Midstream Commercial Incentives for LED Replacement Lamps: Emerging Technology and Channel Assessment Project

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ABBREVIATIONS AND ACRONYMS

3P	Third Party
CALiPER	Commercially Available LED Product Evaluation and Reporting
CIP	Central Inspection Program
DOE	U.S. Department of Energy
DI	Direct Install
ET	Emerging Technology
E&IM	Enrollment & Incentive Management
FC	Foot candles
IEE	Institute for Electric Efficiency
IOU	Investor Owned Utility
LED	Light Emitting Diode
MR	Multifaceted Reflector (lamp)
PAR	Parabolic Aluminized Reflector (lamp)
PG&E	Pacific Gas and Electric Company
RHA	Richard Heath & Associates, Inc.
SSL	Solid State Lighting

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EXECUTIVE SUMMARY

Pacific Gas and Electric Company (PG&E) has commissioned this emerging technologies (ET) report to assess both the market for light emitting diode (LED) replacement lamp products and the delivery channels available for utility promotion of these products. As part of this effort, PG&E created two pilot incentive programs for LED replacement lamps in 2012: a "midstream" pilot which incentivized distributors' sales and a third party (3P) pilot which utilized a "direct install" (DI) model.

The LED lamp types chosen for promotion were the Parabolic Aluminized Reflector (PAR) lamps and Multifaceted Reflector (MR) lamps. These are well-established product categories for LED products and a wide variety of products in these categories are currently on the market: well over one thousand LED reflector lamps have met ENERGY STAR® performance requirements to date. However, recent estimates of the national market place LEDs at around 2% of the installed base for PAR and MR lamps (Navigant Consulting Inc., 2011).

This report reviews the two utility incentive program designs and their performance, and incorporates customer and vendor feedback to summarize the state of the market and its response to these delivery channels. The report reviews the current state of the market for LED replacement lamps and provides recommendations for future PG&E programs which target this measure.

PROJECT GOALS

The primary goals of this study are to:

- Evaluate LED replacement lamp characteristics and customer satisfaction with available products
- Evaluate customer purchasing practices for replacement lamps to inform utility energy savings assumptions
- Evaluate the distributor and direct install incentive delivery channels for LED replacement lamps
- Assess the ability of the distributors to coordinate the supply of product for two separate utility incentive offers without applying for duplicative incentives

PROJECT DESCRIPTION

Four distributors were selected to participate in the three-month distributor pilot. During that time, participating distributors were paid a per-lamp rebate of between $5 and $20 to incentivize sales of qualifying LEDs to eligible non-residential PG&E electric customers. The distributor pilot was considered a midstream program in this market, as it provided incentives to the supply chain at a point between the manufacturer (the upstream end) and the end-use customer (the downstream end).

The five-month DI pilot was implemented as a Third-Party program (3P) by Richard Heath & Associates, Inc. (RHA). PG&E paid incentive funds directly to RHA at $0.24/kWh, who in turn provided low-cost or no-cost installations to participating non-residential PG&E electric customers. A direct install program is one in which an end-use customer is served directly by the incentive program, often with turn-key services that may be available at low-cost or no-cost.

Energy Solutions, who implemented the distributor pilot on behalf of PG&E, was also tasked with summarizing the pilot data and authoring this report. The study called for field assessments of lighting quality, and customer and vendor interviews. The report evaluates the effectiveness of the program delivery channels, product promotion and the incentive application process. The primary research questions fall under three research areas:

- Incentive Delivery Channel:
  - Can incentives be effectively coordinated across channels to maximize adoption?
  - How effective was the midstream channel in affecting sales of PAR lamps?
  - Since midstream and downstream/DI install programs are promoting the same measure, will double-dipping[1] be an issue?
- Replacement Lamp Market:
  - What factors are driving customer decision-making when purchasing PAR and MR lamps?
  - Are customers satisfied with this incentive structure?
- LED Replacement Lamp Products:
  - Is lighting quality consistent with manufacturer equivalency claims?
  - How do customers view available LED replacement lamp products?

PROJECT FINDINGS

The two pilot programs resulted in the installation of 1,329 LED replacement lamps at 54 non-residential PG&E electric customer locations. The expected annual energy savings are 184,500 kWh and 38 kW in peak demand reduction. Surveyed customers indicated a high level of satisfaction with their purchased products.

Over a period of 3 months, the distributor pilot incentivized sales of 878 replacement lamps (66% of LED lamps incentivized under both pilot offers) to 29 PG&E customers who bought an average of 35 lamps per location. The pilot paid $12,218 in incentives and expects benefits of 125,400 kWh in annual energy savings and 26.5 kW in peak demand reduction. The results are summarized in Table 1.

Over a 5-month period the direct install pilot incentivized 451 lamp sales to 25 PG&E customers who bought an average of 16 lamps per location. The pilot paid $15,749 in

[1] Double dipping occurs when the same energy efficiency measure is incentivized twice, usually because the same measure is offered by two different programs or at two different points in the sales channel.

incentives and expects benefits of 59,129 kWh in annual energy savings and 11.7 kW in peak demand reduction.

The distributor pilot created a shift in distributor and market behavior, with the pilot providing an opening for distributor salespeople to discuss a category of product that most customers were not yet purchasing. LED lamp customers surveyed were only in the beginning stages of their transition from incandescent to LED lamps, and the customer interviewees all acknowledged the role of the distributor in their LED purchases. Customers were clearly influenced by the product recommendations of the distributors, and these sales were unlikely to have occurred without the distributor involvement.

Perhaps not surprisingly, the most successful distributor in the pilot was also the only distributor to have developed customer marketing materials which summarized the pilot offer and the products available. There was a clear connection between "upselling" the pilot offer, and LED lamp sales. Two of the other distributors had lower levels of participation, and the third distributor was not able to submit any applications. In the distributor interviews, the participants stated that the primary reasons for low numbers of incentive applications were the short timeframe of the pilot offer, and competing utility incentive offers with higher incentive rates. All four distributors stated that a longer program implementation period will allow them to more effectively incorporate the incentives into their sales structure, and sell more LED lamps as a result.

The results of both pilots also show that there is consistency in the alignment of the delivery channel with different customer markets. In the distributor pilot, 70.6% of LEDs sold were bought by large office, large retail or hospital customers[2]. Conversely, 71.6% of LEDs sold through the DI pilot were bought by small office, small retail or sit-down restaurant customers.

From the interviews conducted with DI customers, we also learned that small business customers often are not served by commercial distribution channels. A majority of these interviewees, primarily small retailers, noted that they normally purchase replacement lamps at retail stores serving the residential consumer. This market sector might be under-served by a distributor-only program, because they do not normally engage with lighting or electrical distributors for replacement products.

