

[17] Navigant. January 2012. Page 24

[18] September 2010. U.S. Department of Energy. "ENERGY STAR® CFL Market Profile". Prepared by D&R International Ltd. Page 22.

Table 37. Typical Reflector Attributes by Technology

Attributes	Reflector LED	Reflector CFL	Reflector Halogen	Reflector Incandescent
Wattage (Watts)	10 W	15 W`	50 W	65 W
Brightness (Lumens)	415 lms	660 lms	520 lms	400 lms
Efficiency (Watt Equiv.)	65 W	65 W	-	-
Color	Soft White	-	Bright White	Soft White
Temperature (Kelvin)	2700 K	2700 K	2800 K	2700 K
Average Lifetime (Years)	22.8	9.1	2.7	1.8
Dim-able?	Yes	No	Yes	Yes
ENERGY STAR®/UL Cert?	No	Yes	No	No
Beam Type	Spot	Flood	Flood	Flood
Beam Angle (Degrees)	16-20 degrees	33-45 degrees	30-40 degrees	33-45 degrees
Average Price	$28.43	$5.51	$4.99	$3.66

LEDs are more expensive than any other lighting technology, but considerably cheaper in California. Our secondary data review of KEMA's shelf survey shows that national prices for LEDs range from $20 to $40 for A-Lines and $20 to $60 for Reflectors. However, KEMA finds that in California these prices are substantially lower: $11 on average for A-Lines and $38 dollars on average for Reflectors.[19] These California averages are much closer to the online price ranges we found from our online retail channel overview: $18 and $28 for A-Lines and Reflectors, respectively.

Additionally, the premium commanded by Reflectors across the board is supported by our findings on the price range customers were willing to pay for Reflector LEDs during our IDIs (see our findings on "Price and First Cost" in the next section).

LEDs are comparable to other lighting technologies in terms of wattage and color, but LED A-Lines are significantly less bright. While the actual wattage of LEDs is much lower than other

[19] KEMA June 2012. Pages 34-35, 43-47

lighting technologies, the wattage equivalent of LEDs (measured by lumens per Watt) is almost identical to Incandescents (65W). Typical color temperatures are also fairly consistent across all technologies. However, while Reflector LEDs are of similar brightness to incandescents (approximately 400 lumens), LED A-Lines are considerably dimmer than other technologies. We find that the typical LED A-Lines are about 450 lumens, compared to typical Incandescents and CFLs, which are 860 and 900 lumens, respectively. During their shelf survey, KEMA similarly observed that A-Lines and Reflectors had limited brightness options, typically in the low range and an average of 430 lumens.

References

Literature Review:

- September 2010. U.S. Department of Energy. "ENERGY STAR® CFL Market Profile". Prepared by D&R International Ltd.
- January 2012. U.S. Department of Energy. "2010 U.S. Lighting Market Characterization". Prepared by Navigant Consulting.
- June 2012. DNV KEMA Energy & Sustainability. "California LED Lamp Market Characterization Report". Prepared for the CA Public Utilities Commission (CPUC)
- August 2012. DNV KEMA Energy & Sustainability. "California LED Lamp Market Characterization Study". PPT slides prepared for the CPUC.

Online Retail Overview:

- 1,000 Bulbs: www.1000bulbs.com (Last Accessed: July 20, 2012)
- Amazon: www.amazon.com (Last Accessed: July 20, 2012)
- Home Depot: www.homedepot.com (Last Accessed: July 27, 2012)
- Target: www.target.com (Last Accessed: July 27, 2012)

APPENDIX H: ABRIDGED ONLINE RETAIL OVERVIEW TABLES

This appendix presents a detailed overview of the results from our online retail overview. These findings are useful as inputs into our market simulator, in that they give us a sense of the average attributes of lamps demanded by customers, by technology and product category. However, we note that the reliability of these findings is subject to several limitations. First, our analysis covers only four retailers. Additionally, this data is limited to the time period in which it was tabulated (August 2012), and customer preferences may change over time, especially as LEDs continue to penetrate the market. Finally, we defined the most "popular" lamps as those which appeared in the top three sold or customer-rated items. We note that prices, discount and sales may be primary drivers of popularity in his case, and not necessarily other lamp attributes.

