EVERGREEN ECONOMICS

Early EM&V of Pacific Gas and Electric Company's Commercial LED T8 Incentives

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Table of Contents

EXECUTIVE SUMMARY 1

Introduction 1

Overview of Study Objectives 1

Overall Research Approach 2

Summary of Conclusions 2

Recommendations 3

1 INTRODUCTION 5

1.1 Background 5

1.2 Technology Overview: LED T8 Replacement Lamps 5

1.3 Study Objectives 7

1.4 Specific Study Objectives 8

2 STUDY METHODS 10

2.1 In-depth Interviews with PG&E Direct Install Program Project Managers and Direct Install Program Implementers 10

2.2 In-depth Interviews with LED T8 Manufacturers and Lighting Distributors 10

2.3 Telephone Survey with Direct Install Program Participants (Who Received LED T8s) 12

3 FINDINGS 16

3.1 Sales Process 16

3.2 Direct Install Process 21

3.3 Customer Satisfaction 27

3.4 Cost Considerations 33

3.5 Technology Persistence 34

3.6 Benefits of the Direct Install Approach 36

3.7 Non-Direct Install Approach Feasibility 39

4 CONCLUSIONS AND RECOMMENDATIONS 42

4.1 Conclusions 42

4.2 Recommendations 49

APPENDIX A – DIRECT INSTALL PARTICIPANT SURVEY GUIDE 50

APPENDIX B – INTERVIEW GUIDES 64

Executive Summary

Introduction

Pacific Gas and Electric Company (PG&E) contracted with Evergreen Economics (Evergreen) in November of 2016 to conduct early evaluation research to inform numerous research objectives related to the delivery of rebate programs for commercial LED T8 replacement lamps. Since the start of 2015, PG&E has provided LED T8 replacement lamps exclusively through its Regional Direct Install (DI) programs. The DI programs provide reduced cost (or free) LED T8 replacement lamps to small commercial customers to replace their existing linear fluorescent lamps. (The DI programs also offer numerous other lighting and non-lighting measure options).

Overview of Study Objectives

The primary, overarching objectives of this research are:

1. To understand participating DI customers' decisions in selecting LED T8 lamp options.
2. To assess participating DI customers' overall satisfaction with installed LED T8 lamps.

Furthermore, PG&E requires information to inform whether and how LED T8 replacement lamps should be considered for inclusion as an energy efficiency option in its broader portfolio, and therefore, hopes to obtain DI participating customer and implementer feedback regarding future program design and implementation.

Specific study objectives of this research include informing the following key topics:

- Sales process
- DI process
- Customer satisfaction
- Cost considerations
- Technology persistence
- Benefits of the DI approach
- Non-DI approach feasibility

Table 1 in Section 1.4 contains additional information on these research topics, including specific research questions.

Overall Research Approach

Evergreen conducted the following research tasks to inform both the primary overarching objectives and the specific research objectives:

- Roundtable interview with three PG&E DI program managers;
- In-depth interviews with all nine PG&E DI program implementers;
- In-depth interviews with eight LED T8 manufacturers;
- In-depth interviews with 12 commercial lighting distributors; and
- Telephone surveys with 151 DI program participants that received LED T8 replacement lamps (since January 2015).

Evergreen developed sampling plans (where appropriate), interview guides and a participant survey tool. Evergreen researchers conducted all in-depth interviews, and CIC Research conducted the computer assisted telephone interview (CATI) survey of program participants.

Summary of Conclusions

PG&E's DI programs target small and medium-sized business (SMB) customers with demand of less than 200kW. A slim majority (53%) of the participants that had LED T8 replacement lamps installed as part of their DI participation initially learned about LED T8s from DI implementers (they were not previously aware of LED T8s). DI programs' direct outreach strategies were effective at reaching the hard-to-reach SMB segment (70 percent of participants were approached by the DI installer or their contractors).

Implementer messaging focuses on the low upfront cost, return on investment, overall energy and cost savings, product lifespan and light quality, and was cited as the greatest source of influence among 63 percent of participants. The vast majority of DI participants reported that they were only presented with LED T8s as an option for upgrading their existing linear fluorescents (86%), and the vast majority (78% overall) of customers would not have retrofitted or replaced their existing linear fluorescents (lamps or fixtures) in absence of the LED T8 replacement lamps provided through the DI programs.

Regarding LED T8s, most market actors and implementers agreed that these lamps are the most cost effective solution for upgrading linear fluorescent lighting at this time. Market actors reported that, for SMBs in particular, other options typically have upfront costs that are too expensive and payback periods that are too long. The DI approach is very effective at reducing the upfront cost barrier for the end-users. A midstream approach would reduce the upfront cost barrier, but a downstream approach would not. Regarding LED fixtures, market actors also noted that fixture installations are significantly more disruptive than lamp replacements.

The vast majority (approximately 95%) of participants were satisfied with the LED T8s, indicating that the lamps met their expectations and were appropriately specified (in terms of light output and color). The continued use of LED T8s among participants is highly likely. Only one participant survey respondent had removed all of their LED T8s, and only a few had to replace small numbers of lamps due to failure or unsatisfactory lighting levels. Market actors reported very few or no returns or issues with LED T8s other than the occasional ballast incompatibility[1] or concern over lighting levels (these issues are easily resolved).

While the DI approach is an effective means of reaching hard-to-reach and busy SMB owners and facility managers (including driving initial awareness), the DI approach does not address any installation challenges that would not be addressed as part of installations outside of the DI programs (or through downstream or midstream programs). That said, the DI approach might help ensure high levels of participant satisfaction because the initial DI audit (which identifies opportunities for energy efficiency upgrades) helps address potential ballast incompatibility issues.

Providing incentives for LED T8s through other channels besides DI programs is inherently riskier in terms of customer satisfaction and technology persistence, as well as free ridership, than providing incentives solely through the DI programs. Simply put, PG&E has less control over the process. However, DI ignores customers larger than 200kW, which is significant. A switch to—or the addition of—other incentives mechanisms has the potential to increase overall gross sales due to increasing the number of target customers (and thus targeted linear fluorescent lamps).

Recommendations

Based on the conclusions presented above, the following recommendations are made to PG&E program planners.

1. **Provide incentives for LED T8s through additional channels.** Due to high levels of satisfaction and technology persistence, coupled with the likely significant potential for LED T8s in larger facilities, PG&E should consider including LED T8s in the Commercial Midstream Lighting Program and/or the Commercial Deemed Program.
2. **Continued high levels of satisfaction (and therefore persistence) may require professional installation.** To ensure satisfaction and technology persistence if LED T8s are offered outside of the DI programs, PG&E should investigate requiring professional installation of LED T8s in order to receive incentives. The entity submitting the rebate would be responsible for collecting installer information. For the Commercial Midstream Lighting Program the distributor would collect installer

[1] Occasionally the existing ballast is incompatible with certain LED T8 replacement lamps.

information, and for the Commercial Deemed Program either the end-user or, if applicable, a Trade Professional Alliance member would collect installer information.

3. **Continue providing incentives through Direct Install programs.** The DI programs are effective at targeting SMB customers, who are harder to reach through downstream or midstream incentive programs. Furthermore, and related to the second recommendation, the DI programs achieve high levels of satisfaction and persistence in part because the lamps are installed by a professional.
4. **Develop an LED T8 marketing, education, and outreach strategy.** If PG&E provides incentives for LED T8s through channels other than DI, PG&E and traditional market actors would need to provide marketing, education and outreach. Therefore, PG&E should develop a strategy for promotion and education of commercial customers, likely including in-store promotional materials (i.e., in a distributor's storefront) and content on PG&E's website must be updated. PG&E should consider other marketing, education and outreach strategies as well.
5. **Do not provide incentives for Type B LED T8s at this time.** It is unclear if these lamps/installations create safety concerns (fire hazards). More research is needed.

1 Introduction

1.1 Background

Pacific Gas and Electric Company (PG&E) contracted with Evergreen Economics (Evergreen) in November of 2016 to conduct early evaluation research to inform numerous research objectives related to the delivery of rebate programs for commercial LED T8 replacement lamps. Since the start of 2015, PG&E has provided LED T8 replacement lamps exclusively through its Regional Direct Install (DI) programs. The DI programs provide reduced cost (or free) LED T8 replacement lamps to small commercial customers to replace their existing linear fluorescent lamps. (The DI programs also offer numerous other lighting and non-lighting measure options).

This evaluation stemmed from an initial meeting between PG&E and Evergreen in May of 2016, in which PG&E requested a scope of work. Between the initial meeting and contracting, there were a number of important developments, including a change of project roles at PG&E, minor adjustments to the scope of work through iteration and consultation with the California Public Utilities Commission Energy Division (CPUC ED), as well as changes to the schedule necessary due to a shift in the project initiation date.

1.2 Technology Overview: LED T8 Replacement Lamps

In this section, we provide a background of the LED T8 replacement lamp technology.

1.2.1 How Do LED T8s Compare to Fluorescent T8s?

Compared with fluorescent T8 lamps, LED T8s have the following characteristics:

- Higher efficacy (lumen output per Watt)
- Lower heat output
- Longer lifespan
- Higher upfront cost
- Limited beam spread / directionality

In a practical sense, the higher efficacy drives energy savings as customers typically want a comparable amount of light output (lumens) for their space. The higher efficacy means that the lamps draw less power for the same output. Additionally, the LED T8s run cooler and last longer. Since they last longer, they are promoted as a way to reduce facility management costs (less frequent lamp replacement).

LED T8s are still more expensive to purchase than their fluorescent counterparts, though this is rapidly changing.

Lastly, there is a limit to the beam spread among available LED T8 products. Depending on the application, this can be a benefit (i.e., in directional fixtures such as parabolic troffers) or can be a customer satisfaction barrier (i.e., in suspended direct/indirect fixtures, especially if they are installed with the beam facing the wrong direction).

1.2.2 Types of LED T8s

There are four types of LED T8s available on the market. Findings in this report focus on Type A LED T8s unless otherwise noted.

Type A LED T8 replacement lamps are "plug and play." To install the lamp, you remove an existing linear fluorescent and install the LED as if it was the exact same lamp type. Power for the Type A LED T8 is routed through the existing ballast,[2] so, in most cases, installing a Type A lamp is like replacing a new fluorescent tube. Occasionally the existing ballast is incompatible with certain Type A LED T8s[3] (i.e., from a certain brand or a specific model). Remedies for incompatibility include selecting a different Type A LED T8 or replacing the ballast. Furthermore, ballasts have lifespans that are typically shorter than the Type A LED T8 lamps, and since power for Type A LED T8s must be routed through the ballast, ballasts will need to be replaced during the life of the Type A LED T8. Lastly, since the fixture requires no modification, a Type A LED T8 can be replaced with a linear fluorescent lamp at any time.

Type B LED T8 replacement lamps run on internal drivers, and power cannot be routed through an external ballast. Due to this, installation of Type B LED T8s requires shutting off the power to the fixture, removing the ballast, and hardwiring in the linear LED T8s. This is not "plug and play" and should be installed by an electrician.[4] While the setup and installation is more involved, a benefit is that there is no ballast that can fail and require replacement. Since the fixture has been rewired and configured specifically for Type B LED T8s, it is impossible to install a linear fluorescent without undoing the configuration (which is very unlikely to occur).

Type C LED T8 replacement lamps rely on external drivers instead of ballasts or internal drivers. Otherwise, they are very similar to Type B LED T8 replacement lamps, and the same type of installation is required (not "plug and play").[5]

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[2] Ballasts regulate the power delivered to fluorescent lamps to ensure stable light output. Fluorescent lamps do not work without ballasts.

[3] Ballast incompatibility issues are infrequent; one manufacturer reported there were ballast incompatibility issues in approximately 3% of lamp installations.

[4] Some manufacturers are reportedly concerned with Type B LED T8s due to potential electrical wiring issues that could lead to a fire hazard. We are unable to corroborate that this is a valid concern.

[5] We did not encounter concerns with Type C LED T8s regarding the potential for fire hazard.

Type A/B Hybrid LED T8 replacement lamps may be installed per the Type A or Type B descriptions above. The positives and negatives of Type A/B LED T8s are directly related to the installation. If they are installed with the power routed through the existing driver they assume the attributes of Type A LED T8s. If the ballast is removed and power is routed directly to the lamps, through the internal driver, they assume the attributes of Type B LED T8s.

For additional information regarding the types of LED T8 lamps:

- U.S. Department of Energy CALiPER, 2016. *Snapshot Linear Lamps (TLEDs)*.[6] This document provides an overview of available linear LED lamp options, including a discussion of pros and cons of various other technologies in comparison to linear LED lamps (i.e., in comparison to LED fixtures and retrofit kits).
- Idaho Power, 2017. *TLEDs: Tubular LED or Linear Fluorescent Replacement*.[7] This two-page document provides an overview of the types of linear LED lamp options available on the market (in addition to requirements for Idaho Power incentives).

1.2.3 Title 24, Part 6: Code Compliance Considerations

The 2016 Title 24, Part 6, code update includes compliance requirements for "Luminaire Modifications-in-Place." Type A LED T8 replacement lamp installations are not considered a luminaire modification-in-place. However, if Type A LED T8s are installed in a fixture and the ballast is replaced as part of the installation, it is considered a luminaire modification-in-place and thus must comply with California building code. However, a business must replace lamps and ballasts in 70 or more fixtures on a given floor of their facility within a given year for any code requirements to be triggered.

While this is not an issue for most, if not all, SMB customers, it will become important if Type A LED T8s are offered through mass market incentive programs such as PG&E's Commercial Midstream Lighting Program and/or the Commercial Deemed Program. However, many of the lighting products incentivized through these programs come with similar code considerations (i.e., LED fixtures), so this is not a new barrier but should be considered when assessing likely market potential for Type A LED replacement lamps across the commercial sector.

1.3 Study Objectives

The primary, overarching objectives of this research are:

1. To understand participating Direct Install (DI) customers' decisions in selecting LED T8 lamp options.

[6] https://energy.gov/sites/prod/files/2016/07/f33/snapshot2016_tleds.pdf
[7] https://www.idahopower.com/pdfs/EnergyEfficiency/business/retrofits/TLED.pdf

2. To assess participating DI customers' overall satisfaction with installed LED T8 lamps.

Furthermore, PG&E requires information to inform whether and how LED T8 replacement lamps should be considered for inclusion as an energy efficiency option in its broader portfolio, and therefore, hopes to obtain DI participating customer and implementer feedback regarding future program design and implementation.

We next describe the specific study objectives that informed the overarching study objectives.

1.4 Specific Study Objectives

Through this research study, Evergreen focused on addressing a number of specific study objectives based on DI program participation, experience with LED T8 products, and market actor expertise. In Table 1, we show these specific study objectives and their associated research questions.