TABLE 1. PILOT OFFER RESULTS

PILOT	LED PRODUCT TYPE & WATTAGE	LAMP QUANTITY	ELECTRIC SAVINGS (KWH)	PEAK DEMAND SAVINGS (KW)	INCENTIVE AMOUNT
Distributor Pilot	**Total**	**878**	**125,400**	**26.49**	**$12,218**
	LED PAR20: ≤ 9 Watts	29	2,992	0.68	$218
	LED PAR30: < 14 watts	60	4,758	1.18	$450
	LED PAR30: 14 to ≤16 watts	24	3,040	0.68	$420

[2] Building types defined by the California Public Utilities Commission Database for Energy Efficient Resources, http://www.deeresources.com/

	LED PAR38: 14 to ≤ 21 Watts	487	98,848	20.85	$9,740
	LED MR-16, < 7 watts	177	8,017	1.58	$885
	LED MR-16, 7 to <=11	101	7,745	1.52	$505
3P DI Pilot	**Total**	**451**	**59,129**	**11.73**	**$15,749**
	LED PAR20: ≤ 9 Watts	78	9,577	1.84	$2,277
	LED PAR30: < 14 watts	45	4,103	0.92	$1,629
	LED PAR30: 14 to ≤16 watts	100	13,939	2.88	$4,156
	LED PAR38: 14 to ≤ 21 Watts	61	13,969	2.63	$3,779
	LED MR-16, < 7 watts	60	3,843	0.83	$856
	LED MR-16, 7 to <=11	97	12,765	2.43	$2,733
	LED PAR38: < 14 Watts	10	932	0.19	$319
GRAND TOTAL		**1329**	**184,529**	**38.22**	**$27,967**

PROJECT RECOMMENDATIONS

Through the two pilot offers, PG&E was able to demonstrate clear customer interest in LED replacement lamps, and responsiveness to the different program delivery channels. After reviewing the program results and soliciting the feedback of customers, distributors and the pilot implementers, there are a few takeaways for future programs targeting these measures or considering these delivery channels.

First, PG&E and other utilities interested in these measures should use the commercial distributor channel as a way to significantly increase the market share of LED replacement lamps in non-residential markets, for the following reasons:

- The midstream pilot demonstrated that distributors play an important role in the supply chain for lighting equipment sold to commercial properties. Interviews with key decision makers at non-retail commercial properties showed that it is common for customers to have a direct relationship with their supplier, who may provide value-added services including product recommendations, insights on utility incentive funding and trusted opinions on lighting design considerations.
- A focus on distributors means a limited number of market actors. While incentive funds are paid to a small group of distributors, they improve market penetration broadly, by reducing prices to customers and increasing competition among distributors.
- Distributors are aware of new product developments from manufacturers, and are well-positioned to improve the market share of high quality LEDs.

Second, the DI pilot showed that the DI model can be effective for certain market sectors, and should be utilized when targeting the small retail and small business markets. The DI pilot was responsible for more than 80% of the LED lamp sales to small retail customers – clearly outperforming the distributor channel in this market.

Third, distributors participating in future midstream programs should be encouraged to market the incentive offer openly to their customers. Distributors were not required to pass off the full value of the incentive to their customers and some do not disclose the incentive values, but the participant with the most LED sales did both. The most successful distributor developed a flyer summarizing lamp costs and incentive levels, listed the incentive amount as a line item on the invoice, trained sales staff on the pilot offer details, and had a single staff person responsible for entering applications.

Finally, regardless of the program delivery channel, utility programs which target LED replacement lamps work to ensure that customers are receiving an LED product with the desired light output. While both pilot offers found that customers were generally happy with their LED lamps, some customers had found the replacement LEDs to be too bright or too dim. In midstream programs, this could be addressed by working collaboratively with distributor salespeople to learn about how their lamp sales are specified and why sub-optimal products may sometimes be selected. In downstream or DI programs, this may simply mean exercising caution in assuming baseline lamp outputs, since customers tend to define new lamps as "dim" or "bright" relative to the lamp that was installed before the replacement.

INTRODUCTION

This report analyzes the pilot offer delivery channels, customer procurement of LED replacement lamps, and LED replacement lamp technology based on the feedback of customers and distributors. The research project also reviews product performance as installed at customer facilities, distributor perspectives, and the feedback of both pilot offer implementers (Energy Solutions and Richard Heath and Associates, Inc. (RHA)).

PILOT OFFER CHANNELS

Two delivery channels for LED replacement lamps were evaluated: a midstream distributor model and a DI model. The report summarizes the challenges, successes and risks associated with these two models.

WHY A MIDSTREAM INCENTIVE PROGRAM FOR LED REPLACEMENT LAMPS?

Midstream incentive programs provide an opportunity to leverage the position of distributors in the market. Lighting distributors often have working relationships with local contractors, customers and PG&E representatives, and they are generally aware of the latest products available to the commercial market. Distributors can be an optimal point of intervention in the supply chain, and have demonstrated in certain cases a high degree of responsiveness to utility incentives for several reasons:

- Most distributors in California serve a territory dominated by one or two large electric utilities, unlike manufacturers, and can coordinate more closely with utility incentives;
- Distributors have a sales staff promoting select products, and make promotion decisions based on input from both utilities and manufacturers;
- Distributors are a point of commonality in the sales chain: almost all commercial lighting products are sold through distribution, but not all products are sold through contractors.
- Distributor-to-contractor and/or distributor-to-facility manager sales generally involve more robust discussions of product quality, performance characteristics, and payback; whereas smaller customers are usually less informed customers about issues of quality and more focused on “first cost;”
- Profit margins on more advanced technologies are usually higher than standard products; thus, distributors prefer to sell the more advanced technologies;

DO DISTRIBUTORS "UPSELL"?

A distributor's primary business interest is product sales, but midstream program models operate on the assumption that distributors are capable of transforming the market. Rather than simply selling customers what they order, distributors should demonstrate that they can move the market and alter the purchasing decisions of their customer base. Do they play an active role in consulting with their customers on product options and technology developments? What strategies are used to help upsell energy efficient LEDs?

DI PROGRAM INFLUENCE IN THE LED REPLACEMENT LAMP MARKET

DI incentive programs are generally a good fit for customers who would not normally pursue energy efficiency projects or investment-type equipment upgrades for lack of resources, funding or technical knowledge. The implementer of the DI offer will typically provide free or low cost installations, minimizing operating costs through streamlined measure offerings, bulk equipment pricing and limited customer input on project scope. Grouped together with high utility incentive rates (or generous "cost share" offers), participants in DI programs can reap significant benefits with little effort on their own behalf. Clearly, no or low-cost projects present an attractive opportunity for some customers, but how effective is the DI model in transforming the market?

RISKS AND LIMITATIONS

There are some challenges associated with each program design. First, midstream programs will generally have an increased risk of double dipping. The primary reason for this is that the midstream market actors may have little interaction with vendors or customers. As a result, customers or other vendors may apply for other utility incentives, not realizing that the products were already incentivized midstream or upstream. This is a risk for LED replacement lamps in PG&E service territory, where there are a number of downstream programs available for this measure.

Second, both the midstream and DI program models have limits to their effectiveness, primarily based on factors inherent to the position of distributors and contractors in the market. For example, distributors will often set a minimum potential project value for a customer to be of interest, and if the customer does not meet that threshold then they might not establish a customer relationship. Similarly, contractors will have a limited ability to reach large accounts unless they have an existing relationship with the customer, and they may also have limited capabilities simply due to the size of the contractor firm, geographic location or technology area of expertise.