A-Line LEDs

Brand	Philips	Philips	EcoSmart	EcoSmart
Wattage (Watts)	8	12	8	13
Brightness (Lumens)	470	805	430	800
Efficiency (Watt Equiv.)	40	-	40	60
Color	Soft White	Soft White	Bright White	Warm White
Temperature (Kelvin)	2700	2700	3000	3000
Average Lifetime (Years)*	22.8	22.8	45.7	$22.80
Dim-able?	Yes	Yes	Yes	Yes
ENERGY STAR®/UL Cert?	Yes	Yes	Yes	No
Beam Angle	Ambient (360)	Ambient (360)	Ambient (360)	Ambient (360)
Price: Online Retailer 2	$20.00	-	-	-
Price: Home Improvement 1	$21.97	$24.97	$9.97	$23.97

Reflector LEDs

Brand	Philips	EcoSmart	GE Energy Smart	GE Energy Smart
Wattage (Watts)	10	14	4	1
Brightness (Lumens)	415	800	100	35
Efficiency (Watt Equiv.)	35	65	-	-
Color	Soft White	Soft White	White	White
Temperature (Kelvin)	3000	2700	3050	2900

Average Lifetime (Years)	$22.80	$22.80	$13.70	$11.00
Dim-able?	Yes	Yes	-	-
ENERGY STAR®/UL Cert?	No	No	-	-
Beam Angle	-	-	-	-
Price: Big Box 2	-	-	$18.99	$16.09
Price: Home Improvement 1	$24.97	$29.97	-	-

A-Line CFLs

Brand	EcoSmart (TCP)	EcoSmart (TCP)	TCP	GE Reveal
Wattage (Watts)	14	14	14	20
Brightness (Lumens)	800	900	900	1200
Efficiency (Watt Equiv.)	60	60	60	75
Color	Daylight	Soft White	Soft White	Soft White
Temperature (Kelvin)	5000	2700	2700	2500
Average Lifetime (Years)	9.1	9.1	9.1	7.3
Dim-able?	No	No	No	-
ENERGY STAR®/UL Cert?	Yes	Yes	Yes	-
Beam Angle	-	-	-	-
Price: Big Box 2	-	-	-	$2.41
Price: Home Improvement 1	1.94	1.44	1.49	

Reflector CFLs

Brand	GE Energy Smart	GE Reveal	TCP	Feit
Wattage (Watts)	15	15	14	15
Brightness (Lumens)	720	660	640	750
Efficiency (Watt Equiv.)	65		65	65
Color	White	Clear	Soft White	Soft White
Temperature (Kelvin)	2700	2700	2700	2700
Average Lifetime (Years)	9.1	1.1	7.3	9.1
Dim-able?	-	-	No	No

ENERGY STAR®/UL Cert?	Yes	No	Yes	Yes
Beam Angle	-	-	-	-
Price: Big Box 2	$6.24	$8.98	-	-
Price: Home Improvement 1	-	-	$3.33	$3.49

A-Line Halogens

Brand	GE Reveal	GE	GE Reveal
Wattage (Watts)	53	29	43
Brightness (Lumens)	1050	430	750
Efficiency (Watt Equiv.)	75	40	60
Color	White	White	Bright White
Temperature (Kelvin)	2900	2800	2850
Average Lifetime (Years)	0.9	0.9	0.9
Dim-able?	-	-	-
ENERGY STAR®/UL Cert?	-	-	-
Beam Angle	-	-	-
Price: Big Box 2	$2.50	$2.50	$2.50

Reflector Halogens

Brand	GE	Philips	Philips
Wattage (Watts)	90	90	50
Brightness (Lumens)	1310	1370	520
Efficiency (Watt Equiv.)	-	-	-
Color	Bright White	Bright White	Bright White
Temperature (Kelvin)	2900	2900	2800
Average Lifetime (Years)	5.5	1.8	2.7
Dim-able?	Yes	No	Yes
ENERGY STAR®/UL Cert?	No	No	No
Beam Angle			
Price: Home Improvement 1	$7.24	$3.58	$4.99

A-Line Incandescent

Brand	GE Reveal	GE	GE Reveal	GE
Wattage (Watts)	75	150	60	60
Brightness (Lumens)	860	1400	630	780
Efficiency (Watt Equiv.)	-	-	-	-
Color	Soft White	Soft White	Soft White	Bright White
Temperature (Kelvin)	2850	2850	2850	2700
Average Lifetime (Years)	1.4	1.8	0.91	1.8
Dim-able?	No	Yes	Yes	Yes
ENERGY STAR®/UL Cert?	No	No	No	No
Beam Angle	Ambient (360)	Ambient (360)	Ambient (360)	Ambient (360)
Price: Big Box 2	0.85	0.85	-	-
Price: Home Improvement 1	-	-	$1.46	$0.58