Table 1: Specific Study Objectives and Associated Research Questions

Objectives	Research Questions
Sales Process	• How are DI participating customers learning about LED T8 replacement lamps? • Who is making the energy efficiency value proposition to the customer?
Direct Install Process	• Was the participating customer presented with other lighting technology options? • Were they informed about possible and future ballast issues? • Did the DI implementer provide the necessary support to assist the customer in their selection process? • Did the customer make any changes in their ultimate decision based on the information about ballast issues?
Customer Satisfaction	• Where did participating customers install LED T8 replacement lamps (in what types of fixture applications)? • Did this provide the customer satisfactory results? • In absence of the LED T8 replacement lamp option, what would or could the customer have done in these applications?
Cost Considerations	• How cost effective was this choice for the DI participating customer? • Was there a more cost effective solution available? • Is there a cost to waiting (to install the LED T8 replacement lamps)?
Technology Persistence	• How likely is the participating customer to continue the use and maintenance of installed LED T8 replacement lamps in their existing fixtures? • What conditions would lead the customer to remove the LED T8 lamp and change to another lamp or technology? • How frequently are participating customers replacing their ballasts as part of the LED T8 replacement lamp installation?
Benefits of DI Approach	• What worked well using the DI approach that may change if a different incentive mechanism is employed? • What installation challenges were DI implementers able to address? • Does the DI approach have a significant impact on customer satisfaction and technology persistence?
Non-DI Approach Feasibility	• What challenges would PG&E face from the lighting market—ballast issues, issues with product quality, free ridership—if incentives were provided through other channels in addition to DI (e.g., midstream channel)? • How would a switch to other potential incentive mechanisms impact overall (gross) sales and net savings? • How could this impact customer satisfaction and technology persistence?

2 Study Methods

This section provides details on the study methods, as well as details on which research objectives are addressed by each study method.

2.1 In-depth Interviews with PG&E Direct Install Program Project Managers and Direct Install Program Implementers

Evergreen hosted a roundtable discussion with three key recent or current PG&E DI program managers. This roundtable discussion provided relevant and current information about LED T8 products and the DI process.

Evergreen also conducted in-depth interviews with all nine PG&E DI program implementers. Interviews generally were 45 minutes to one hour long. In Table 2, we show the specific study objectives (discussed in detail in Section 1.4) addressed as part of this research task.

The Evergreen Project Manager conducted the roundtable and each of the in-depth interviews with the three PG&E DI program managers.

Table 2: Specific Study Objectives Addressed During Implementer Interviews

Specific Study Objectives	DI Program Implementer Interviews
Sales Process	✓
Direct Install Process	✓
Customer Satisfaction	✓
Cost Considerations	✓
Technology Persistence	✓
Benefits of DI Approach	✓
Non-DI Approach Feasibility	

2.2 In-depth Interviews with LED T8 Manufacturers and Lighting Distributors

Evergreen conducted in-depth interviews with LED T8 replacement lamp manufacturers. We developed a sampling plan based on LED T8 lamp sales through the DI programs, and planned to randomly contact all manufacturers with sales amounting to 1 percent or more of total DI program sales (which gave us a pool of 15 manufacturers to contact) in order to conduct eight interviews. Evergreen was able to obtain contact data for 11 of the 15

manufacturers. We contacted each of these 11 manufacturers and conducted interviews with eight of them, representing approximately 42 percent of LED T8 lamp sales through the DI programs.

Evergreen also conducted 12 interviews with commercial lighting distributors. Evergreen downloaded a list of the 120 distributors participating in PG&E's Commercial Midstream Lighting Program[8] and conducted a thorough review of the distributor contact data before conducting the sampling effort. Evergreen flagged 25 unique distributors located outside of California and removed them from the sample, leaving 95 distributor records in the dataset. Nine of the 95 records were for one distributor with multiple locations, so Evergreen limited this company to one potential response (all records were included in the randomized list of companies to contact, but we effectively established a strata for these nine records with a target of one complete).

Evergreen staff members who conducted the manufacturer and distributor in-depth interviews are trained in in-depth interview methods and have an understanding of the key issues that PG&E is working to inform.

In Table 3, we show the specific study objectives addressed by the manufacturer and distributor in-depth interviews.

Table 3: Specific Study Objectives Addressed During Manufacturer and Distributor Interviews

Specific Study Objectives	LED T8 Manufacturer Interviews	Lighting Distributor Interviews
Sales Process	✓	✓
Direct Install Process		✓
Customer Satisfaction	✓	✓
Cost Considerations	✓	✓
Technology Persistence	✓	✓
Benefits of DI Approach	✓	✓
Non-DI Approach Feasibility	✓	✓

[8] Source: https://www.pge.com/includes/docs/pdfs/mybusiness/energysavingsrebates/rebatesincentives/ref/lighting/lightemittingdiodes/led_reflector_participant_list.pdf

2.3 Telephone Survey with Direct Install Program Participants (Who Received LED T8s)

Evergreen targeted 150 surveys of DI program participants who received LED T8s since January of 2015 as part of their program-sponsored lighting installation. Participants are all small and medium-sized business (SMB) customers with demand of less than 200kW. This number of surveys balances the desire for some comparisons across different groups (e.g., customers with and without ballast replacements) with project budget limitations.

CIC Research fielded the computer aided telephone interview (CATI) survey, ultimately completing 151 surveys with DI program participants.

We show the specific study objectives addressed by the participant survey in Table 4. The survey also captured information such as sources of LED T8 awareness and installation location within each participant's facility.

Table 4: Specific Study Objectives Addressed During Participant Surveys

Specific Study Objectives	Surveys of Participants (who received LED T8s)
Sales Process	✓
Direct Install Process	✓
Customer Satisfaction	✓
Cost Considerations	✓
Technology Persistence	✓
Benefits of DI Approach	✓
Non-DI Approach Feasibility	✓

2.3.1 Sampling Approach and Methodology

Evergreen Economics received two files from PG&E containing information regarding the direct installation of LED T8s at commercial facilities in PG&E's territory since 2015. One file contained project and contact information (e.g., measure names and quantities, as well as business name, phone number, and contact name), while the other file contained more information about the business (e.g., business type and peak demand). The datasets contained a common field, the service agreement identification number (SA_ID) and we merged the files in order to incorporate the data from both files.

After removing duplicate records and cleaning the merged datasets, the resulting dataset included 1,579 participant records.

In consultation with PG&E, Evergreen developed a sampling strategy that accounts for DI implementer practices (for example, whether they reportedly replace 100 percent of ballasts during an installation) and customer business type. This approach ensured that responses covered the implementation strategies employed by the local DI implementation firms, as well as ensured that we obtained feedback regarding the LED T8 products from a variety of end-user types (i.e., business types). Initial discussions with PG&E indicated that DI implementers handle ballast replacements differently, which may lead to varying levels of customer satisfaction and equipment persistence.

Sample Frame: Direct Install Participants Who Received LED T8s

Table 5 shows the sample frame, which consists of all DI program participants who received LED T8s between January of 2015 and mid-December of 2016. Participating businesses are broken out by business type and whether the DI implementer responsible for their project reportedly replaces all or only some of the ballasts they encounter.[9] The table shows the number of projects for each combination of business type and implementation strategy.

Table 5: LED T8 Program Participants—Survey Sample Frame

	% of Ballasts Replaced **		
Business Type	**100%**	**< 100%**	**Total Projects**
Retail	357	199	556
Office	123	77	200
Hospitality	123	76	199
Manufacturing, Transportation, Government and Healthcare	117	68	185
Other *	55	33	88
Unknown	252	99	351
Total Projects	**1,027**	**552**	**1,579**

* 'Other' includes schools, food processing, agriculture, high tech/biotech and petroleum.

** Self-reported business practice of DI implementer.

[9] Note that the percentage of ballasts replaced (100% and less than 100%) is based on PG&E's DI program managers' understanding of the DI implementers' practices. This was confirmed via self-report during the DI implementer interviews, but was not confirmed during the DI participant telephone survey; some participants from the group served by DI implementers that reportedly replace 100% of ballasts reported that their ballasts were not replaced.

Sample Design

Table 6 contains the 12 strata and the total number of participating end-user sites targeted within each stratum. In developing the stratified random sample, our default for allocating sample points is to allocate the points evenly across the strata (in this case, that equals approximately 12.5 sample points per strata since there are 12 unique strata and an overall target of 150 surveys).[10] We targeted 13 surveys from both implementation strategies across retail, office and hospitality businesses, and 12 surveys from the remaining strata.

Table 6: Participant Survey Targets by Strata

	% of Ballasts Replaced **	
Business Type	**100%**	**< 100%**
Retail	13	13
Office	13	13
Hospitality	13	13
Manufacturing, Transportation, Government and Healthcare	12	12
Other *	12	12
Unknown	12	12

* Other includes: schools, food processing, agriculture, high tech/biotech, and petroleum.

** Self-reported business practice of DI implementer.

Survey Completes

The sample frame included strata for which we were not likely to achieve 12 surveys due to relatively low numbers of projects.[11] Therefore, when the number of targeted sample points was greater than the number of projects that *responded* to our request to participate in the survey (i.e., when we exhausted all contacts from within a strata but had not achieved the target), we moved those sample points to strata with remaining business contacts. Table 7 shows the targeted and completed number of surveys, by strata.

[10] "Proportional allocation" is the standard approach for stratified random samples.

[11] We did not anticipate 100 percent interview success rates in these strata, but rather intended to contact each end-user within those strata with the goal of ensuring we provided those end-users the opportunity to respond to the survey.

Table 7: Participant Targets and Completes by Strata

	Target			Survey Completes		
	% of Ballasts Replaced **			% of Ballasts Replaced **		
Business Type	**100%**	**<100%**	**Total**	**100%**	**<100%**	**Total**
Retail	13	13	**26**	15	14	**29**
Office	13	13	**26**	14	14	**28**
Hospitality	13	13	**26**	14	12	**26**
Manufacturing, Transportation, Government and Healthcare	12	12	**24**	13	13	**26**
Other *	12	12	**24**	13	4	**17**
Unknown	12	12	**24**	13	12	**25**
Total	**75**	**75**	**150**	**82**	**69**	**151**

* Other includes: schools, food processing, agriculture, high tech/biotech, and petroleum.

** Self-reported business practice of DI implementer.

2.3.2 Survey Weights

We developed sample weights for the survey data to weight the data in proportion to the population. Sample weights for each respondent are based on the ratio of survey completes to the total population in each category. For example, the 15 survey completes of retail businesses served by DI implementers that replace all ballasts at 100% of sites (shown in the top left of the survey completes in Table 7) represent the 357 similar businesses shown in the top left of Table 5. Therefore, each respondent is given a weight equal to 357 divided by 15, or 23.8. This means that each survey response from the 15 completes in this group represents 23.8 businesses in the population. When calculating the proportion of participants responding a particular way to a survey question, each survey respondent's answer is weighted in order to represent the population of participants whom they are representing.

We classified each respondent based on his or her business type category and the ballast replacement characteristics of the DI implementer responsible for their project (i.e., whether the DI implementer reportedly replaces all of the ballasts they encounter as opposed to replacing them on an as-needed basis). Weights were calculated and applied independently to each of these categories and used for analysis of survey data (i.e., we developed separate "business type" and "ballast replacement" weights).

We weighted survey results using the business type weight unless otherwise noted. The ballast replacement weight is used for survey questions where responses are more likely influenced by DI implementer ballast replacement than participant business type.

3 Findings

We organize findings in this section by the specific research objectives (see Section 1.4 for the full descriptions of the research objectives).

3.1 Sales Process

The key research questions related to the sales process for LED T8 replacement lamps include:

- How are DI participating customers learning about LED T8 replacement lamps?
- Who is making the energy efficiency value proposition to the customer?

We next explore the findings related to the sales process, organized by respondent group.

3.1.1 Sales Process: Manufacturer Findings

Lighting manufacturers primarily sell commercial lighting products—including LED T8 replacement lamps—to distributors.[12] Some of the manufacturers provide trainings or send regular emails to their partner distributors regarding product updates in order to keep them informed. The manufacturers almost never sell commercial lighting products directly to the end-user, and rarely sell to others in the supply chain other than their partner distributors (they will sometimes sell their products to an energy service company (ESCO) or manufacturer representative, and sometimes directly to retail).

Manufacturers are not entirely sure what lighting distributors promote, because the distributors typically carry a range of lighting products as well as a vast array of other commercial building equipment and tools. However, manufacturers noted a few important drivers of what lighting products a distributor may promote and recommend:

- Many recommendations are based on what the distributor or contractor thinks they can sell, which may push them to promote lower cost, lower quality[13] options to their customers.
- Some recommendations are based on the facility type and/or fixture type (i.e., the application).
- When selling LED lamps (of any type), distributors and contractors focus on return on investment (ROI), lower maintenance, and ease of installation (for Type A T8 replacement lamps).

[12] This was confirmed by visiting websites that direct potential customers to local distributors.
[13] "Quality" may be associated with light color, directionality, lumen output, lifespan, etc., and is not necessarily measured the same by different respondents.

Manufacturers noted that customers seeking an easy and inexpensive retrofit tend to buy LED T8s because of the relatively lower initial cost, faster payback period and ease of installation. For new construction or major renovation projects, customers may select LED fixtures.

Three of the eight manufacturers are heavily promoting Type B LED T8s while another three are very reluctant to do so, based on a perceived risk of poor wiring leading to potential fire hazards, and therefore do not manufacture Type B LED T8s (it is unclear how valid this risk is at this point in time).

3.1.2 Sales Process: Distributor Findings

Out of the 12 distributors we interviewed, six of them sold only directly to the end-user, one sold only to installers, and the remaining five sold to both the end-user and the installer.

Eight of the 12 distributors reported that commercial customers looking to upgrade linear fluorescent lighting are equally interested in LED replacement lamps (including Type B and C LED T8s) and LED fixtures (with one predicating this on the availability of On-Bill Financing[14]). The remaining four estimated that customers are more interested in LED T8 replacement lamps than replacing existing fixtures with LED fixtures.

For LED T8 replacement lamps, company owners and managers (end-use customers) rely heavily on distributors (and installation contractors) to make recommendations on the type of replacement lamp to install based on building characteristics and functionality (this is in line with previous commercial lighting market studies).[15] Six of the 12 surveyed distributors reported that cost is the main driver in end-user purchase decisions, four stated that ROI was the main factor, and two indicated that ease of installation was the most important criteria (all of these lead to many customers selecting LED T8s over LED fixtures).

Eight distributors stated that the space type—such as whether the lamps are intended for a hallway, a bathroom, a retail floor, or a warehouse space—has the biggest influence on what they present to the end-user while the other four reported that what they present is determined based on their assessment of the most appropriate technology type for the end-user. All distributors reported that when their staff sells LED T8 replacement lamps, the most common messages are the relatively low cost and the ROI.

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[14] The On-Bill Financing program offers 0% financing for qualifying energy-efficient improvements that are paid through a non-residential customer's bill.