CUSTOMER PAR AND MR LAMP PROCUREMENT

This assessment identified some of the key factors that influence customer purchasing decisions and enable the implementation of projects. The variables were expected to vary based on customer profile. The DI pilot targeted jewelry, small retail, fitness centers, restaurants, and other small to medium non-residential customer types. In most cases, the customers approached had already engaged with the DI Program in some capacity, having either considered or completed a DI project

in the past. The midstream distributor pilot did not exclude any non-residential building types, but trended towards large commercial and retail properties.

It was expected that key enabling factors in project implementation would include:

- Customer experience with energy efficiency projects
- Customer familiarity with lighting technologies and perceptions of light quality
- Influential building staff or building owners
- Motivation for completing the project
- Funding availability, for both general maintenance and energy efficiency projects
- Vendor support and influence with the customer

LED REPLACEMENT LAMPS – PERFORMANCE ASSESSMENT

LED replacement lamps have improved significantly in recent years, and many LED products have successfully replaced other lighting sources as the optimal technology type in applications such as refrigerated case lighting and area lighting. In other applications, LEDs are continuing to improve and are increasingly outperforming incumbent lighting technology types.

The U.S. Department of Energy (U.S. DOE) Commercially Available LED Product Evaluation and Reporting (CALiPER) test summaries demonstrate LED PAR lamp improvements in lumen output, efficacy, correlated color temperature, color rendering index, power factor, heat control and lamp beam directivity. A recent CALiPER exploratory study noted that LED replacement lamps have improved in most of these areas, and in their equivalency claims of performance with incumbent lighting technology types (U.S. DOE, 2012). These improvements are seen in many other LED lighting products and make this technology promising for most PAR and MR applications.

Rather than focusing on the performance characteristics of different products from laboratory testing, the results of this report are informed by the qualitative feedback of customers, a review of onsite light levels, comparisons with the incumbent lamp type where possible, and an assessment of overall lighting design of the space type.

BARRIERS TO ADOPTION

A primary aim of this project is to identify both technical and market barriers that inhibit market exposure and uptake of LED replacement lamps. Technical barriers may include performance issues related to lamp operation (dimming functionality, lumen depreciation, color temperature, etc.) or the application of the technology in the space. Technical barriers can be based on lab-tested performance characteristics, the specification of lamp types and overall lighting design, or the more subjective feedback of consumers on light quality or lamp performance.

The primary market barrier for solid state lighting is generally understood to be that more advanced equipment is priced higher than incumbent technologies. LED replacement lamps are no exception; MR16 and PAR lamps cost 78-85%[3] more than incumbent lamp types. As a result, utility incentive programs will continue to play an important role in reducing the cost of LED lamps to the end user. Utilities need to determine the type of incentive structure and incentive levels that will be effective at increasing the LED market share.

[3] Lamp price data gathered from distributors participating in the midstream pilot offer.

PROJECT STRUCTURE

This project covered two concurrent Pilot offers that provided incentives on the sale of ENERGY STAR® approved PAR20, PAR30, PAR38 and MR16 LED lamps. After successful implementation of these two Pilot offers, the performance of each pilot was evaluated through feedback from customers, program participants (distributors in the midstream Pilot), and the program implementers.

WORKING WITH DISTRIBUTORS

Implementation timelines for both pilot offers were fast, with the midstream pilot launching on September 1st, and the DI pilot launching July 1st. Both Pilot offers were closed on November 30th, 2012. The three month pilot program duration was challenging for participating distributors, for a few reasons:

- The distributor customer base is generally slow-moving compared to small businesses which may have a single decision maker. The person responsible for lighting procurement may need separate approvals from management
- Missing the sales and application deadline of November 30th would mean a loss of incentive funds to the distributor, regardless of quotes provided to the customer. Incentives were nearly 50% of the lamp cost in some cases
- For distributors to effectively upsell, they needed to inform salespeople of the pilot rules and details

Once the Program launched, a meeting was scheduled with each distributor to train both sales and administrative staff on strategies to leverage the incentives.

The midstream Pilot used the online application system at www.cainstantrebates.com for the submittal and processing of distributor applications. The online application system has proven successful with other midstream and upstream incentive offers and was already familiar to some of the participating distributors, who with experience can submit a complete rebate application in less than 2 minutes.

DIRECT INSTALL PROGRAM STRUCTURE

The DI Program was implemented by RHA, and was already in full operation prior to the launch of the DI Pilot offer, covering other energy efficiency measures. The addition of LED PAR and MR lamps expanded on a variety of measure types already supported by the DI Program, including lighting, HVAC and water heating measures. The Program Description states:

> *The Energy Fitness Program enables small business owners to lower their energy use through retrofit measures. RHA partners with local utilities to offer energy efficiency incentives and rebates to the small commercial market. The service is aimed at businesses, municipal governments and non-profits. Local RHA Energy Advisors conduct energy assessments on site to provide*

customers with customized lists of energy efficient measures that may be installed at low- to no-cost.

Core service offerings:

- Energy efficiency assessments for small- to medium-sized businesses, city-owned municipal buildings, and non-profit organizations.
- Direct install services with measure packages tailored to savings goals. Measures typically include lighting, HVAC, refrigeration, and water heating.
- Quantified kWh savings based on applicable standards (DEER and E3 calculations, deemed savings)
- Co-branding and co-marketing with utility
- Administration of rebates and incentives.

The DI Program leveraged their existing customer base and site survey data to help determine which customers might benefit from LED PAR or MR16 lamp installations. The Pilot incentives were an addition to the existing suite of measures supported by the DI Program.

The DI implementers received $0.24 per kWh saved from PG&E, which covered program implementation costs, as well as project incentives to small business customers.

LED LAMP ELIGIBILITY AND REBATE LEVELS

Both Pilot offers incentivized the sale of ENERGY STAR® listed PAR20, PAR30, PAR38 and MR16 lamps. Eligible ENERGY STAR® lamps needed to also meet wattage limits for specific tiers. The ENERGY STAR® performance specifications are summarized in Appendix A. Table 2 lists the additional wattage limitations for eligibility in both Pilot offers, as well as the incentive amounts paid to participants in the midstream pilot. Incentive payments in the DI program varied by customer, with payments made to RHA at $0.24/kWh saved.

TABLE 2. QUALIFYING WATTAGES AND INCENTIVES FOR PG&E MIDSTREAM LED REPLACEMENT LAMP PILOT

LAMP TYPE	LED QUALIFYING WATTAGE RANGE	INCENTIVE AMOUNT	HALOGEN BASE CASE WATTAGE RANGE
MR16	< 7 watts	$5.00	20 watt
MR16	7 to ≤ 11 watts	$5.00	35 watt
PAR20	≤ 9 watts	$7.50	30 – 50 watt
PAR30	< 14 watts	$7.50	35 – 55 watt
PAR30	14 to ≤16 watts	$17.50	60 – 70 watt
PAR38	<14 watts	$10.00	50 – 65 watt
PAR38	14 to ≤21 watts	$20.00	70 – 90 watt

LED REPLACEMENT LAMP PERFORMANCE

TECHNOLOGY BACKGROUND

PAR and MR lamps are common in non-residential buildings, and are used to provide general and accent illumination in a variety of space types. They have traditionally used incandescent and halogen lighting technology.

The most common MR lamp type is the MR16, where the 16 refers to the diameter of the lamp, at 16/8 or 2 inches (lamp diameters are referenced in increments of an eighth of an inch). The same numbering system applies to PAR lamps, with a PAR20 diameter being 2.5", a PAR30 being 3.75", etc.