Reflector Incandescent

Brand	GE Reveal	GE	Philips	Philips
Wattage (Watts)	45	45	65	65
Brightness (Lumens)	230	400	635	620
Efficiency (Watt Equiv.)	-	-	-	-
Color	Clear	White	Soft White	Soft White
Temperature (Kelvin)	2550	3000	2700	2700

Average Lifetime (Years)*	1.8	1.8	1.8	2.3
Dim-able?	-	-	Yes	Yes
ENERGY STAR®/UL Cert?	-	-	No	No
Beam Angle	-	-	-	-
Price: Big Box 2	-	$4.33	-	-
Price: Home Improvement 1	-	-	$2.37	$4.29

APPENDIX I: LOOKUP TABLES FOR ENERGY SAVINGS CALCULATIONS

Lookup Tables for Energy Savings

Number of years to use as standard measure of savings:	10
Average usage (hours/year):	931
Electricity rate ($ / kWh):	$0.14

See table below for source

A-Type Lamp Installed Base

		Number of lamps (millions)			Operating hours per year		
Lamp type	Percentage	Residential	Commercial	Total lamps	Residential	Commercial	
Incandescent	63.2%	1680	33.3	1710	821	3723	
CFL	36.6%	897	92.5	990	764	3541	Weighted average
LED	0.01%	0.22	0.02	0.24	801	3589	931
Total	100%	2580	126	2700			

Source: http://www.ssl.energy.gov Energy Savings Estimates of Light Emitting Diodes in Niche Lighting Applications, DOE, 2011, Table 2.14 and paragraph 2.4.2, p.25.

		CFL	Halogen	LED	Incandescent
Lumens per watt	Upper	75.0	19.8	81.9	15.2
	Mean	60.5	18.3	68.5	14.5
	Lower	46.0	16.7	55.1	13.8

Source: http://en.wikipedia.org/wiki/Luminous_efficacy

Economic cost of incandescent bulb Source: http://www.1000bulbs.com

Wattage	Initial cost	Life (hours)	Energy cost / year	Bulb purchases required / year	Total cost per year	Brand & Model
40	$0.86	1500	$5.21	0.620652307	$5.75	*Brand & model excised*
60	$0.83	1500	$7.82	0.620652307	$8.34	*Brand & model excised*
75	$0.75	5000	$9.78	0.186195692	$9.91	*Brand & model excised*
100	$0.68	1500	$13.03	0.620652307	$13.46	*Brand & model excised*

Economic cost of other bulbs

Lookup code	Type	Incandescent equivalent wattage	Actual wattage	Ratio, actual to incandescent wattage	Energy cost / year	Brand and Model
CFL40	CFL	40	9.3	0.233333333	$1.22	*Brand & model excised*
CFL60	CFL	60	14	0.233333333	$1.82	*Brand & model excised*
CFL75	CFL	75	18	0.24	$2.35	*Brand & model excised*
CFL100	CFL	100	25.6	0.255555556	$3.33	*Brand & model excised*
Halogen40	Halogen	40	31.8	0.794520548	$4.14	*Brand & model excised*
Halogen60	Halogen	60	47.7	0.794520548	$6.21	*Brand & model excised*
Halogen75	Halogen	75	59.6	0.794520548	$7.77	*Brand & model excised*
Halogen100	Halogen	100	79.5	0.794520548	$10.36	*Brand & model excised*
Incandescent40	Incandescent	40	40.0	1	$5.21	*Brand & model excised*
Incandescent60	Incandescent	60	60.0	1	$7.82	*Brand & model excised*
Incandescent75	Incandescent	75	75.0	1	$9.78	*Brand & model excised*
Incandescent100	Incandescent	100	100.0	1	$13.03	*Brand & model excised*
LED - A-Lamp40	LED - A-Lamp	40	8	0.2	$1.04	*Brand & model excised*
LED - A-Lamp60	LED - A-Lamp	60	12.5	0.208333333	$1.63	*Brand & model excised*
LED - A-Lamp75	LED - A-Lamp	75	15.6	0.208333333	$2.04	*Brand & model excised*
LED - A-Lamp100	LED - A-Lamp	100	20.8	0.208333333	$2.72	*Brand & model excised*

Source: http://www.1000bulbs.com