[15] For example: *SCE/PG&E Basic/Advanced/LMT Program Process Evaluation: Commercial Lighting Retrofits – Targeted Research*. Evergreen Economics, 2013. [CALMAC ID: SCE0307.01]

While distributors who sell to installers (five of the 12) are unsure of how contractors promote LED T8s to end-users, they tend to assume the promotion of LED T8s is aligned with their messaging. Two believe that the low cost is the most common message from contractors to customers, two cited ease of installation, and one mentioned ROI.

Ten of the 12 distributors reported that LED T8s are a common upgrade in today's commercial lighting market, and that end-users know that LED T8 replacement lamps will save them energy and lower their long-term costs. The other two distributor respondents stated that the end-user typically does not have any prior knowledge of the benefits of the technology.

When asked how they address potential ballast failures in their discussions with end-users, half of distributor respondents reported that they promote installing Type B LED T8s in order to bypass the ballast to avoid potential ballast failures. Four distributors stated that they have warranties that cover any failures that may occur, and two reported that they encourage full ballast replacements in their discussions with end-users.

3.1.3 Sales Process: Direct Install Implementer Findings

DI implementer sales messaging for LED T8 replacement lamps tends to focus on energy and cost savings, ROI, as well as the longer life of the lamps. Many also include messaging regarding the light quality, but there are divergent views regarding appropriate messaging. Four of nine DI implementers sell LED T8s as a source of superior light quality, which they find is a key attribute of LEDs versus fluorescents. Two of the nine DI implementers report that the most important factor with regard to light quality is that the customers should not notice any difference between the fluorescent T8s or the LED T8s.

Three of the nine implementers we interviewed reported that customers are more interested in LED T8s than LED fixtures. Another two said hard-to-reach and smaller customers were more interested in LED T8s, and another two mentioned that customer interest depends on the application (with one noting that high bay applications such as in warehouses are better suited for full fixture replacements and one mentioning that LED T8s are inappropriate for parabolic fixtures).

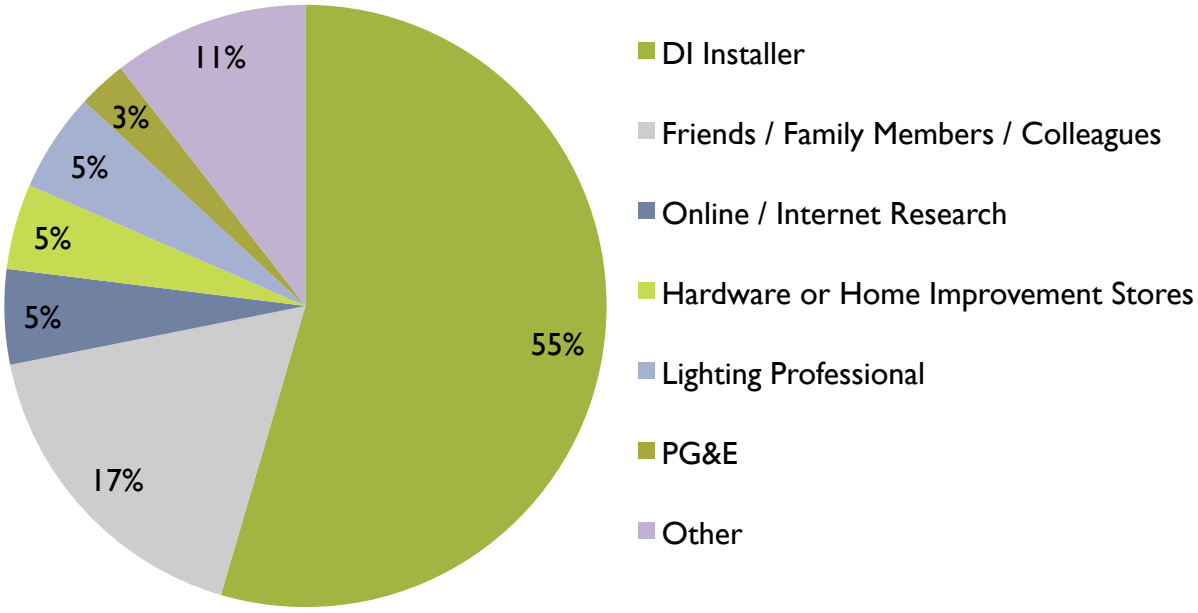
Implementers agreed that small customers were more likely to prefer LED T8s instead of new LED fixtures, whereas customers seeking a new aesthetic (possibly due to having very old fixtures in place) may prefer new fixtures, if they can afford the upfront cost.

3.1.4 Sales Process: Participant Survey Findings

Seventy percent of customers reported they were approached by the DI firm or their contractors in order to recommend a site audit and possible energy efficiency upgrades (30 percent of customers reported they reached out to either the DI firm, an installer who passed their information to the DI firm, PG&E, or a local government).

Figure 1 shows that the majority of DI program participants learned about LED T8s from the DI installer (55%). Other key sources of awareness included friends/family members/ colleagues (17%), online/internet research (5%), hardware or home improvement stores (5%), and lighting professionals[16] (5%). PG&E was mentioned as the source of awareness among 3 percent of participants.

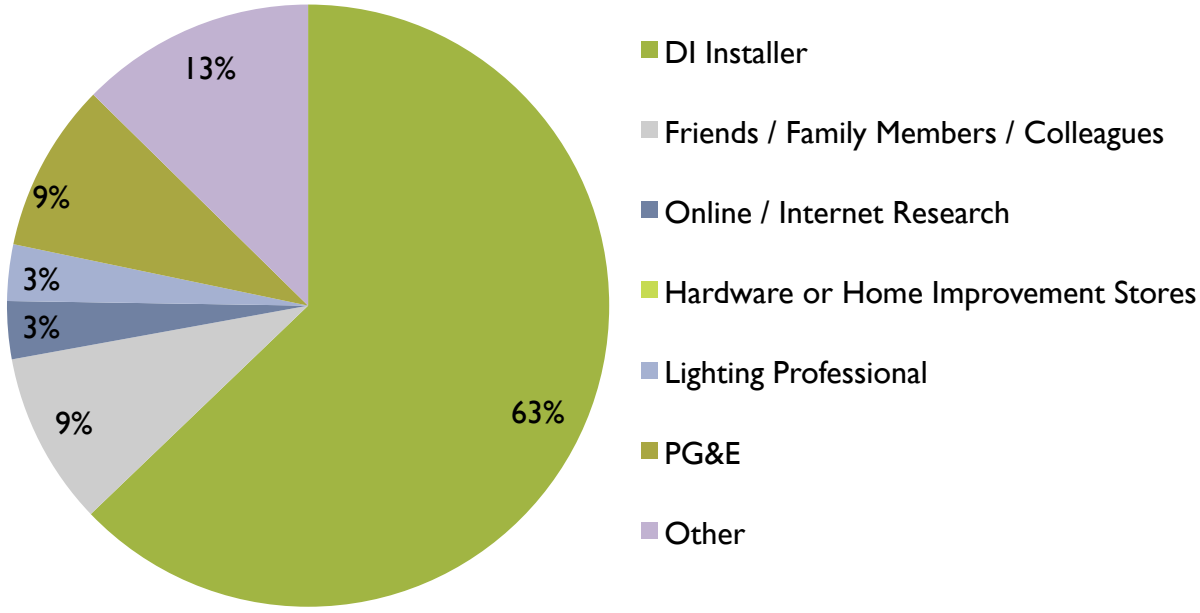
Figure 1: Source of Participant Awareness of LED T8s (n=144)



Regardless of how DI program participants first became aware of LED T8 replacement lamps, Figure 2 shows that 63 percent reported that the DI installation firm had the greatest influence on their organization's decision to install LED T8s. Friends/family members/colleagues were cited by 9 percent of participants as the most important influence, and PG&E (including PG&E representatives, mailers/bill inserts, and the PG&E website) also were cited by 9 percent of participants. The Internet and lighting professionals were the greatest sources of influence for 3 percent of participants each, while home improvement and hardware stores were not mentioned.

[16] Lighting professionals include lighting contractors, lighting distributors, and lighting manufacturer representatives.

Figure 2: Greatest Source of Influence on Participant Decision to Install LED T8s (n=125)



DI program participants were asked to rate the importance of the information from the source of greatest influence on their decision to install LED T8s, on a scale of 1 to 10, with 1 being "not at all important" and 10 being "very important." On average, participants rated the information from PG&E as most important at 9.4 out of 10, the information from the DI installer as 8.5 out of 10, and the information from friends/family members/colleagues as 8.3 out of 10.

The sources of greatest influence explained some of the benefits of LED T8 replacement lamps to the participants, and the most influential messages are shown in Table 8. Nearly 60 percent of participants were convinced to install LED T8s as a way of lowering their electric bill, while 39 percent mentioned saving energy (not in the context of cost savings). One quarter were influenced by the message that the installation would be low cost or free. Participants were allowed to provide multiple responses.

Table 8: Reasons for LED T8 Installation (learned from source of greatest influence) (n=132)

Reasons Mentioned	Percent of Participants *
Lower electric bill	59%
Save energy	39%
Low cost or free to install	25%
They last a long time	16%
Brighter than fluorescents	15%
Improved / better light quality	12%
Other	14%

* Question allowed multiple responses; total may not equal 100%.

We asked DI program participants who reported lower electric bills, saving energy, improved/better light quality or brightness relative to fluorescents as a main reason for installing LED T8s if they perceived these benefits since the installation of their LED T8s. While a majority of participants who reported lower electric bills or saving energy have perceived these outcomes (57%), a large minority has not perceived lower bills, or report that it is difficult to determine an impact. Nearly every participant who reported improved light quality or brightness relative to fluorescents perceived these outcomes (96% and 97%, respectively).

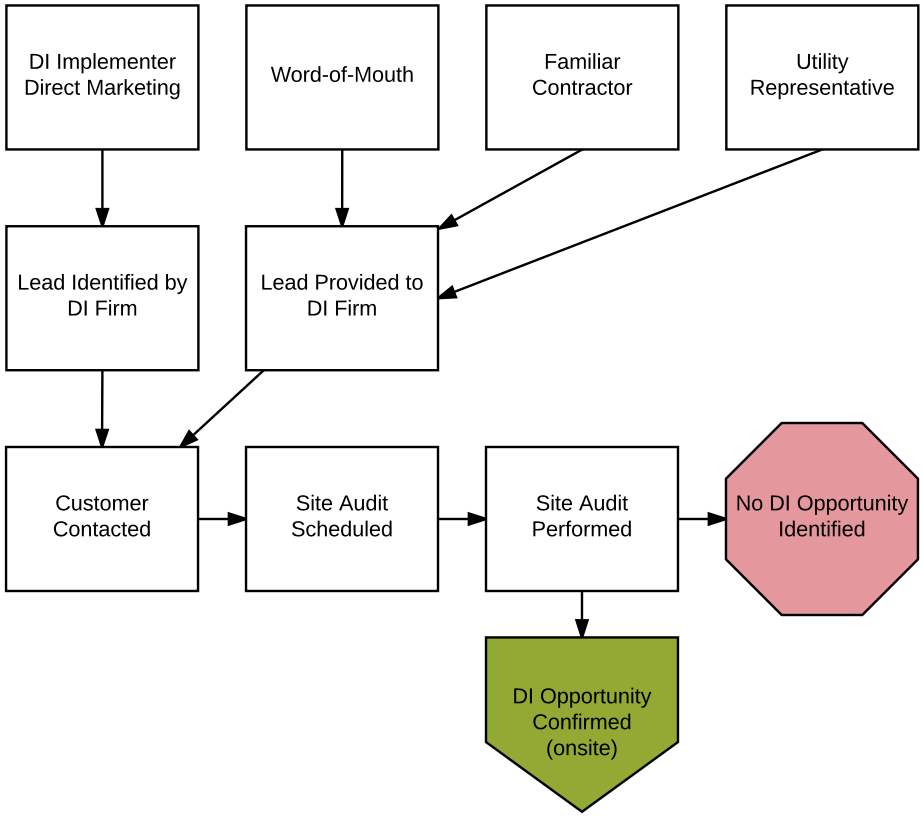
3.2 Direct Install Process

The overall DI process consists of three successive efforts:

1. Customer engagement and recruitment
2. Site scheduling
3. Installation and project completion

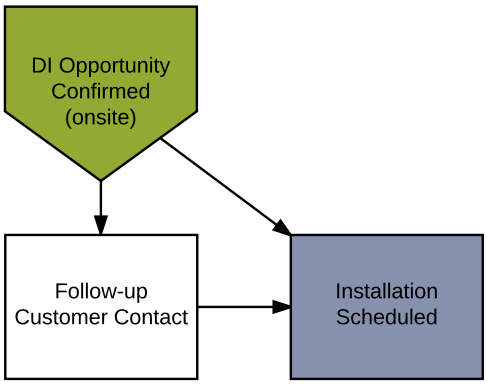
We show the customer engagement and recruitment processes in Figure 3. There are two types of engagement: either the DI firm generates their own leads, or the DI firm is provided leads from another party. Once the potential customer is known by the DI firm, the process is effectively the same, leading to the identification (or not) of a DI opportunity.

Figure 3: Direct Install Customer Engagement and Recruitment Diagram



Following recruitment of a customer with an identified DI opportunity, it is up to the DI firm to schedule the installation, as shown in Figure 4.

Figure 4: Direct Install Customer Site Scheduling Diagram



Depending on the DI firm, some installations are handled in house by DI firm staff members, and some installations are handled by third party installers. Some DI firms exclusively rely on third party installers. We show the two installation processes, from the scheduling of the installation to a project's completion, in Figure 5 and Figure 6.

Figure 5: Direct Install Customer Installation Diagram (In-house DI Installers)

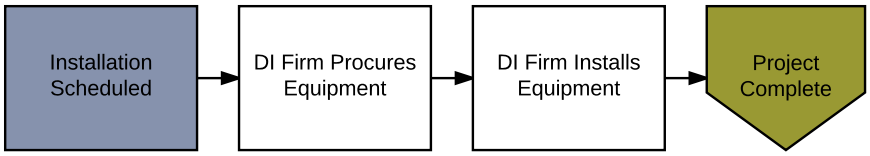


Figure 6: Direct Install Customer Installation Diagram (Third Party Installers)

The key research questions related to the DI process for LED T8 replacement lamps include:

- Was the participating customer presented with other lighting technology options?
- Were they informed about possible and future ballast issues?
- Did the DI implementer provide the necessary support to assist the customer in their selection process?
- Did the customer make any changes in their ultimate decision based on the information about ballast issues?[17]

We next explore the findings related to the DI process, by respondent group.

3.2.1 Direct Install Process: Direct Install Implementer Findings

The DI implementer firms use a variety of methods to identify potential projects. Many mentioned receiving leads from PG&E directly or via local government partnerships (LGPs). Most also cold call or canvass for leads (or both). For the implementers that direct projects to local contractors (all but one implementer uses contractors for at least some of their projects), as opposed to handling the installations themselves, most reported that

[17] Early in the evaluation process, PG&E and Evergreen determined that this question was out of the scope of this assessment due to budget constraints and lack of nonparticipant tracking information.