Incandescent or halogen PAR and MR lamps offer adequate light quality, but they have a short lamp life and high lamp wattage, or low efficacy. Compact fluorescent (CFL) PAR lamps offer considerably higher efficacies than halogen sources at 35-45 lumens per watt, but CFLs have a few drawbacks which make them sub-optimal PAR replacements. CFLs tend to have a poor reputation for dimming and struggle in directional lighting applications, which are significant shortcomings since dimming capability and directionality are two of the more defining characteristics of reflector lamps. Given rapid improvements to LED lamp performance and lower lamp costs, it is clear that incandescent and halogen PAR and MR lamps will be replaced with LED equivalents in the coming years.

LED technology has seen rapid advances in recent years. Performance improvements including efficacy, color rendering, beam control, color temperature options and controllability have all brought increasingly strong interest to LED lighting. Yet as the technology has improved and prices have dropped, LEDs still make up a very small percentage of the market. Recent estimates of the LED Parabolic Aluminized Reflector (PAR) and Multifaceted Reflector (MR) lamp market share are no higher than 2% (Navigant Consulting Inc., 2011)

EMERGING TECHNOLOGY/PRODUCT

The CALiPER program completed two studies in 2011 and 2012 on LED replacement lamps in the retail market. The 2012 findings show that there have been significant improvements in the technical performance of LED lamps, and more products met their performance claims. There have also been reductions in the cost per lumen output, and as more LED products match the light output of traditional PAR and MR lamps, the expectation is that prices will drop significantly.

LEDs operate by emitting light from a semiconducting chip. In 2012, most LED types, including LED replacement lamps, outperformed incumbent lamp types on a lumens per watt (lm/W) basis. Incandescent or halogen PAR lamps typically have an efficacy of 10-15 lm/W. Halogen MR16 lamps have efficacies between 15-25 lm/W. The efficacy of LED PAR and MR replacement lamps are commonly 40-60 lm/W

(Navigant Consulting Inc., 2011). The minimum efficacy required by ENERGY STAR® (a prerequisite for PG&E incentive eligibility) is 40 lm/W, and as high as 55 lm/W depending on the lamp type in question.

The installed base of LED PAR, BR, and R shaped lamps, based on manufacturer shipment data is estimated to have reached 0.9 million units, which is roughly 0.2% of the total U.S. PAR, BR and R lamp installed base. The installed base of MR16 lamps based is estimated to be slightly higher at 1.67% of the total MR16 installed base, or roughly 2 million units. These are assumed to be primarily installed in the commercial sector (Navigant Consulting Inc., 2011). While the installed percentages within PG&E service territory may differ from the nationwide data, it is reasonable to assume that market penetration of LED replacement lamps is low. While LED lighting has shown significant growth, LEDs still account for less than 1% of general illumination (Navigant Consulting, Inc., 2012). Still, it is expected that LEDs will dominate the replacement lamp market by 2020 (DNV KEMA, 2012).

LED technology is also particularly well-suited to PAR and MR lamp types due to their high level of optical control, dimming capability (Gonzalez, 2011)and higher efficacy over halogen PAR and MR lamps.

ENERGY STAR® listing is the key qualification for acceptance in the pilot offers, and it is an important indicator of the quality of an LED product. To achieve ENERGY STAR® qualification, LED replacement lamps must undergo laboratory testing to assess performance characteristics, including color consistency, color rendering, lumen maintenance, and efficacy.

These ENERGY STAR® qualification metrics were not included in this report because the replacement lamps have already been vetted on technical characteristics through the process of achieving ENERGY STAR® listing. Instead, the report focuses on product evaluation by soliciting customer feedback, and by reviewing the installation in the field. Customer feedback was collected through surveys and through site visits. The DI and midstream pilot implementers each developed their own surveys.

MARKET ASSESSMENT AND CUSTOMER DECISION MAKING

Overwhelmingly, feedback on the procurement and installation of LED PAR and MR lamps was positive: 100% of customers surveyed under both pilots were pleased with the LED lamps. While there were a few comments on the change in light levels (being both brighter and dimmer than the existing lamps), the general message from customers was that the LED lamps were an improvement. Even when light levels had changed, the customers were pleased with the forecasts on lifetime of the lamps, energy savings, reduced temperature, and dimming capabilities. The pilot offers have shown that customers are interested in LEDs and view them favorably, but most had not purchased LEDs prior to establishing contact with the DI pilot implementer or midstream pilot distributors. Understanding the motivations behind customer decision making will help direct energy efficiency program resources.

DI PILOT CUSTOMERS

The DI Pilot was able to survey dozens of their customers while onsite. The responses varied based on the availability of the customer and the contact's ability to respond to the questions. The questions focused on the customer decision-making and review of the new LED lamps, and provide a useful glimpse in the (primarily) retail LED market. Table 3 summarizes the primary reasons why customers purchased LEDs. Roughly 60% of customers surveyed were retail, ~18% are office, and 21% were churches.

TABLE 3. CUSTOMER RATIONALE FOR PURCHASING LED REPLACEMENT LAMPS

REASON FOR LED PURCHASE	PERCENTAGE OF CUSTOMERS
Lamp Rated Life	12%
No-cost/low-cost purchase	15%
Lighting Design Considerations	19%
Lower Electricity Bill	35%
All of the above	19%

Electricity savings were a key consideration for most of the customers in the DI Pilot. Surprisingly few respondents cited the long rated life of LEDs, and the substantial incentive Table 4 provides some additional detail on customer opinions of the new LEDs and lamp procurement.

TABLE 4. DI PILOT: CUSTOMER SURVEY SUMMARY

SURVEY	YES	NO
Have you researched the advantages of LED's yourself prior to being contacted by RHA?	29%	71%
Are you satisfied with your LED lights that you received?	100%	0%
Would you recommend LED's to friends, family and other business owners? If so why?	94%	6%
Would you have purchased the LEDs without the rebate offered through PG&E incentive?	47%	53%
When you purchase lights and lighting equipment, do you typically purchase lighting equipment from a single supplier?	65%	41%

One consistent comment from the DI pilot customers was that they rarely use lighting suppliers or contractors when purchasing lighting equipment. Sixty three percent of respondents stated that they normally purchase lighting equipment from retail locations including Home Depot, local hardware stores, or Costco. This

indicates that the DI LED installations are unlikely to have occurred without the DI offer, unless competitive rebates on comparable products were offered at consumer retail locations.

MIDSTREAM PILOT CUSTOMERS

Energy Solutions visited three customer locations that had purchased and installed LED replacement lamps incentivized through the distributor channel. Surveys were completed in a conversational format.

The key decision-makers at all three customer facilities were facilities engineers or building supervisors. They were familiar with energy efficiency project implementation, with lighting technology and lamp performance characteristics. Within set operating budgets, they make their own decisions on lighting equipment purchases. All three had pre-approved operating budgets for lighting maintenance, and are in most cases the person responsible for product procurement. In cases where there is a need for additional funding, they could approach the building management team/owners with proposals for approval of additional funds. Each customer contact thought that management would only consider spending additional funds for projects that have a payback of 2 years or less.