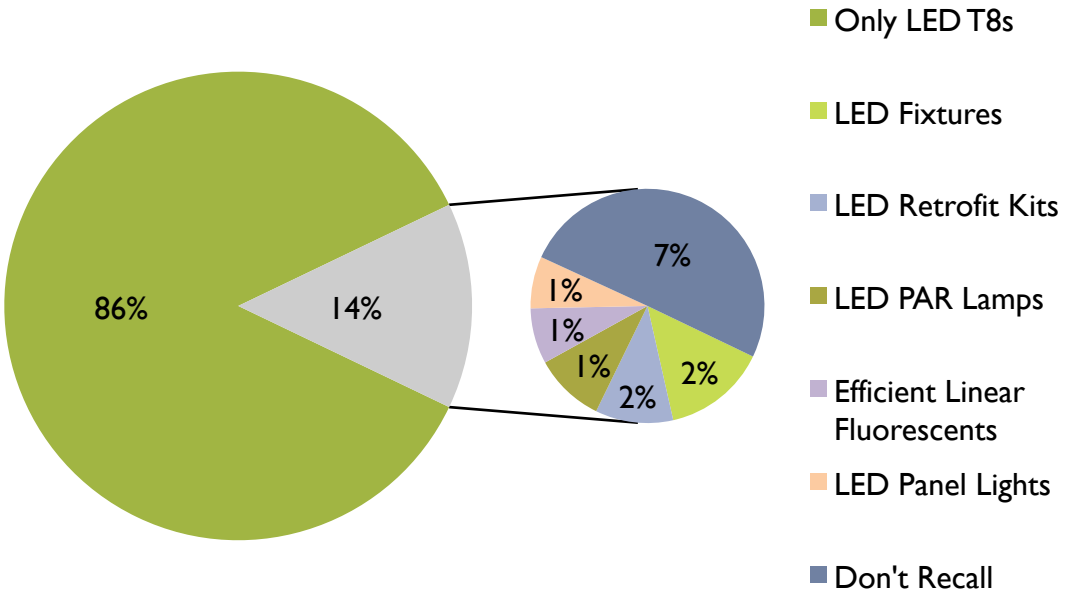
contractors are bringing *their customers* to the DI implementers when they think their customer may qualify for low-cost or free equipment through the program. There is some word-of-mouth lead generation among commercial customers, and one implementer reported that they have a long and generally strong relationship with businesses in their area, so businesses know to reach out when they are considering an upgrade.

Most implementers reported that the ROI cutoff for gauging whether a project will be successful is two years. For lighting, ROI for LED T8 replacement lamps essentially depends on hours of use. That said, most DI implementers said the ROI concern from the customer perspective is *project dependent*, not *measure dependent*, so if a customer qualifies for multiple measures and if the project ROI is less than two years, the customer will likely proceed. If the lighting ROI is greater than two years, but a refrigeration measure ROI brings the project to an ROI of less than two years, the customer is still likely to proceed.

3.2.2 Direct Install Process: Participant Survey Findings

Part of the DI process involves conducting a site assessment to identify potential lighting and other equipment efficiency upgrades. With respect to lighting, 14 percent of DI program participants were offered solutions for upgrading their existing fluorescent lighting equipment in addition to LED T8 replacement lamps (represented by the light gray wedge of the pie chart in Figure 7). The majority of DI program participants (86%) were only offered LED T8 replacement lamps for upgrading existing linear fluorescents. Other solutions that were offered to participants included LED fixtures (2%), LED retrofit kits (2%), efficient linear fluorescents (1%), LED panel lights (1%) and LED PAR lamps (1%), though it is unclear what type of fixture would have been installed in place of an existing linear fluorescent fixture. Seven percent of DI program participants were offered another type of lighting, but they could not recall the type.

Figure 7: Lighting Options Presented to DI Participants in Addition to LED T8s (n=129)



During the interviews with DI implementers, and through discussions with PG&E, we identified that standard practice for three of the nine DI implementers involves replacing 100 percent of ballasts for all installations. Based on participant (end-user) self-reports, these DI implementers are replacing all ballasts in nearly half of installations (49%), with more than one-quarter of participants unsure and many reporting that only some or none of their ballasts were replaced (see Figure 8; "ballast replacement" weights used). While it is unclear how many of the respondents who did not know if their ballasts were replaced actually had their ballasts replaced, the fact that many of the participants reported less than 100 percent of their ballasts were replaced is at odds with the reported practices of the DI installers.

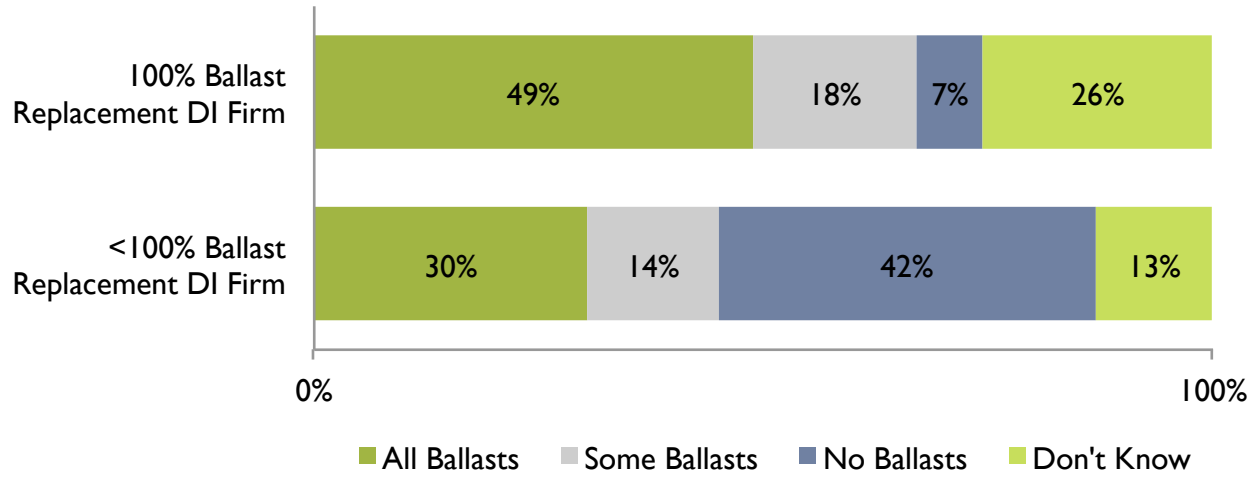
Among DI program participants who received their LED T8 replacement lamps from the DI installers that do not always replace 100 percent of ballasts, 30 percent reported that all of their ballasts were replaced, and 42 percent reported receiving no new ballasts ("ballast replacement" weights used).

Among participants who had some or all of their ballasts replaced, 86 percent were aware of the reason for ballast replacement ("ballast replacement" weights used). They reported either that the ballasts were incompatible or old (including the replacement of magnetic ballasts with compatible electronic ballasts).

Among participants who reported that they had no ballasts replaced or were unsure (reporting that they did not know), 80 percent were aware prior to the survey that

fluorescent fixtures have ballasts. That is to say, most who reported that ballasts were not replaced understand that ballasts are a component of linear fluorescent fixtures.

Figure 8: Ballast Replacements by DI Firm Standard Practice[18] (n=121)

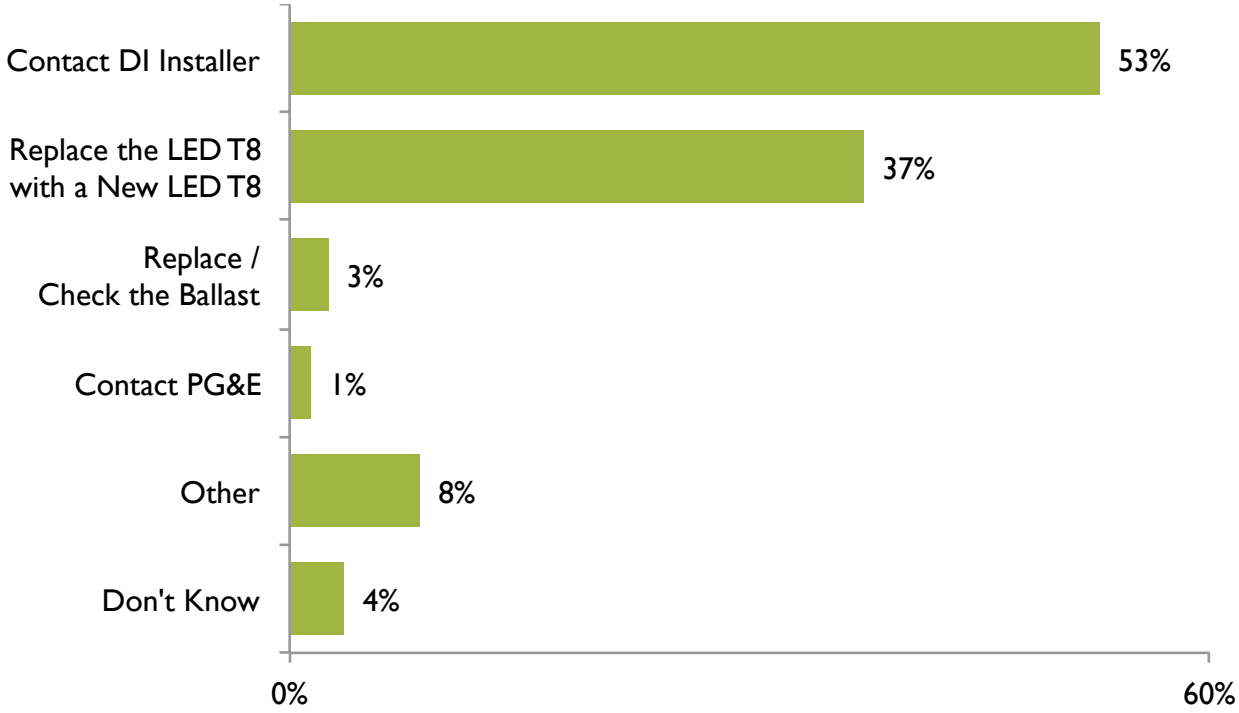


Thirty-eight percent of participants reported receiving information from the DI installer regarding what to do if one or more of the LED T8s stop working, and 30 percent did not receive information (another 30 percent did not know, and one respondent refused to answer the question). Of those who received information, two-thirds were told to contact the DI installer directly if a LED T8 fails. Eleven percent of participants who received information were told to replace the lamp, and 3 percent were told to replace or check the ballast.

Among all participants, 53 percent said they would contact the DI installer if a LED T8 fails, and 38 percent would replace the LED T8 with a new LED T8. Only 3 percent would replace or check the ballast, and only 1 percent reported that they would contact PG&E directly.

[18] "Ballast replacement" weights used for this analysis.

Figure 9: Participant Likely Action Following LED T8 Failure (n=151)



Other likely courses of action include contacting an electrician (3%); contacting their landlord or maintenance staff (2%); and reviewing the paperwork provided by the installer to determine what to do (3%). One respondent (0.5%) reported that they would revert back to linear fluorescents when a LED T8 fails, but this was their second mentioned option—they first mentioned that they would try a new LED T8.

3.3 Customer Satisfaction

The key research questions related to customer satisfaction with LED T8s include:

- Where did participating customers install LED T8 replacement lamps (in what types of fixture applications)?
- Did this provide the customer satisfactory results?
- In absence of the LED T8 replacement lamp option, what would or could the customer have done in these applications?

Next, we explore the findings related to customer satisfaction, by respondent group.

3.3.1 Customer Satisfaction: Manufacturer Findings

Manufacturers reported high levels of end-user satisfaction with LED T8 replacement lamp products. Customers typically do not perceive a difference in lighting quality between the existing fluorescent T8s and the LED T8s, or they typically perceive an

improvement, with the one caveat that if the specifying person (distributor or contractor, typically) does not specify the right color temperature (noted as a very mild concern in office locations), there might be some pushback from the customer based on perceived light quality. Manufacturers also noted that customers are satisfied when they perceive energy savings, and that perceiving savings is easier for larger customers (it is easier to distinguish if comparing bills from one month to the next).

While four of eight manufacturers noted that there is significant demand for the LED T8 product class, one mentioned that LED T8s will become obsolete as the price for retrofit kits and fixtures decreases over time.

The only customer complaints were due to ballast incompatibility (reported by six of eight manufacturers). Some manufacturers suggested that instead of replacing ballasts while installing a Type A LED T8 replacement lamp, it might make more sense to install a Type B (as you are already taking apart the fixture to a greater degree than just a lamp swap). With Type B products, there is no ballast issue. Another manufacturer mentioned that Type C products are suited for installations that would require a ballast change, or for cases where the customer is interested in added functionality (e.g., dimming). However, both Type B and Type C products were noted as costing more than Type A products, both in terms of equipment and labor to install, and thus tend to be less desirable in many SMB installations where customers tend to have limited available capital.

One manufacturer noted a complication with the DesignLights Consortium (DLC) approved products list related to customer satisfaction: some customers want brighter LED T8 replacement lamps, but these would cost more and save less energy, and may not meet DLC efficacy thresholds. Further, calculated energy savings are greater for the less expensive lower wattage lamps than the more expensive higher wattage lamps. Thus, the resulting incentives cover a larger proportion of the less expensive, lower wattage lamps, making them an easier sale to end-users despite the potential for dissatisfaction with the lighting levels.

3.3.2 Customer Satisfaction: Distributor Findings

In general, distributors reported that end-use customers and installers are highly satisfied with the performance of LED T8 replacement lamps. Not a single distributor reported that they have received complaints after installation. Furthermore, all distributors reported that LED T8s result in consistent high levels of satisfaction regardless of installation application.

Ten of the 12 distributors we interviewed believe that DI program participants would not have upgraded their linear fluorescent lighting in absence of incentives for LED T8s. The other two took a technology-agnostic stance, reporting that in absence of incentives, DI program participants would default to the cheapest option, whether that be fluorescents or

LEDs (though it must be noted that fluorescents are currently cheaper and will likely remain less expensive for the foreseeable future).

3.3.3 Customer Satisfaction: Direct Install Implementer Findings

LED T8 replacement lamps were reported by most of the DI implementers as very common sense upgrades for their customers, and they reported that their customers are highly satisfied. It is important that this finding is considered within appropriate context—it is the implementers' job to leave their customers satisfied (so they may not report issues of this nature), but also, the DI implementers are the ones who have to manage unsatisfied customers, and they are not observing many return visits or customer complaints. This includes DI implementers who replace all ballasts and DI implementers who do not; they were surprised that the ballast issue was not as big of a problem as anticipated, though some noted the early installations (around the start of 2015) had more problems as the implementers and contractors learned about the potential for compatibility issues.

It was noted that certain installation applications may be somewhat problematic: two implementers mentioned that direct/indirect fixtures that work best with 360-degree light output are less ideal because of the narrower beam spread of LED T8 replacement lamps.

3.3.4 Customer Satisfaction: Participant Survey Findings

Overall, participant satisfaction with LED T8s is very high, with the overall average satisfaction at 9.2 out of 10. The three most frequently cited reasons for high satisfaction include that the LED T8s are brighter (mentioned in 32% of responses), improved light quality (27%), and lower energy bills/saving energy (18%).

There were only five mentions of dissatisfaction (a rating of 1, 2, or 3) with LED T8s, regarding space types in particular.[19] Two participants reported dissatisfaction in dining rooms; one customer reported poor light quality, and the other said that the LED T8s were too bright. One participant was dissatisfied with LED T8s on their retail floor because they could not see a difference between the fluorescent lamps that were replaced and the new LED T8s. One participant who had LED T8s installed in their bathrooms reported that they were not bright enough, and one participant who had LED T8s installed in office spaces said they did not meet their expectations (but declined further comment).

Table 9 shows the space types where DI program participants installed LED T8s in order of frequency. Respondents were allowed to report one or more space types. As shown, 37 percent of participants installed them in retail floor settings and 36 percent in offices, the two most common installation locations.

[19] These findings are presented without weights.

Table 9: Percentage of Installations by Space Type* (n=151)

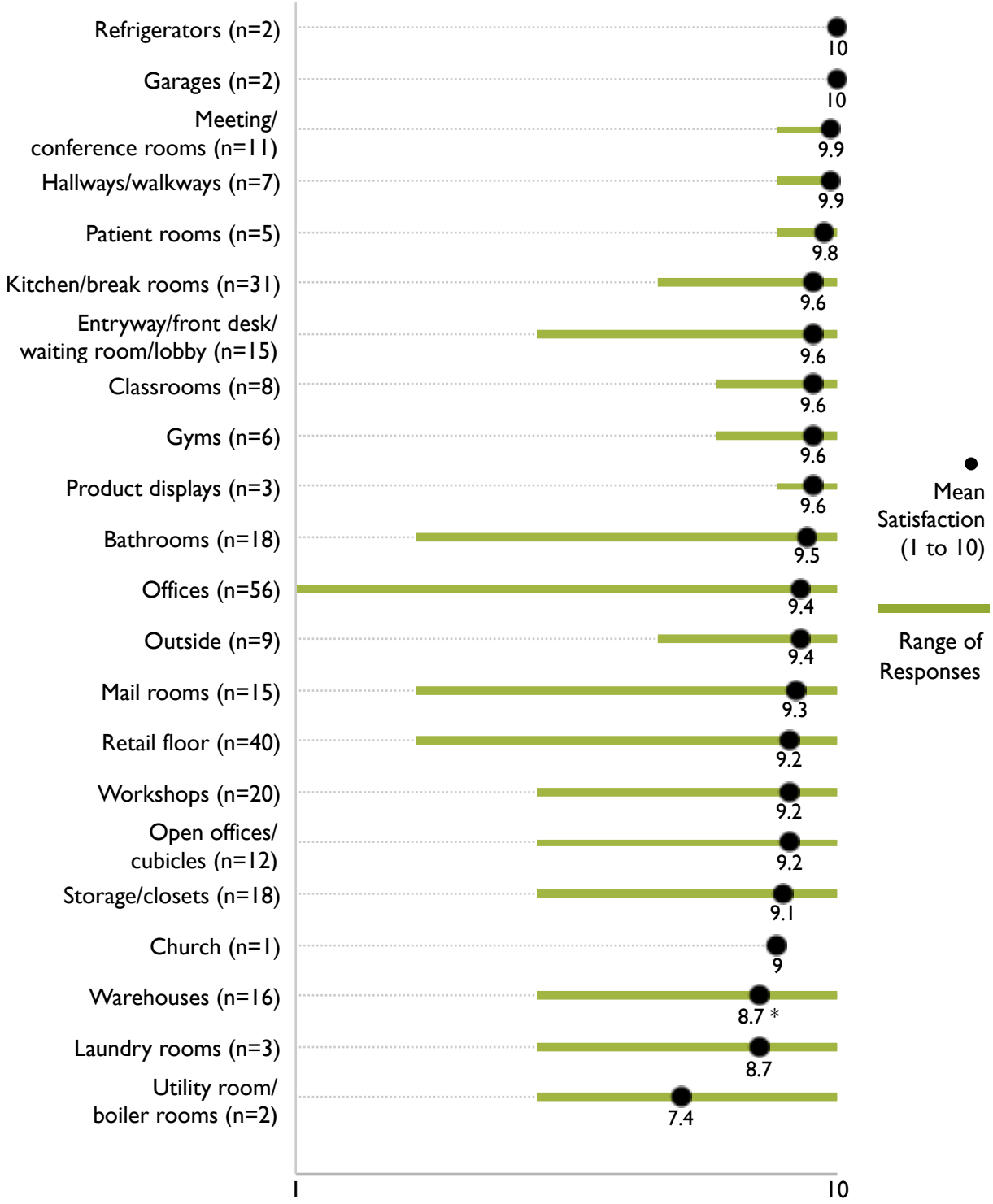
Space Type	Percentage of Participants
Retail floor	37%
Offices	36%
Kitchen/break rooms	18%
Storage/closets	16%
Workshops	13%
Bathrooms	12%
Warehouses	10%
Outside	9%
Dining rooms	9%
Entryway/front desk/waiting room/lobby	8%
Open offices/cubicles	6%
Meeting/conference rooms	5%
Hallways/walkways	4%
Classrooms	3%
Patient rooms	3%
Gyms	2%
Product displays	2%
Refrigerators	2%
Laundry rooms	2%
Garages	2%
Utility room/boiler room	1%
Church	0.4%

* Question allowed multiple responses; total may not equal 100%

DI program participants were asked their level of satisfaction with the installed LED T8s for each space type in which they had them installed. For example, if an office facility had LED T8s installed in the entryway, hallways, and in offices, they would have provided a satisfaction rating for each of those three space types. Participants were asked to rate their level of satisfaction on a scale of 1 to 10, with 1 being "not at all satisfied" and 10 being "extremely satisfied." Findings by room type are shown in Figure 10. The mean rating is shown as a black dot, with the range of responses shown as a green bar.

DI program participants reported statistically lower levels of satisfaction with the LED T8s in warehouse spaces than was reported for hallways/walkways and meeting/conference rooms (at the 95% confidence interval). There were no other statistically different levels of satisfaction by space type.

Figure 10: Participant Satisfaction with LED T8s, by Space Type
Mean Satisfaction (1 to 10) (n=151)



* Mean satisfaction statistically lower than for hallways/walkways and meeting/conference rooms (95% CI).

Table 10 shows what participants would have done if LED T8s were not an option provided to them through one of PG&E's DI programs. For the most part, across space types, inaction prevails—the majority of participants would have left their linear fluorescents installed if LED T8s were not available (78% overall).

Table 10: Participant Action in Absence of LED T8s, by Space Type (n=130)

Space Type	Nothing	LED Fixtures	LED Retrofit Kits	Other	Don't Know
Refrigerators (n=2)	100%	0%	0%	0%	0%
Garages (n=2)	79%	0%	0%	21%	0%
Meeting/conference rooms (n=11)	57%	9%	0%	17%	17%
Hallways/walkways (n=7)	78%	0%	0%	22%	0%
Patient rooms (n=5)	100%	0%	0%	0%	0%
Kitchen/break rooms (n=31)	77%	13%	0%	7%	3%
Entryway/front desk/waiting room/lobby (n=15)	94%	6%	0%	0%	0%
Classrooms (n=8)	100%	0%	0%	0%	0%
Gyms (n=6)	100%	0%	0%	0%	0%
Product displays (n=3)	100%	0%	0%	0%	0%
Bathrooms (n=18)	68%	14%	0%	14%	4%
Offices (n=56)	75%	6%	0%	11%	9%
Outside (n=9)	68%	19%	0%	13%	0%
Dining rooms (n=15)	74%	0%	0%	20%	6%
Retail floor (n=40)	79%	2%	0%	14%	5%
Workshops (n=20)	90%	0%	0%	7%	4%
Open offices/cubicles (n=12)	79%	0%	0%	14%	7%
Storage/closets (n=18)	74%	12%	0%	14%	0%
Church (n=1)	0%	0%	0%	0%	100%
Warehouses (n=16)	74%	17%	0%	5%	5%
Laundry rooms (n=3)	52%	48%	0%	0%	0%
Utility room/boiler rooms (n=2)	100%	0%	0%	0%	0%

3.4 Cost Considerations

The key research questions related to cost considerations with LED T8s include:

- How cost effective was this choice for the DI participating customer?
- Was there a more cost effective solution available?
- Is there a cost to waiting?

We next explore the findings related to cost consideration, by respondent group.

3.4.1 Cost Considerations: Manufacturer Findings

Five of six manufacturers report that in the absence of rebates, it is unlikely that the SMB customers that received LED T8s through the DI programs would have done anything (two manufacturers did not answer this question). The six manufacturers believe that the contractors and customers are smart and would have looked for other incentives for similar products (e.g., LED fixtures, magnetic strips) or waited until new rebates became available in the following year.

In the absence of incentives, manufacturers reported that when a fluorescent lamp failed, customers would replace it with another fluorescent lamp (they will not naturally upgrade to LED T8s as their linear fluorescents fail). Two manufacturers did note that the LED adoption rate is increasing across the board, but slowly for SMBs (they did not provide a reason for slower uptake in the SMB segment).

One manufacturer noted that Type A LED T8 replacement lamps have a shorter ROI, but Type B LED products save more money over time. They report that while Type A lamps are cheaper (especially when you factor in the higher installation costs for Type B lamps) the wattage reduction is greater for Type B products. Thus, the higher initial cost for a Type B installation results in greater energy savings—and cost savings—over time, despite the higher initial cost. However, their assessment did not factor in ballast replacement costs, which may tilt the balance towards Type B products.

Most manufacturers believe that Type A LED T8 replacement lamps are the most cost effective solution for end-users looking to upgrade their fluorescent lamps, especially for SMBs.

3.4.2 Cost Considerations: Distributor Findings

Distributors believe that the likely upside of lower energy bills (for the consumer) outweighs potential performance risks of LED T8s. Furthermore, all distributors we interviewed reported that LED T8s are the most cost effective solution for upgrading linear fluorescent T8s.

3.4.3 Cost Considerations: Direct Install Implementer Findings

There is a fairly strong consensus that the incentives for LED fixtures were too high in 2016 and that, through "channel alignment",[20] the DI implementers became constrained and simply could not offer fixtures. This may have led to an increase in LED T8 replacement lamp installations where an LED fixture would have been installed under different incentive circumstances (albeit in limited cases where a customer would have allowed the more invasive installation and had sufficient capital available). In particular, customers looking for upgraded aesthetics may have chosen new LED fixtures to replace older fluorescent fixtures instead of simply changing the lamps.

Implementers reported a significant decline in LED T8 replacement lamp cost, and that lamps are now in the $10-20 range per lamp. One reported that the cost was around $27 per lamp in 2015. They also reported that rebates cover a significant portion of the lamp cost.

3.5 Technology Persistence

The key research questions related to technology persistence with LED T8s include:

- How likely is the participating customer to continue the use and maintenance of installed LED T8 replacement lamps in their existing fixtures?
- What conditions would lead the customer to remove the LED T8 lamp and change to another lamp or technology?
- How frequently are participating customers replacing their ballasts as part of the LED T8 replacement lamp installation?

Next, we explore the findings related to technology persistence, by respondent group.

3.5.1 Technology Persistence: Manufacturer Findings

Manufacturers reported very low product return rates, with the vast majority of lamps remaining installed (close to 100%). It is important to consider that manufacturers are unlikely to report significant issues with their own products, but this finding is highly corroborated by the other research efforts. Manufacturers reported that the only reason customers have exchanged lamps is if the lighting levels or color do not meet their expectations, in which case another LED T8 replacement lamp would be installed.

[20] Channel alignment resulted in single deemed savings and incentives levels for similar measures across programs, regardless of delivery mechanism (e.g., direct install versus core). Previously, DI firms were able to adjust incentive levels—while still meeting their cost effectiveness targets—to allow for flexibility based on local conditions (e.g., higher cost installations in more rural areas).

Manufacturers reported a range of practices regarding ballast replacement upon installation of Type A lamps. Some reported that many of their products are installed in situations where the installer replaces all ballasts to avoid having to go back into their fixtures, whereas other manufacturers believe very few ballasts are replaced upon installation. One manufacturer is moving away from Type A lamps towards a Type A/B hybrid lamp, reportedly because the installation contractors do not like dealing with callbacks from ballast failures (though in order to avoid callbacks, the lamps would have to be installed as Type B lamps, so it is unclear why they are not pursuing Type B lamps instead of the hybrid lamps).

Half of the manufacturers reported that customers try to self-diagnose when a lamp stops providing light. This can involve removing the lamp and installing a functioning lamp, only to find no light—at this point, they know the ballast has failed. Manufacturers reported that they try to train their distributors to educate the end-users.

3.5.2 Technology Persistence: Distributor Findings

No distributors reported any end-users removing or replacing their LED T8 replacement lamps after installation, and approximately 50 to 60 percent of end-users are replacing their ballasts as part of LED T8 installations. It was also reported by five out of 12 distributors that it is becoming increasingly more common that end-users are looking for a simple replacement and opting for a plug-n-play option over a whole fixture replacement.

3.5.3 Technology Persistence: Direct Install Implementer Findings

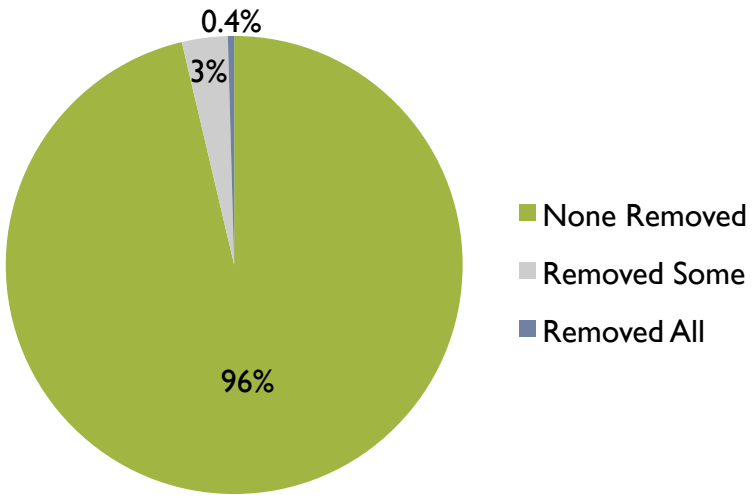
We asked implementers if any of their customers have removed and replaced their LED T8s. According to the implementers, there have been no instances of reverting back to fluorescent lamps, but in a few rare cases, a lamp has burned out or the lighting levels were off, and those lamps were all replaced with LED T8 replacement lamps. Furthermore, the DI implementers generally work to ensure satisfaction through post-installation discussions with the end-users and will address any concerns prior to considering a project complete.