Each facility contact had an established relationship with their vendor: 2 of the 3 customers surveyed stated that their purchasing decisions were influenced by the utility incentive and that product selection was based on the recommendations of their primary vendor. The third customer contact was new to his position so could not comment on the procurement of the LED replacement lamps, but was already in contact with the distributor responsible for the LED lamp sales.

CUSTOMER ONE: CHURCH

The first customer facility surveyed was a large church with significant daylight in much of the building. Daylight is utilized so effectively in the cathedral that there is little need for general overhead lighting in much of the building. Various types (PAR30, PAR38, halogen and fluorescent bulbs) of recessed can lights provide the vast majority of electric lighting in the space. T5 lamps and ballasts are the dominant linear fluorescent technology in the offices and back/uplighting applications, with T8 equipment used in stairwells, maintenance areas and restrooms. Still, PAR and MR lamps cover most of the facility lighting needs, including the hallways directly outside of meeting rooms and general walkways around the building.

PROJECT DECISION MAKING

Project decision-making responsibilities are somewhat split between the church itself and the property manager. The church has a contract with a facilities management and engineering firm to oversee day-to-day operations of the building as well as investment grade equipment improvements. The site visit and interview were completed with the contracted chief engineer, who is considered to be the "customer" in this report.

The customer purchased both PAR and MR16 LED replacement lamps: ninety-one MR16s (10 watt), four PAR30s (11 watt), and four PAR30 (14 watt) LEDs. The new lamps replaced 50 watt MR16s, 75 watt PAR30s and 150 watt halogen bulbs.

Overall customer feedback was very positive. The customer clearly had energy efficiency in mind when purchasing the LED replacement lamps, and cited the significant wattage reduction as the primary reason for the move from halogen to LED reflector lamps. Wattage reductions were in the range of 80-93%, and as a result he'd received positive feedback on the project from church management.

LED Reflector Lamp Application And Performance Review

The customer found that the PAR30 LED lamps were slightly dimmer than the halogen base case, but because the existing halogens were a blend of 75 watt and 150 watt lamps, it was difficult to isolate if the difference was due to the replacement lamp wattage or the base case wattage variability. Furthermore, all PAR30 lamps were on a dimmer, and were found to be dimmed at time of the site visit resulting in reduced light output.

The replacement PAR30 lamps were installed in a large hallway outside of a conference room, with very little daylighting, no other overhead lighting aside from some decorative linear fluorescent uplights, and a dark stone floor which offered little reflectivity. Still, light levels underneath the beam of LEDs were acceptable, consistently in the range of 17 to 20 foot candles (FC). See Figure 2 below for an image of this application.

FIGURE 1. LED PAR30 REPLACEMENT LAMPS INSTALLED IN HALLWAY

The customer found the 10 watt MR16s to be much brighter than the existing 50 watt MR16 halogen lamps. In this application, the 10 watt MR16s were an excellent replacement for the existing 50 watt halogens.

Lamps were installed at a 14' mounting height and provided general illumination in addition to accent lighting in certain areas. This was an excellent showcase for the output of the LED MR16s. Cleaning crews had mentioned that due to the increase in light levels, imperfections in the glass had become more visible. Since the MR16 replacement, they'd needed to spend more time cleaning the glass surfaces.

The MR16s were installed in the church's mausoleum, found in the lower level of the building. There is no daylighting, but a daylighting-like effect is produced by backlighting behind some of the walls. There was limited reflectivity in the space, due to the prevalence of dark stone floors and glass. Operating hours of the lamps in this area were nearly 24 hours a day. See Figure 2 to view the application of the MR16 LEDs.

FIGURE 2. LED MR16 LAMPS INSTALLED IN MAUSOLEUM AREA

Customer feedback was overwhelmingly positive. The only technical shortcoming of the LED replacement lamps was that light levels may have been reduced in areas that had utilized 150 watt halogen lamps in recessed cans. However, there are a few reasons to see this more as a result of the application rather than the lamps themselves. The lamps were not designed to replace 150 watt halogen bulbs (the existing lamp type in some of the cans), so it should be expected that they would appear dimmer in this scenario. Secondly, the replacement PAR30 LEDs were found to be dimmed at the time of the site visit, and while the customer noted lower light levels, the reduced output was not mentioned as a downside of the new LEDs.

CUSTOMER TWO: COMMERCIAL OFFICE PROPERTY

The second property visited was a large commercial office building. Most of the building used conventional office fixture types, predominately T8 troffer fixtures with an assortment of strip, wrap, and can fixtures elsewhere in the building. The LED replacement lamps were installed on the first floor, in the lobby and elevator bays, which are common space types for recessed cans with PAR lamps. The LED replacement lamps were installed alongside the existing lamp type, which was a 75 watt halogen PAR38. In Figure 4, it is easy to notice the new LED PAR38, which provides a noticeably brighter wall wash than the baseline 75 watt PAR halogen lamps.