When LED T8s installed through the DI programs stop producing light either due to a lamp or ballast failure, the customers contact the DI implementer or, as mentioned by only one implementer, they may call the installation contractor.

3.5.4 Technology Persistence: Participant Survey Findings

Approximately 96 percent of participants have not removed a single LED T8 since the installation (see Figure 11). A very small percentage of participants (3%) have removed some but not all LED T8s, and less than half a percent of participants have removed all LED T8s (0.4%), switching back to fluorescent lamps.

Figure 11: LED T8 Removal by Participants (n=150)



The one survey respondent who removed all of their LED T8s reported that the lamps were not bright enough. Of the few that reported removing some but not all LED T8s, most said that it was because one or more lamps had failed. Some lamps were also removed because they were too bright for the space.

All participants who had installed LED T8s—excluding the one respondent who removed all of their lamps—plan to keep their LED T8 replacement lamps installed for the foreseeable future.

3.6 Benefits of the Direct Install Approach

The key research questions related to cost considerations with LED T8s include:

- What worked well using the DI approach that may change if a different incentive mechanism is employed?
- What installation challenges were DI implementers able to address?
- Does the DI approach have a significant impact on customer satisfaction and technology persistence?

Next, we explore the benefits of the DI approach, by respondent group. Note that DI implementers are biased—promoting benefits of the DI approach is in their interest—so findings regarding these DI implementers should be considered in context.

3.6.1 Benefits of the Direct Install Approach: Manufacturer Findings

Manufacturers reported that DI programs are very important for the SMB segment. Contractors and distributors do not see the value proposition of trying to sell LED T8s or LED fixtures/retrofit kits to these customers, as it requires a significant effort for outreach

and discussion, with potentially very small sales in terms of dollars (and often, the contractor or distributor takes a small cut of the profit, so it can be a very small amount of money for a significant amount work).

One manufacturer noted that the local installers might suffer if the DI programs do not involve them (i.e., for the locations served by DI implementers that handle the entire process, including installations).

According to one manufacturer, the DI approach may have a positive impact on installation rate (customers will not receive rebates for LED T8s put into storage).

One manufacturer reported that DI implementers are able to navigate some specific challenges changing from fluorescents to LEDs, such as directionality (facing them in the right direction since they do not produce 360 degrees of light) and two mentioned that knowledgeable installers help avoid or remedy issues of ballast incompatibility. Two other manufacturers mentioned that installers are able to deal with installations in spaces with high ceilings.

3.6.2 Benefits of the Direct Install Approach: Distributor Findings

All but two distributors reported that there are benefits to end-users of the DI programs. The benefits of the DI approach include the following:

- Provides low-cost LED T8s for linear fluorescent upgrades (mentioned by 10 distributors)
- Easy to navigate (mentioned by eight distributors)
- Effective at reaching hard-to-reach segments (mentioned by three distributors)
- Increases customer awareness of portfolio of lighting program options (mentioned by one distributor)

There were two concerns regarding the DI approach, each mentioned by one distributor. First, the DI programs are limited by cost effectiveness criteria and thus the end-users typically receive "bottom of the barrel" products that are cheap and may not last as long as higher quality products. Second, it was reported that it can be difficult for some smaller distributors and contractors to receive winning bids because they are unable to quote the same project costs as those going through a DI implementer (and their contractors). Incentivizing certain products only through DI can be perceived as a sort of localized favoritism in that only DI implementers and their preferred contractors can provide the equipment at the incentivized price.

3.6.3 Benefits of the Direct Install Approach: Direct Install Implementer Findings

DI implementers reported a few important (according to them) aspects of the DI approach for LED T8 replacement lamps. These include:

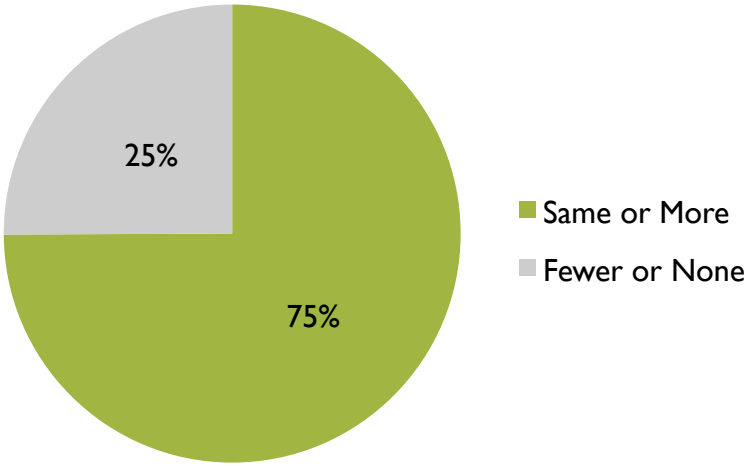
- Many SMBs do not think about lighting (they "have a business to run"); the only way to get them to upgrade is to directly engage with them, but this is cost prohibitive for contractors and installers, particularly for small customers (i.e., those with low volume sales).
- The implementers help their customers navigate the installation process (they coordinate contractors, schedule visits, conduct audits, handle rebates).
- The implementers will help their customers navigate any warranty issues, if they arise.
- There are many products qualify on the Qualified Products List (QPL), but the implementers (or their contractors) can guide customers towards better (i.e., Tier 1 and Tier 2) products.

3.6.4 Benefits of the Direct Install Approach: Participant Survey Findings

Discussed previously in Section 3.1.4 Sales Process: Participant Survey Findings, the majority of participants learned of LED T8s from the DI installer (55%), and the DI installer was the greatest source of influence on their decision to install LEDs for 63 percent of participants.

While three-quarters of participants would have installed the same number or more LED T8 replacement lamps if they had to submit a rebate application, as shown in Figure 12 (instead of receiving them through the DI program), one quarter of participants would have installed fewer or no LED T8 replacement lamps if they were required to submit a rebate application.

Figure 12: Number of LED T8s Installed if Customer Submitted Rebate Application (Instead of Direct Install) (n=137)



Customers who said they would install fewer or no LED T8s most frequently mentioned that the upfront cost would have been a barrier and that they would not want to handle the rebate application. Some customers would not have known about LED T8s, and thus would not have installed any. Others mentioned that the full service nature of the DI implementer—not only handling the paperwork, but also handling the entire installation from start to finish—was important to their participation, while others noted a general dislike or distrust of rebate programs in general.

3.7 Non-Direct Install Approach Feasibility

The key research questions related to cost considerations with LED T8s include:

- What challenges would PG&E face from the lighting market—ballast issues, issues with product quality, free ridership—if incentives were provided through other channels in addition to DI (e.g., midstream channel)?
- How would a switch to other potential incentive mechanisms impact overall (gross) sales and net savings?
- How could this impact customer satisfaction and technology persistence?

We next explore the feasibility of PG&E promoting LED T8s outside of the DI approach, by respondent group. Note that DI implementers were not asked these questions.

3.7.1 Non-Direct Install Approach Feasibility: Manufacturer Findings

Regarding rebates to the end-users, most of the manufacturers agreed: a significant number of customers in the SMB segment will be missed if the LED T8 replacement lamp

products are not provided through the DI channel. Some customers—"savvy end-users" and those with in-house maintenance staff (typically larger customers)—will learn about LED T8 replacement lamps from some other source and then navigate another rebate program, but the majority of SMBs will be missed, according to most manufacturers. This is because they present too small of an opportunity for distributor or contractor salespeople to pursue, due to significant marketing costs and overall "low bang for your buck", as mentioned by one manufacturer.

Manufacturers consider the idea of midstream or upstream incentives—either to distributors or manufacturers—generally a good idea. However, one noted that they are still only effective for larger customers because the installation contractor only gets a percentage of the sale, so reducing the overall project cost potentially reduces the profit for the installer. That said, other manufacturers suggested that a midstream or upstream approach would have a different effect on the sales pitch: lower project costs create more likely sales, thus encouraging salespeople to reach customers they typically would not reach out to, such as SMBs.

3.7.2 Non-Direct Install Approach Feasibility: Distributor Findings

Two-thirds of the distributors we interviewed reported that if PG&E were to provide rebates to the end-user for purchasing LED T8s and installing them themselves, as opposed to relying on the DI programs and their installers, it would make it an even playing field for the smaller installation contactors who are not partnering with a DI program but who may have existing relationships with some SMBs. It is important to note that the impact of a customer rebate reportedly differs based on whether or not the end-user has knowledgeable maintenance staff to complete the installation (mentioned by seven of the 12 distributors).

Eleven distributors reported that midstream incentives would be an effective mechanism for increasing sales of LED T8 replacements. While some of these distributors mentioned that *any* rebate helps, others noted that they prefer midstream incentives to downstream incentives to customers or through DI programs. One distributor mentioned that they do not like midstream incentive programs because the incentive amount gets diluted in the manufacturer and/or distributor margins that vary from one company to the next, while another noted that it could cause some workflow problems internally at a distributor (adding steps to their sales process).

Nine distributors reported that downstream incentives for LED T8s would increase sales, but they shared some concerns. Only one provided justification for their concern, stating that downstream incentives "might be a double-edged sword; it slows the process and creates problems in our accounting and financial tracking, but there is a lot of contractor deception that would go away." The decline in contractor deception they reference as a benefit of downstream incentives for LED T8s is the dilution of incentive dollars

mentioned regarding midstream programs in the preceding paragraph (both statements were from the same distributor).

It was also noted by five of the 12 distributors that without the help of market actors or maintenance staff, customers might make the wrong decisions (i.e., buy the cheapest lamps or lamps that may be incompatible with existing ballasts).

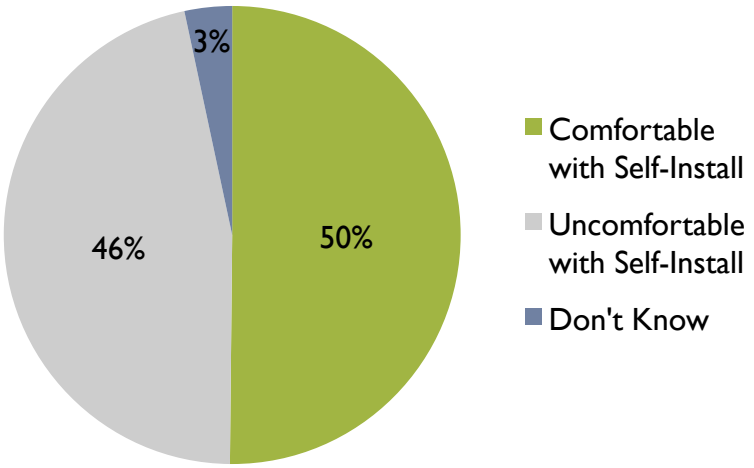
3.7.3 Non-Direct Install Approach Feasibility: Participant Survey Findings

As noted in Section 3.6.4 Benefits of the Direct Install Approach: Participant Survey Findings, three-quarters of DI program participants would have installed the same number or more LED T8 replacement lamps if they had to submit a rebate application.

Some of the DI program participant survey respondents who said that they would install the same number of lamps regardless of whether they had to submit a rebate reported that their facility was in need of new lighting—either because of poor light quality or insufficient light levels. Others mentioned that as long as the rebate amount was the same, they would not have a problem submitting an application. Lastly, some noted that their desire to save energy and reduce their energy bills would have led them to navigate and submit a rebate application.

Figure 13 shows that approximately half of the participants we surveyed would be comfortable installing LED T8s without the help of an outside professional installer, and half would not. Of note, a statistically higher percentage of respondents from the "Manufacturing, Transportation, Government and Healthcare" business types were comfortable installing LED T8s than respondents from the "Office" business type (73% compared to 40%, respectively). Regardless of the program LED T8s are offered through, many customers will still prefer to have them installed by a professional.

Figure 13: Business Owner / Manager Comfort with LED T8 Self-Installation (n=151)



4 Conclusions and Recommendations

This section highlights the conclusions of the study, followed by recommendations.

4.1 Conclusions

The conclusions are organized by key study objective, with each specific research question answered in a "Q&A" format. In addition, there are supplemental conclusions outside of the scope of the specific research questions in a subsequent subsection.

4.1.1 Sales Process

How are DI participating customers learning about LED T8 replacement lamps?

The majority of DI participating customers are learning about LED T8 replacement lamps from DI implementers (53%). This is followed by word-of-mouth among friends, family members and colleagues (17%).

Who is making the energy efficiency value proposition to the customer?

The majority of DI participating customers cited the DI implementers as the greatest source of influence on their decisions to install LED T8s (63%). This is followed by friends, family members and colleagues (9%) and PG&E (9%).

DI implementer messaging related to LED T8s focuses on low upfront cost, return on investment (ROI), energy/cost savings, lifespan, and light quality (either that it is the same or that it is better than fluorescents). Distributors focus on low upfront cost and ROI when selling LED T8s.

4.1.2 Direct Install Process

Was the participating customer presented with other lighting technology options?

The vast majority of DI participants reported that they were only presented with LED T8s as an option for upgrading their existing linear fluorescents (86%).

Channel alignment resulted in very high incentives for LED fixtures, which effectively removed LED fixtures from DI programs' offerings as the cost per kWh saved would not fit into their cost effectiveness goals. Therefore, since 70 percent of participants were approached by the DI installer instead of actively seeking out a retrofit or lighting upgrade—and since all survey respondents were participants who ultimately received LED T8s—it makes sense that most customers were only presented LED T8s.

Furthermore, most market actors and implementers agreed that LED T8s are the most cost effective solution for upgrading linear fluorescent lighting at this time.

Were they informed about possible and future ballast issues?

This question was indirectly addressed so as not to cause apprehension among participants (that PG&E had concerns about ballast failures).

Of the 59 percent of participants who knew they had some or all ballasts replaced (21% did not know), the vast majority were aware of why the ballasts were replaced (86%): either because they were incompatible or old. This does not necessarily mean that they received information regarding potential *future* ballast issues, but in many cases, they are aware that ballasts have an effective useful life (it is unclear if participants are aware that electronic ballasts are rated for approximately 70,000 hours, but they are aware that the ballasts will fail with time.).[21]

Furthermore, 38 percent of participants reportedly received information from the DI installer about what to do if a lamp stops producing light either because of lamp or ballast failure (32 percent were unsure or refused to answer and 30 percent did not receive this information).

Of note, but external to the DI programs, half of distributor respondents reported that they promote installing Type B LED T8s to their customers in order to avoid potential ballast failures.

Did the DI implementer provide the necessary support to assist the customer in their selection process?

The DI implementers provided support to their customers in their decision to have LED T8 replacement lamps installed in their facility. The types of support provided by implementers included the following:

- Discussing with program participants the cost of LED T8s and the likely ROI.
- Discussing the longer life of the LED T8s and the improved light quality (relative to linear fluorescents).
- Working with their customers (DI program participants) to ensure they are satisfied with the end result of the LED T8 installation.

The vast majority (approximately 95%) of participants were satisfied with the LED T8s, indicating that the lamps met their expectations and were appropriately specified (in terms of light output and color).

[21] (DEER, 2012)

Did the customer make any changes in their ultimate decision based on the information about ballast issues?

Early in the evaluation process, PG&E and Evergreen determined that this question was out of the scope of this assessment. Due to budget constraints and lack of nonparticipant tracking information (including participants that were offered and refused LED T8 installations), it is impossible to assess whether any participants changed their ultimate decision, because we spoke only with customers who had LED T8s installed.

There is no indication from the DI implementer interviews that customers refused or were hesitant to install LED T8s due to concerns regarding ballasts.

4.1.3 Customer Satisfaction

Where did participating customers install LED T8 replacement lamps (in what types of fixture applications)?

The most frequently reported space types include retail floor (37% of participants), offices (36%), kitchen/break rooms (18%), storage/closets (16%), workshops (13%), bathrooms (12%), and warehouses (10%).

It was noted by multiple market actors that LED T8s can produce unsatisfactory results in direct/indirect fixtures due to beam spread issues.

Did this provide the customer satisfactory results?

Across space types, the vast majority (approximately 95%) of customers were highly satisfied. Satisfaction was slightly lower in warehouse applications than was reported for hallways/walkways and meeting/conference rooms.

In absence of the LED T8 replacement lamp option, what would or could the customer have done in these applications?

Other applicable equipment types include Type B, Type C, or Type A/B hybrid lamps, LED retrofit kits and LED fixtures.

However, the vast majority (78% overall) of customers would not have retrofitted or replaced their existing linear fluorescent (lamps or fixtures) in absence of the LED T8 replacement lamps provided through the DI programs. This was corroborated by market actors who reported that, for SMBs in particular, other options typically have upfront costs that are too expensive, with payback periods that are too long. For LED fixtures, market actors noted that their installations are significantly more disruptive to the business.

4.1.4 Technology Persistence

How likely is the participating customer to continue the use and maintenance of installed LED T8 replacement lamps in their existing fixtures?

The continued use of LED T8s among participants is highly likely. Only one participant survey respondent had removed all of their LED T8s, and only a few had to replace small numbers of lamps due to failure or lighting levels. That said, every business besides the one that removed all of their lamps plans to keep their LED T8 replacement lamps installed for the foreseeable future.

Market actors corroborate this finding; they reported very few or no returns or issues with LED T8s other than the occasional ballast incompatibility or concern over lighting levels. These issues are easily resolved.

What conditions would lead the customer to remove the LED T8 lamp and change to another lamp or technology?

The one customer that removed all of their lamps and went back to fluorescents did so because the LED T8s were not bright enough. This was mentioned as a minor concern during the specification process (among market actors), as it can be difficult to replicate existing lighting levels (reportedly). DI implementers reported that they work with customers to ensure that the lighting levels are satisfactory before considering a project complete. It is unclear why the DI implementer for the one customer who removed their LED T8s was unable to address the participant's light level concerns.

How frequently are participating customers replacing their ballasts as part of the LED T8 replacement lamp installation?

Many customers are replacing their ballasts as part of the LED T8 installation—42 percent reportedly had all ballasts replaced and 17 percent had some replaced (so a total of 59% of customers replaced at least some of their ballasts). Nineteen percent reportedly had no ballasts replaced, and 21 percent did not know.

4.1.5 Benefits of Direct Install Approach

What worked well using the DI approach that may change if a different incentive mechanism is employed?

The DI approach is very effective at reducing the upfront cost barrier for the end-users. A midstream approach would reduce the upfront cost barrier, but a downstream approach would not.

In addition, the DI approach drives awareness and education of LED T8s and key product attributes among participants (such as ROI, payback period, light quality, brightness, and

lifespan). Door-to-door marketing and cold calls are seen as effective methods for contacting hard-to-reach and busy SMB owners and facility managers. PG&E and traditional market actors would need to provide marketing, education and outreach if a different mechanism is employed.

What installation challenges were DI implementers able to address?

The DI implementers and their contractors addressed the installation challenges of ballast incompatibility and high ceilings. However, while PG&E may be able to control the dissemination of information regarding ballast incompatibility through the DI programs (i.e., the specific messaging implementers should use with potential customers), the issue of incompatibility is known throughout the market and is easily navigated by lighting professionals outside of the DI programs (such as lighting distributors and contractors). This is also true of high ceilings—while DI implementers addressed this challenge, so could any lighting installation contractor.

The DI approach does not address any installation challenges that would not be addressed as part of installations outside of the DI programs (or through downstream or midstream programs).

Does the DI approach have a significant impact on customer satisfaction and technology persistence?

The research indicates that the main impacts of the DI approach are more related to driving initial awareness, educating the potential participant, and guiding the process to completion for busy SMBs.

Satisfaction may be somewhat positively impacted by the DI approach because the initial DI audit helps address potential ballast incompatibility issues, and the DI implementer will assist if there are any issues after the installation to ensure satisfaction. It is unknown but likely that this would happen with installation contractors outside of the DI programs.

Persistence of savings may also be somewhat positively impacted as customers may remove lamps that are not bright enough or are too bright (reported by a very small number of participants), and the DI implementers focus on customer satisfaction. Again, it is unknown but likely that this would happen with installation contractors outside of the DI programs.

4.1.6 Non-Direct Install Approach Feasibility

What challenges would PG&E face from the lighting market—ballast issues, issues with product quality, free ridership—if incentives were provided through other channels in addition to DI (e.g., midstream channel)?

Half of customers are reportedly comfortable installing LED T8s at their facility, but this is both good and bad as it relates to ballast issues. However, lighting professionals are most knowledgeable about ballast incompatibility issues. Customer self-installations *without adequate information* may lead to an increase in ballast incompatibility occurrences—or at least grievances; customers who self-install LED T8s in locations with incompatible ballasts may not understand why they do not work, and this could lead to dissatisfaction and potentially removal of the LED T8s.

Otherwise, ballast compatibility is not a secret among lighting professionals, and compatibility issues are reportedly easy to navigate.

In terms of product quality, the main concern is the potential that Type B products are a fire hazard—we have not confirmed this from any reliable third-party source other than manufacturer self-report. This requires further investigation before we would recommend providing incentives for Type B lamps.

The other concern with respect to product quality is directly related to lamp specification. While each customer has unique lighting needs in terms of brightness and color temperature, lighting professionals understand how to specify appropriate equipment to meet these needs.

The DI programs' LED T8 offering likely has a low rate of free ridership, as the vast majority of participants were approached by the DI implementation firm or their contractors. Furthermore, the DI implementation firms are noted as the most important source of information among even more participants. Providing incentives through other channels would likely lead to higher rates of free ridership similar to levels for other commercial LED measures.

How would a switch to other potential incentive mechanisms impact overall (gross) sales and net savings?

The DI approach's effectiveness at targeting SMBs compared to more mass market approaches (i.e., downstream, midstream) means a *switch* may lead to a reduction in the effectiveness at transforming the SMB lighting market. Because SMBs are overlooked by most lighting salespeople, it also follows that they likely have a lot of potential (i.e., high prevalence of existing linear fluorescents).

However, DI ignores customers larger than 200kW, which is significant. A switch to—or the addition of—other incentives mechanisms has the potential to increase overall gross sales due to increasing the number of target customers (and thus targeted linear fluorescent lamps).

As noted previously, providing incentives through other channels would likely lead to higher rates of free ridership similar to levels for other commercial LED measures. This is because the DI programs' direct outreach strategies were effective at reaching hard-to-reach SMB customers (70% of participants were approached by the DI installer or their contractors).

How could this impact customer satisfaction and technology persistence?

Providing incentives for LED T8s through other channels besides DI programs is inherently more risky in terms of customer satisfaction and technology persistence than providing incentives solely through the DI programs. Simply put, PG&E has less control over the process. In particular, uninformed self-installations have a higher chance of ballast incompatibility *and* a higher chance of customer dissatisfaction from being unaware of the cause of the LED T8 not working (i.e., not understanding that a different LED T8 may work perfectly in the same fixture).

However, education and/or installation requirements—such as that all LED T8s must be installed by a certified electrician—would help ensure high levels of customer satisfaction. Installers can also help ensure high levels of satisfaction through specifying LED T8s with appropriate light levels and light color.

High levels of satisfaction—such as the level uncovered during this assessment—have and will result in persistence of savings over time.

4.1.7 Additional Findings of Interest

The evaluation also uncovered findings outside of the scope of the identified research objectives, including the following:

- Manufacturers are split regarding the safety of Type B LED T8s, and some are refusing to produce them. They are concerned that the product class is unsafe (potential fire hazard).
- Distributors are split regarding the promotion of Type B LED T8s. The distributors that do promote LED T8s do so as a way of bypassing ballasts to avoid callbacks from ballast failures in the future.
- Channel alignment effectively removed LED fixtures from DI program offerings, and it is unclear whether this led to an increase in the number of LED T8 replacement lamp installations (because channel alignment limited the number of options available to retrofit linear fluorescent fixtures).

- LED T8 replacement lamp cost has declined significantly and incentives may cover too high of a percentage of the purchase price.

4.2 Recommendations

Based on the conclusions presented above, the following recommendations are made to PG&E program planners.

1. **Provide incentives for LED T8s through additional channels.** Due to high levels of satisfaction and technology persistence, coupled with the likely significant potential for LED T8s in larger facilities, PG&E should consider including LED T8s in the Commercial Midstream Lighting Program and/or the Commercial Deemed Program.
2. **Continued high levels of satisfaction (and therefore persistence) may require professional installation.** To ensure satisfaction and technology persistence if LED T8s are offered outside of the DI programs, PG&E should investigate requiring professional installation of LED T8s in order to receive incentives. The entity submitting the rebate would be responsible for collecting installer information. For the Commercial Midstream Lighting Program the distributor would collect installer information, and for the Commercial Deemed Program either the end-user or, if applicable, a Trade Professional Alliance member would collect installer information.
3. **Continue providing incentives through Direct Install programs.** The DI programs are effective at targeting SMB customers, who are harder to reach through downstream or midstream incentive programs. Furthermore, and related to the second recommendation, the DI programs achieve high levels of satisfaction and persistence in part because the lamps are installed by a professional.
4. **Develop an LED T8 marketing, education, and outreach strategy.** If PG&E provides incentives for LED T8s through channels other than DI, PG&E and traditional market actors would need to provide marketing, education and outreach. Therefore, PG&E should develop a strategy for promotion and education of commercial customers, likely including in-store promotional materials (i.e., in a distributor's storefront) and content on PG&E's website must be updated. PG&E should consider other marketing, education and outreach strategies as well.
5. **Do not provide incentives for Type B LED T8s at this time.** It is unclear if these lamps/installations create fire hazards. More research is needed.

Appendix A – Direct Install Participant Survey Guide

PG&E LED T8 Replacement Lamp Study
Commercial DI Participant Survey Guide:
FINAL

February 10, 2016

Sample Frame Variables

Contact Name: The first and last name of the contact for the rebate.
Business Name: The name of the business.
Contact Address: The address where the retrofit took place.
DI Installer: Installation contractor.
Month/Year of Install: Installation month and year, from IOU midstream tracking data

Introduction

Int.1. Hello, my name is _ and I'm calling from CIC Research on behalf of PG&E. (This is not a sales call.) May I please speak with **<CONTACT NAME>**?

1. Yes (Skip to INT.3)
2. Not available now (ARRANGE CB)
3. No longer there/Never available (CONTINUE)

Int.2. Is there someone else at your business who is knowledgeable about your company's lighting retrofit at **<CONTACT ADDRESS>** that I may be able to speak with? May I please speak with them?

1. Yes (CONTINUE WHEN PERSON COMES ON TO THE PHONE)
2. Not available now (ARRANGE CB)
3. Never available (THANK & TERMINATE)

Int.3. Hello, my name is _ and I'm calling from CIC Research on behalf of PG&E. I'm calling because our records show that your business recently had new LED T8 light bulbs installed at **<CONTACT ADDRESS>** in **<Month/Year of Install>**. Do you recall this?

1. Yes (CONTINUE)
2. No (GO BACK TO INT.2.)
3. Didn't get LED T8 bulbs/got other bulbs (THANK & TERMINATE)
9. Refused (THANK & TERMINATE)

Int.4. Are you the best person to speak with about your business's experience specifically related to this installation?

1. Yes (CONTINUE)
2. No (GO BACK TO INT.2.)
9. Refused (THANK & TERMINATE)

[IF NEEDED: PG&E would like to better understand how businesses like yours make decisions about LED products in order to determine what type of rebate programs they should offer in the future. They also want to hear your feedback regarding the LEDs themselves, as well as any feedback regarding the installation process. Your input is very important to help improve the energy efficiency programs offered by PG&E.]

[IF **Int. 4.** = 1] Great! I want to assure you that this is not a sales call and we will keep everything you say confidential. Nothing you say will be attributed to yourself or your company, and all results will be reported in aggregate. The purpose of this interview is to improve PG&E's LED installation assistance to better serve customers in the future. We appreciate your participation with this research! The interview will take 10 to 15 minutes to complete.

Before we begin, let me clarify that in this survey we'll be talking only about the LED T8s you installed to replace your linear fluorescent tubes. Just in case they were part of a bigger project, we only want to talk about the LED T8 bulbs. Okay?

So, let's get started.

Sales Process

Q 1. First off, did **<DI INSTALLER>** approach you, or did you or someone else from **<BUSINESS NAME>** contact **<DI INSTALLER>** regarding the energy efficiency upgrade at **<CONTACT ADDRESS>** in **< Month/Year of Install>**?

1. Approached by **<DI INSTALLER>**
2. **<BUSINESS NAME>** contacted **<DI INSTALLER>**
77. Other (Specify: _____)
88. Don't Know
99. Refused

Q 2. Were you aware of LED T8s before your first contact with **<DI INSTALLER>**?

1. Yes (aware)
2. No (unaware)
77. Other (Specify: _____)
88. Don't Know
99. Refused

Q 3. [IF **Q 2** = 1] How did you first become aware of LED T8s? (DO NOT READ LIST. ONE ANSWER ONLY.)

1. **<DI INSTALLER>**
2. PG&E website
3. PG&E mailer / bill insert
4. Online / Internet [ASK Q3A]
5. Mailer [ASK Q3B]
6. Corporate headquarters
7. In-house facility manager(s)
8. Property management company
9. Home improvement store
10. Grocery store
11. Drug store
12. Hardware store
13. Lighting designer
14. Architect
15. General contractor
16. Electrical contractor
17. Engineer
18. Lighting contractor
19. Lighting distributor
20. Lighting manufacturer representative
21. Lighting showroom
22. Friend
23. Family member
24. Colleague
25. Trade association (Specify: _____)
77. Other (Specify: _____)

88. Don't Know
99. Refused

Q3a. [IF Q3 = 4] Do you remember which website?