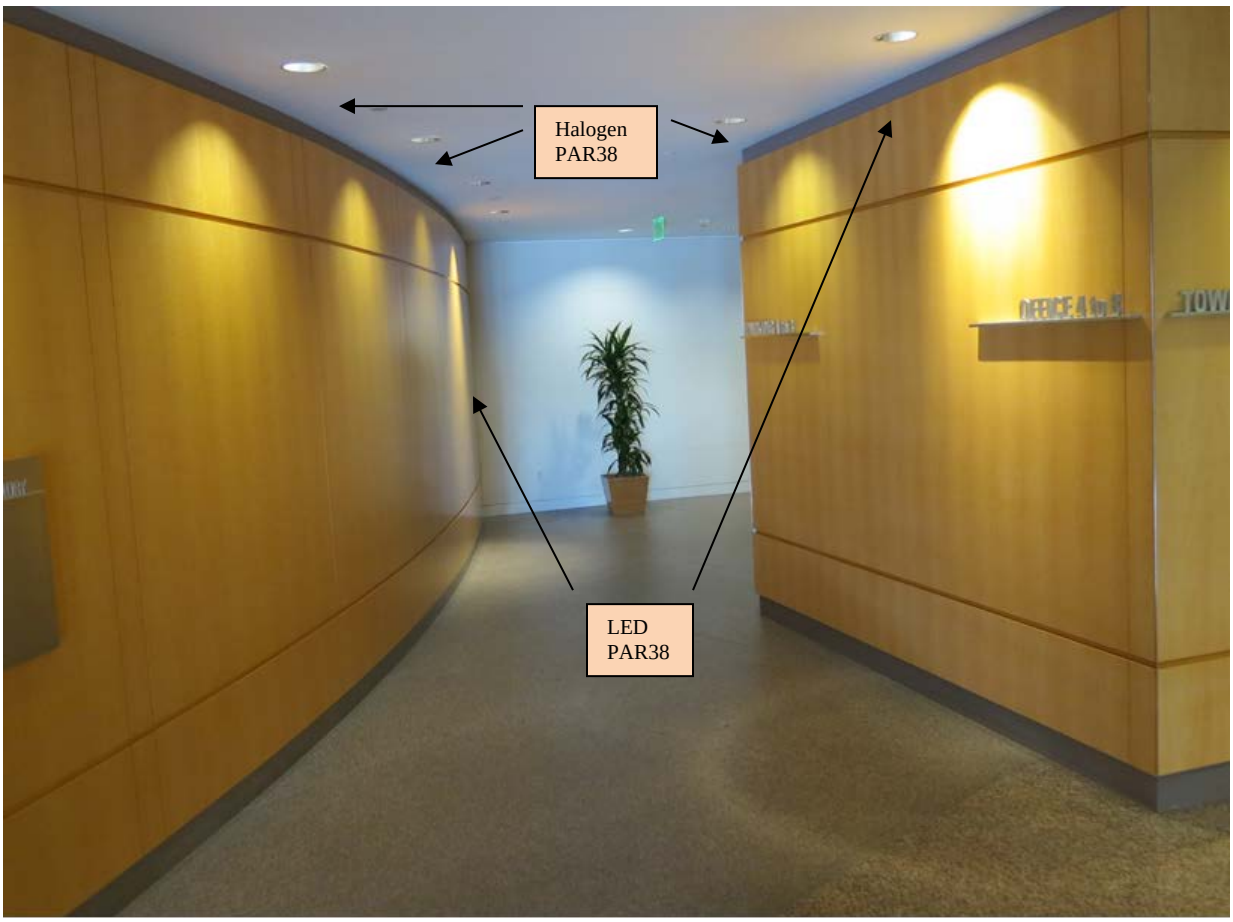

FIGURE 3. BASECASE HALOGEN LAMPS AND LED PAR38 LAMPS IN OFFICE LOBBY

PROJECT DECISION MAKING

The site visit and interview were completed with the contracted chief engineer and the facility engineer, who operate on a lighting maintenance budget of $700 per month. This budget is normally used for lamp and ballast replacement, with occasional work required on the fixtures themselves. The chief engineer was new to the position, but thought that the building owners would normally consider energy efficiency measures if the payback was less than 18 months.

LED REFLECTOR LAMP APPLICATION AND PERFORMANCE REVIEW

The chief engineer had mixed reviews of the new LED PAR38s. While pleased with the wattage reduction from the base case 75 watt lamp, he found the replacement LEDs to be too bright, resulting in sharp contrasts on the wall, and too much light would reach beyond the wall and onto the floor. He was also concerned with the light discoloring the wood, though it seems more likely that discoloration would occur due to the higher operating temperatures of halogen lamps. The facility engineer had a differing opinion and preferred the LED PAR38s, citing beam definition and the overall increase in light levels as being significant improvements. It is true that light levels were quite high on the floor during the day (up to 160 FC), but the lobby area was exposed to daylight and the facility engineer noted that light levels were much lower at night.

FIGURE 4. HALOGEN PAR38 AND LED PAR38 SIDE-BY-SIDE COMPARISON

It is clear from both Figure 4 and Figure 5 that the LEDs are noticeably brighter than the halogen PAR38s, and they have a more focused beam. However, this is an expected result of the lamp replacement: while the new LED PAR38s were designed to replace a 120 watt halogen, the customer had actually been using 75 watt PAR38s. The LED PAR38s were 65-80% brighter[4], at roughly 145 FC (horizontal at 6 feet) for the LED PAR38 and 40 FC for the 75 watt halogen. At ground level, a similar comparison yielded around 35 FC for the LED and 11 FC for the halogen. While the FC variance is significant, the visual impact is less drastic because none of the lamps provide general overhead lighting. They are used as indirect accent lights, so the contrast is primarily noticeable when examining the areas of the wall and floor directly in the beam path.

CUSTOMER THREE: CITY HALL

The City Hall project was completed by the City's building maintenance supervisor, in a meeting/training room located in the City Hall. The application received was for 12 PAR38 20 watt LED lamps. The room is usually used for training sessions for City employees. Training sessions regularly incorporate an overhead projector or video. See Figure 6 below for a view of the room layout and lighting:

FIGURE 5. CITY HALL TRAINING ROOM

[4] Measurements were taken under halogen and LED PAR38 lamps in the elevator bay and the lobby, both at ground level and at the 6 foot height. Readings taken in the center and perimeter of the beam.

The meeting room uses 18 cell parabolic 2X4 troffers in addition to the PAR38 lamps. However, in normal use during training sessions, the maintenance supervisor noted that the troffers are probably used less than the PAR38s because of the ability to dim lights to an optimal level for projector or video presentations.

LED Reflector Lamp Application and Performance Review

Light levels were adequate for paper tasks at desk level, even without the 2X4 troffers. Luminance readings taken at the desks showed about 35 FC on the low end, and about 58 FC in the brightest areas. The customer was pleased with the light color, distribution and overall aesthetic quality of the new lamps. He also noted a reduction in operating temperatures, and as a result he expected less cooling demand when the room is occupied. The 20 watt LEDs clearly provided sufficient illumination, and functioned well on the dimmer.

After reviewing the lamp stock in the supply room, there were a couple noteworthy findings. First, it appeared that the existing lamps were likely to have been 60 watt halogen lamps, not 100 watt as expected by the customer. As a result, it should be expected that the customer found the new LEDs to be relatively bright compared to the baseline lamp. The second discovery was that the customer had only installed six of the 12 LED replacement lamps, but was planning to replace additional lamps in the near future.

Program Design and Delivery Channel

The two pilot offers had some significant differences including the implementation time periods, incentive levels and customer/vendor relationships, so some of the successes and shortcoming of each pilot are best analyzed separately. However it is still informative to compare costs, savings, and application data side-by-side. Table 5 summarizes the total savings and incentive payments of each pilot

Table 5. Pilot offers: savings and incentive summaries

Pilot Offer	Lamp Quantity	Electric Savings (kWh)	Peak Demand Savings (kW)	Incentive Payments
Midstream	878	125,400	26.49	$12,218
Direct Install	451	59,129	11.73	$15,749
Grand Total	1329	184,529	38.22	$27,967

There were clear trends in the most commonly sold lamp types and most significant building types. Table 6 provides some insights into these patterns. In the midstream pilot, the large office, large retail and hospital customers bought the most LED lamps, and most of the

lamps sold were LED PAR38s in the 14-21 watt range. In the DI pilot, most lamps were sold to retail and restaurant customers, with relatively few LED PAR38s sold (mostly LED PAR30 and MR16s).

TABLE 6. PILOT OFFER LAMP SALES BY WATTAGE AND BUILDING TYPE[2]

MEASURE	BUILDING TYPES											
	ASM	HSP	HTL	MLI	OFL	RSD	RT3	RTL	RTS	RFF	OFS	SUN
MIDSTREAM PILOT												
LED PAR20: ≤ 9 WATTS					17				12			
LED PAR30: < 14 WATTS	4				56							
LED PAR30: 14 TO ≤16 WATTS	4				12				8			
LED PAR38: 14 TO ≤ 21 WATTS		100	4	12	210	7		139	15			
LED MR-16, < 7 WATTS		20	87		52	2	12	4				
LED MR-16, 7 TO <=11	91	10										
DIRECT INSTALL PILOT												
LED PAR20: ≤ 9 WATTS	6				4	28		19	19		2	
LED PAR30: < 14 WATTS									21	2	22	
LED PAR30: 14 TO ≤16 WATTS	16					5			64		15	
LED PAR38: 14 TO ≤ 21 WATTS	6					28		21	3		3	
LED MR-16, < 7 WATTS						8		8	18		26	
LED MR-16, 7 TO <=11						13		36	48			
LED PAR38: < 14 WATTS												10

There were also significant differences in costs and incentive payment structures. Table 7 offers a glimpse into customer payments, with customers in the midstream pilot paying an average of 35% more than customers in the DI pilot after utility incentives were applied.

TABLE 7. AVERAGE PRICE TO CUSTOMERS IN PILOT OFFERS

MEASURE	MIDSTREAM PRICE TO CUSTOMER	MIDSTREAM REBATE	MIDSTREAM NET PRICE	AVERAGE DI PRICE TO CUSTOMER	DIFFERENCE BETWEEN PILOT OFFERS
LED MR-16, < 7 watts	$20	$5.00	$15	$14	6%
LED MR-16, 7 to <=11	$30	$5.00	$25	$17	31%
LED PAR20: ≤ 9 Watts	$28	$7.50	$21	$15	27%
LED PAR30: < 14 watts	$53	$7.50	$46	$25	45%
LED PAR30: 14 to ≤16 watts	$47	$17.50	$30	$18	39%
LED PAR38: < 14 Watts	$53	$10.00	$50	$14	73%
LED PAR38: 14 to ≤ 21 Watts	$54	$20.00	$34	$25	26%

Some of the factors contributing to the customer cost differences are bulk LED lamp pricing to the DI pilot, differences in incentive structures and limited distributor pricing data, as evident in PAR30s < 14 watts listed at a higher cost than the 14-16 watt versions. Conversations with distributors have also indicated that they are often flexible in pricing LEDs, and distributors are forecasting significantly lower costs in 2013.

DISTRIBUTOR INTERVIEWS AND ASSESSMENT

Despite the large variance in performance by each of the distributors, they all relayed a consistent message of support for the midstream program design. In addition, they all envisioned far more productive participation with a longer (1-2 year) program cycle. Distributors stated that the 3 month pilot period did not allow for adequate resources to be devoted to marketing, sales tracking and application entry. Each distributor expressed confidence in significantly improving sales and application entry with a full program launch.

PARTICIPATION

Three of the four participating distributors were able to submit incentive applications during the pilot offer. Distributor #1, the most active distributor in the pilot, is unique in that their business model is nearly entirely focused on lighting products. In addition, Distributor #1 has participated in past midstream PG&E lighting programs which use the online application system, so there was a high level of familiarity with the pilot concept and structure. That being the case, it was expected that Distributor #1 would be particularly successful in selling eligible lamps. While the other three distributors were not able to fully take advantage of the pilot, they expect to do much better during a full program cycle. Furthermore, the primary reason for their slow participation was not a lack of eligible lamp sales, but that the sales were incentivized through other 3P incentive programs.

DISTRIBUTOR MARKETS, SALES AND RELATIONSHIPS

Distributor #1 may have been the most successful simply because they have the largest commercial customer base of the participating distributors, and therefore sell the highest volume of lighting equipment. However, there are a few factors that likely contributed to their superior performance:

1. They sell directly to end-use customers
2. Sales staff were all trained on the Pilot offer, and made specific product recommendations to their customers
3. They provided their customers with documentation of the rebates, and listed the rebate value directly on customer invoices

For Distributor #1, there were a few advantage of selling directly to end-use customers. First, it is easier for the distributor to collect and track the required fields for submitting an application. Distributors who are not in direct contact with

customers often have difficulty obtaining some of the required project data in midstream programs if the sale runs through a contractor. Though not an absolute barrier, the additional level of communication from distributor-contractor-customer can pose challenges in obtaining accurate project data for an application. Also, a lack of customer contact reduces the distributor's ability to understand the customer's level of interest, timeline, and decision-making process. This may have less of an impact in day-to-day sales, but due to the short Pilot period, these factors had a significant impact on distributors' ability to sell and reduce the cost of LED replacement lamps.

Conversely, Distributor #2's poor performance was partially due to their position in the supply chain. They rely more heavily on contractor sales and have fewer (or less impactful) direct relationships with customers. As a result they have very little influence with most of their customers. Even if they complete eligible sales, it can be difficult for them to collect the customer data required for incentive application processing.

While Distributor #2 sells regularly to contractors, they do have some direct customer relationships with large commercial accounts. The challenge with this type of customer is that the project approval period can be 6 months or longer due to layers of customer management. Furthermore, once a project decision has been made, they often open for bidding. The project values needs to be $20,000 or more for the distributor to become involved directly with the customer, but they will make an exception for high visibility or demonstration-type projects if there could be additional sales potential down the road. Distributor #2 noted that any business operating under single ownership is a good target because project approval is likely to be easier.

Competing Incentive Offers

Distributor #3 expressed frustrated that they weren't able to submit more sales for rebates. It seems that the primary reason for them not being able to sell more lamps and submit more applications was the presence of two additional incentive offers for LED replacement lamps, both of which were ratepayer funded Programs that could not be used together with midstream incentives. The other programs were paying relatively high customer incentives, at $0.70-80 per watt reduction, and rebates o $20-40 per LED lamp. As a result, Distributor #3 was inclined to take full advantage of the best incentive offer available, and directed a substantial amount of their efforts towards these two Programs. Distributor #3 sold thousands of lamps through these Programs.

Distributor #4 had the same conflict. While they sold many LED replacement lamps during the pilot, the LED lamp orders were from installation contractors who worked directly with competing ratepayer funded programs. Without competing incentive offers, Distributor #3 and Distributor #4 would have been more active midstream participants.

Distributor Influence in Market Transformation

Distributor #1 sales staffs were clearly influential in the developing project leads and closing sales. All of the customers interviewed were regular customers of the distributor, and the onsite contact at each customer facility noted that their sales rep had influenced the decision to purchase LED replacement lamps. At least two of the

customers said that they regularly receive product recommendations from the distributor.

Distributor #1 was also active in marketing the pilot offer. They produced their own sales documents that summarized the incentives, product eligibility, and project timelines. The distributor also listed the value of the PG&E incentive as a cost reduction, shown on the invoice.

Distributor #2 plans to work more closely with their contractor customers and educate them on the incentives so that they can relay information to end-use customers. It was not an option for them through the Pilot due to time constraints, but Distributor #2 plans on implementing an outreach effort with contractors should there be another program.

Distributor #4 works with both contractors and customers. The have hundreds of direct accounts with customers, who they are in touch with at least once a year. In the event of a full Program launch, they'd likely be able to target both through marketing efforts.

DISTRIBUTOR FEEDBACK

Distributor #2 stated they would have been strong participants if the Pilot period had simply lasted a little bit longer. By the time they'd engaged sales staff and thoroughly reviewed product and sales eligibility, there was only one month left in the Pilot. With so little time left, their concern was that sales would not be completed by the closing of the Pilot. As a result, they never actively marketed the Pilot offer to customers. Still, they were excited about the potential for a full program in future years and thought that with more time prepare, they would be able to sell and participate more.

TECHNOLOGY AND INCENTIVES

Distributor #4 expected LED replacement lamps to substantially improve in market share next year. They'd noted prices were trending towards $20-45 for LED PAR and MR lamps but that costs are expected to drop further in 2013 as manufacturers seek to roll out new products. Normally, they tend to stock as few LED lamps as possible because manufacturers are releasing new models on a regular basis and they do not want to keep the older versions on their shelves.

Distributor #2 made some critiques of the incentive levels offered during the Pilot. While they found the rebates strong enough to increase sales, they believed that LED MR16s should receive a larger rebate. They noted that the net cost of a PAR38 would be roughly $18 if the LED is $38, receiving a $20 rebate. At the same time, the net cost of an MR16 LED would be $15 with lamps priced around $20, receiving a $5 rebate. In a non-incentivized market, the MR16 costs roughly half of the PAR38, but with incentives, the cost is quite similar.

RESULTS AND RECOMMENDATIONS

PG&E was able to demonstrate clear customer interest in LED replacement lamps, and successful implementation of two different pilot offers. Since the pilot incentives were only offered for a short window, and were only available to select groups within the lighting market, it is difficult to evaluate the pilots on cost-effectiveness or savings goals. Yet both pilots were able to show considerable customer interest and savings potential within a brief implementation period.

PROGRAM DESIGNS FOR LED REPLACEMENT LAMPS

PG&E and other utilities interested in these measures should use the commercial distributor channel as a way to significantly increase the market share of LED replacement lamps in non-residential markets. Distributors have shown the ability to "upsell" and are influential in customer purchasing decisions. Commercial customers will frequently look to their vendor or distributor for product recommendations, and distributors tend to have thorough understanding of both the technology and the market.

For program managers, midstream programs come with the additional attribute of involving a limited number of market actors. While incentive funds are paid to a small group of distributors, they improve market penetration broadly, by reducing prices to customers and increasing competition among distributors. Program managers may also benefit from simpler and more direct program marketing efforts due to the consolidated participant base, and an improved capability to respond to technology and market changes, which may assist in cost effective program implementation.

The pilots also showed that certain market sectors are outside of the reach of commercial distribution channels, and for incentive programs to have an impact in these markets, a DI or downstream program would be an effective alternative. The DI pilot was responsible for more than 80% of the LED lamp sales to small retail customers in the pilot offers.

LAMP SPECIFICATION

All three customers surveyed through the midstream Pilot were using at least one LED in an application that it was not designed for. While feedback on the new LED lamps was generally positive through the Pilot offers, it is concerning that sub-optimal lamp specifications or installations were so common. Questions to consider include:

- Did the vendor specify the lamp model number or was the customer responsible for product selection?
- If the vendor specified the LED replacement lamp, did customer provide incorrect information on the existing lamp to the vendor?

- If the vendor and customer were both aware of the existing lamp output, did they consider the LED manufacturer equivalency recommendations to be inadequate?

It is recommended that future Programs take a closer look at lamp specification and which market actors are making the key decisions on the specific make, model and color temperature of lamp included on an equipment order. Distributors and contractors should be encouraged to properly specify LED replacement lamps based on the existing lamp output, unless another level of output is requested by a customer

REBATES AND PARALLEL UTILITY INCENTIVE OFFERS

Rebate levels seem to have been effective in influencing customer decision making. In the midstream pilot, rebates occasionally covered as much as half of the lamp cost, and occasional no-cost projects in the DI pilot. While distributors and customers were found the rebate levels to be effective, distributors stated that LED MR16 lamps were not given an adequate rebate under the Pilot offer. Their primary justification was based on the fact that the rebate/lamp cost ratio was considerably smaller for MR16s than the PAR lamps. Of course, energy efficiency programs must consider factors (cost effectiveness, market size, technical barriers, etc.) beyond lamp pricing in determining rebate levels, but the market size for MR16 lamps, the incremental cost and the incentive/savings ratio should be reassessed to identify potential areas of improvement.

Program implementers must also be keenly aware of other utility programs covering the same measure. Two of the four Pilot participants noted that many of their sales, and their efforts, were directed at other programs which provided significantly higher rebates than the midstream offer. While double dipping may be a primary concern of program managers, overall program performance is too: vendor or distributor incentive programs will follow the most attractive incentive options, and managers should develop a thorough understanding of competing incentive offers to reduce double dipping risks, and to improve program forecasting and performance.

TARGET MARKETS OF LED LAMP PROGRAMS

From the interviews conducted with DI customers, we also learned of the limits of midstream programs and the importance of downstream programs in some non-residential markets. A majority of interviewees noted that they normally purchase LED replacement lamps at retail stores, much like a residential consumer. The customers in the DI Pilot were primarily small retail. It is unlikely that this market sector (and others) would receive much benefit from a distributor-focused program, because they do not normally engage with lighting/electrical contractors or distributors for products such as LED reflector lamps.

Similarly, more than 70% of the lamps incentivized through the midstream Pilot were sold to large office, large retail and hospitals, with less around 5% of lamps being installed at small and restaurant customers.

Given the trends in sales and purchasing practices, utility program managers should match the program delivery channel with the targeted market. Through the pilot offers, it was shown that distributors are in an optimal position in the market to reach large, non-residential customer types, and they have the capacity to penetrate

into smaller market segments if they collaborate with contractors or develop stronger marketing efforts. Small non-residential customer would be best served by DI or downstream programs, since their typical project procurement and decision making project more closely resembles the retail channel.

APPENDICES

APPENDIX A. ENERGY STAR® KEY EFFICIENCY CRITERIA

PERFORMANCE CHARACTERISTIC	SPECIFICATION CFLS	SPECIFICATION INTEGRATED LED LAMPS
Efficacy (Total lumen output divided by input wattage)	Bare lamp: Lamp power < 10W: 50 lm/watt 10W ≤ Lamp power < 15: 55 lm/watt Lamp power ≥ 15W: 65 lm/watt	Bare lamp: Lamp power < 10: 50 lm/watt 10 ≤ Lamp power : 55 lm/watt Decorative lamp: 50 lm/watt Directional: 40 lm/watt-45 lm/watt
Minimum Rated Life	Medium screw-base Covered, Globe and Outdoor reflector CFLs: ≥ 6,000 hours Bare medium screw-base CFLs and GU24-base covered, dimmable, and reflector Lamps: ≥ 8,000 hours GU24 Bare Lamps: ≥ 10,000 hours	Decorative: ≥70% Lumen Maintenance at 15,000 hours All others: ≥70% Lumen Maintenance at 25,000 hours
Correlated Color Temperature	Lamps must have one of the following designated correlated color temperatures (CCT): 2700K, 3000K, 3500K, 4100K, 5000K, or 6500K.	Lamps must have one of the following designated correlated color temperatures (CCT): 2700K, 3000K, 3500K, or 4000K.
Warranty	Warranty or limited warranty statement must cover at least a minimum of 24 months, or 2 years, from date of purchase based on no less than 3 hours per day of use.	A warranty must be provided for lamps, covering material repair or replacement for a minimum of three (3) years from the date of purchase.
Power Factor	≥ 0.5	For lamp power ≤ 5W and for low voltage lamps, no minimum power factor is required. For lamp power >5W, power factor must be ≥0.70 Note: Power factor must be measured at rated voltage.
CRI	An Average of the 10 samples tested must be greater than 80, and no more than 3 individual samples can have a CRI less than 77.	Minimum CRI (Ra) of 80.

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