1. PG&E website
2. Other website
88. Don't Know
99. Refused

Q3b. [IF Q3 = 5] Do you remember who sent the mailer?

1. PG&E
2. Other
88. Don't Know
99. Refused

Q 4. Regardless of how you first became aware of LED T8s, which source of information or individual had the greatest influence on your organization's decision to install them? (IF NECESSARY:) Some people hear about them first from one place, but may find additional information from other sources, and this additional information has a bigger influence on their decision to install the LED T8s. Was there another source of information or individual that had even more influence on your decision to install them than where you first heard about them? [DO NOT READ LIST. ONE ANSWER ONLY]

1. **<DI INSTALLER>**
2. PG&E website
3. PG&E mailer
4. Online / Internet [ASK Q4A]
5. Mailer [ASK Q4B]
6. Corporate headquarters
7. In-house facility manager(s)
8. Property management company
9. Home improvement store
10. Grocery store
11. Drug store
12. Hardware store
13. Lighting designer
14. Architect
15. General contractor
16. Electrical contractor
17. Engineer

18. Lighting contractor
19. Lighting distributor
20. Lighting manufacturer representative
21. Lighting showroom
22. Friend
23. Family member
24. Colleague
25. Trade association (Specify: _____)
77. Other (Specify: _____)
88. Don't Know
99. Refused

Q4A. [IF Q4 = 4] Do you remember which website?

1. PG&E website
2. Other website
88. Don't Know
99. Refused

Q4B. [IF Q4 = 5] Do you remember who sent the mailer?

1. PG&E
2. Other
88. Don't Know
99. Refused

Q 5. What did you learn about from **<Q 4>** (IF Q4 = 88 OR 99, INSERT **<Q3>**) that led to your decision to install LED T8s? [DO NOT READ LIST; ACCEPT MULTIPLES]

1. Low cost or free to install
2. Last a long time
3. Save energy
4. Lower energy bill
5. Improved / Better light quality (color, reduced glare)
6. Brighter
7. Do not require replacing fixtures / can use in existing fixtures
8. Did not require a building permit to install
77. Other (Specify: _____)
88. Don't Know
99. Refused

Q 6. [IF **Q 5** = 3] And have you noticed energy savings that you attribute to the LED T8s?

1. Yes

2. No
3. Difficult to determine
88. Don't Know
99. Refused

Q 7. [IF **Q 5** = 4] And have you noticed a lower energy bill that you attribute to the LED T8s?
1. Yes
2. No
3. Difficult to determine
88. Don't Know
99. Refused

Q 8. [IF **Q 5** = 5] And have you noticed better light quality from the LED T8s?
1. Yes
2. No
3. Difficult to determine
88. Don't Know
99. Refused

Q 9. [IF **Q 5** = 6] And have you noticed that the LED T8s are brighter?
1. Yes
2. No
3. Difficult to determine
88. Don't Know
99. Refused

Q 10. Now, thinking about your decision to install LED T8s… On a scale of 1 to 10, where "1" is "not at all important" and "10" is "extremely important", how important was the information from **<Q 4>** in your decision to install LED T8s?

___ [Enter 1 – 10]
88. Don't Know
99. Refused

Q 11. [IF **Q 10** = 1, 2, or 3] Why do you say that? [OPEN-ENDED; RECORD RESPONSE VERBATIM]

_____

Direct Install Process, Benefits of DI approach, and Non-DI Approach Feasibility

Q 12. Thinking about your interactions with **<DI INSTALLER>**, did they offer or recommend any alternative lighting options for upgrading your existing fluorescent tubes or fixtures besides LED T8s?

1. Yes
2. No
77. Other (Specify: _____)
88. Don't Know
99. Refused

Q 13. [IF **Q 12** = 1] What else did they offer or recommend? (DO NOT READ LIST; MULTIPLES OK)

1. LED fixtures
2. LED retrofit kits
3. Efficient fluorescent tubes
4. Lighting controls
77. Other (Specify: _____)
88. Don't Know
99. Refused

Q 14. [IF **Q 12** = 1] Why did you choose the LED T8 replacement lamps that were installed in **<Month/Year of Install>** instead of **<Q 13>**? [OPEN-ENDED; RECORD RESPONSE VERBATIM]

_____

Q 15. If you were required to submit a rebate application in order to receive the LED T8s at the same cost, instead of receiving them through **<DI INSTALLER>**, would you have installed the same number, more, fewer, or no LED T8s in **<Month/Year of Install>**?

1. Same number
2. More
3. Fewer
4. No / none
77. Other (Specify: _____)
88. Don't Know
99. Refused

Q 16A. (IF Q15 = 1-4) Why would you install <Q15> LED T8s if you had to submit a rebate application?? [OPEN-ENDED; RECORD RESPONSE VERBATIM]

_____

Q16B. (IF Q15 = 77, 88, or 99) Why do you say that? [OPEN-ENDED; RECORD RESPONSE VERBATIM]

_____

Q 17. Now I have a question about fluorescent tube fixtures. Fluorescent tube fixtures have something called a "ballast" inside the fixture. This is not the light bulb, but rather hardware inside the fixture itself. Thinking back to when **<DI INSTALLER>** replaced the tubes, did they replace some or all of the ballasts as well?

1. Yes (SOME tubes and ballasts)
2. Yes (ALL tubes and ballasts)
3. No (tubes only)
77. Other (Specify: _____)
88. Don't Know
99. Refused

Q 18. [IF **Q 17** = 3, 88, or 99] Before today, were you aware that fluorescent fixtures had ballasts?

1. Yes
2. No
77. Other (Specify: _____)
88. Don't Know
99. Refused

Q 19. [IF **Q 17** = 1 or 2] Do you know why **<DI INSTALLER>** would replace the ballasts?

1. Yes
2. No
88. Don't Know
99. Refused

Q 20. [IF **Q 19** = 1] Why did they replace the ballasts? [OPEN-ENDED; RECORD RESPONSE VERBATIM]

_____

Q 21. From a technical standpoint, would you or someone else at your location have felt comfortable physically installing the LED T8s without the help of an outside professional installer?

1. Yes
2. No
88. Don't Know
99. Refused

Q 22. [IF **Q 21** = 2] Why not? [OPEN-ENDED; RECORD RESPONSE VERBATIM]

_____

Q 23. Did **<DI INSTALLER>** provide information about what to do if one or more of the LED T8s stops working?

1. Yes
2. No
88. Don't Know
99. Refused

Q 24. [IF **Q 23** = 1] What did **<DI INSTALLER>** tell you to do if one or more of the LED T8s stops working? [DO NOT READ LIST; ACCEPT MULTIPLES]

1. Contact **<DI INSTALLER>**
2. Contact PG&E
3. Contact an electrician
4. Replace/check the ballast
5. Replace the LED T8 with a new LED T8
6. Replace the LED T8 with a fluorescent tube / "T8"
7. Replace the entire fixture
77. Other (Specify: _____)
88. Don't Know
99. Refused

Q 25. What will you do if one or more of the LED T8s stops working? [DO NOT READ LIST; ACCEPT MULTIPLES]

1. Contact **<DI INSTALLER>**
2. Contact PG&E
3. Contact an electrician
4. Replace/check the ballast
5. Replace the LED T8 with a new LED T8
6. Replace the LED T8 with a fluorescent tube / "T8"
7. Replace the entire fixture

77. Other (Specify: _____)
88. Don't Know
99. Refused

Customer Satisfaction

Q 26. In what locations in your facility were the LED T8s installed in **<Month/Year of Install>**? [DO NOT READ LIST BUT USE LIST TO CLARIFY ANSWER AS NECESSARY; ACCEPT MULTIPLES]

1. Entryway / front desk / waiting room / lobby
2. Offices
3. Hallways / walkways
4. Stairways / stairwells / stairs
5. Open offices / cubicles
6. Bathrooms
7. Meeting / conference rooms
8. Kitchen / break room
9. Copy room
10. Mail room
11. Dining room
12. Classrooms
13. Warehouse
14. Storage / closets
15. Retail floor
16. Changing rooms
17. Product displays
18. Gym
19. Pool room
20. Garage
21. Locker room
22. Patient rooms
23. Utility room / boiler room
24. Refrigeration / walk in refrigerator
25. Outside
77. Other (Specify: _____)
88. Don't Know
99. Refused

[INSTRUCTION: Repeat **Q 27** through **Q 33** (if applicable) for each of the locations mentioned in **Q 26**]

Q 27. On a scale of 1 to 10, where "1" is "not at all satisfied" and "10" is "extremely satisfied", how satisfied are you with the LED T8s installed in the **<Q 26>** area or areas?

____ [Enter 1 – 10]
88. Don't Know
99. Refused

Q 28. [IF **Q 27** < 4] Why do you say that? [DO NOT READ LIST; ACCEPT MULTIPLES]

1. Did not meet expectations
2. Failed / burned out
3. Too bright
4. Not bright enough
5. Made noise
6. Poor light quality
77. Other (Specify: _____)
88. Don't Know
99. Refused

Q 29. [IF **Q 28** = 1] What expectations were not met? [DO NOT READ LIST; ACCEPT MULTIPLES]

1. Failed / burned out
2. Too bright
3. Not bright enough
4. Made noise
5. Poor light quality
77. Other (Specify: _____)
88. Don't Know
99. Refused

Q 30. [IF **Q 27** = 4, 5, or 6] Why do you say that? [OPEN-ENDED; RECORD RESPONSE VERBATIM]

_____

Q 31. [IF **Q 27** > 6] Why do you say that? [DO NOT READ LIST; ACCEPT MULTIPLES]

1. Met expectations
2. Low cost or free to install
3. Last a long time
4. Save energy
5. Lower energy bill

6. Improved / Better light quality (color, reduced glare)
7. Brighter
8. Do not require replacing fixtures / can use in existing fixtures
77. Other (Specify: _____)
88. Don't Know
99. Refused

Q 32. [IF **Q 31** = 1] What expectations were met? [DO NOT READ LIST; ACCEPT MULTIPLE]

1. Low cost or free to install
2. Last a long time
3. Save energy
4. Lower energy bill
5. Improved / Better light quality (color, reduced glare)
6. Brighter
7. Do not require replacing fixtures / can use in existing fixtures
77. Other (Specify: _____)
88. Don't Know
99. Refused

Q 33. If LED T8s were not an option, what would you have done in the **<Q 26>** area or areas, if anything? [DO NOT READ LIST; ACCEPT ONE]

1. Nothing / left the fluorescent tubes installed
2. Replaced the fixtures with LED fixtures
3. Installed LED retrofit kits
77. Other (Specify: _____)
88. Don't Know
99. Refused

Technology Persistence

Q 34. Have you removed all, some, or none of the LED T8s since they were installed in **<Month/Year of Install>**?

1. Yes – all
2. Yes – some
3. No – none
88. Don't Know
99. Refused

Q 35. [IF **Q 34** = 1 or 2] Why did you remove [IF **Q 34** = 2: "some of"] them? [DO NOT READ LIST; ACCEPT MULTIPLES]

1. Did not like them
2. Failed / burned out
3. Too bright
4. Not bright enough
5. Made noise
6. Poor light quality
77. Other (Specify: _____)
88. Don't Know
99. Refused

Q 36. [IF **Q 35** = 1] What didn't you like about them? [DO NOT READ LIST; ACCEPT MULTIPLES]

1. Failed / burned out
2. Too bright
3. Not bright enough
4. Made noise
5. Poor light quality
77. Other (Specify: _____)
88. Don't Know
99. Refused

Q 37. [IF **Q 34** = 2 or 3] Do you plan to keep the [IF **Q 34** = 2: "remaining"] LED T8s installed for the foreseeable future?

1. Yes
2. No
88. Don't Know
99. Refused

Q 38. [IF **Q 37** = 2 or 88] Why do you say that? [OPEN-ENDED; RECORD RESPONSE VERBATIM]

_____

Those are all my questions. Before I let you go, is there anything you'd like to add, anything that you think I should have asked about or that we should keep in mind as we conduct this research on LEDs in California?

Thank you very much for your time today!

Appendix B – Interview Guides

PG&E LED T8 Replacement Lamp Study
Commercial Direct Install Implementer Interview Guide
February 1, 2017

Overview

Evergreen will attempt to conduct in-depth interviews with all nine DI program implementers identified by PG&E at the initial project-scoping meeting.

The primary, overarching objectives of this research are:

1. To understand participating DI customers' decisions in selecting LED T8 lamp options.
2. To assess participating DI customers' overall satisfaction with installed LED T8 lamps.

The specific study objectives for this research task include informing the following:

- Sales process
- Direct install process
- Customer satisfaction
- Cost considerations
- Technology persistence
- Benefits of direct install approach

Introduction

Hi, my name is _____, and I'm calling from Evergreen Economics on behalf Pacific Gas and Electric (PG&E). You should have recently received a letter explaining the study and letting you know that we would be contacting you.

We are an independent research firm hired to help PG&E to improve their programs for customers seeking lighting upgrades, specifically those involving LED T8 replacement lamps. My questions should take about 15 minutes. Can you discuss this now, or would it be better to schedule a different time to talk?

[Screen for correct person – person who knows most about lighting equipment]
[Get contact's full name, email address and telephone number.]
[If scheduled, immediately send an email with the date and time of the call and an Outlook appointment (with reminder set for ½ hour before call).]
[Send reminder email one day prior to call if scheduled more than 3 days in advance. (Text for email will be provided.)]

Date:
Respondent:
Interviewer:
Length of interview:
Disposition:

Respondent and Firm Background Information

I'd like to start by finding out a bit about you and your job.

1. What does [Company] do? Anything else?
2. [If not mentioned in 1] Just to confirm, [Company] does offer LED T8 replacement lamps for the commercial sector through PG&E's Direct Install Program, correct? [If no, thank and terminate.]
3. [If not mentioned in 1 or 2] Do you offer LED fixtures for the commercial sector?
4. Does [Company] serve a particular segment of the commercial market? What segment? [Probe for: business type, geography, etc.]
5. What is your position at [Company]? [Probe on: Title, and responsibilities/ description]
6. How long have you been at [Company]?
7. Since January 2015, approximately what percentage of your total projects included lighting work?
8. Of those lighting projects what percentage included LED T8 replacement lamps?

General Questions

9. Are commercial end-use customers more interested in T8 LED replacement lamps or in replacing fluorescent fixtures with new LED fixtures? Why do you say that? [Probe for: differences in applicability, ease of installation, cost, ROI, etc.]
10. For upgrades to linear fluorescent lighting, what percent of commercial end-use customers prefer T8 LED replacement lamps as opposed to other lighting technologies?
11. Are there any differences between the commercial customers served by [Company] who prefer T8 LED replacement lamps versus customers who prefer to replace linear fluorescent fixtures with new LED fixtures? Like what? [Probe on business type, business size, own/lease, going through remodel]

Direct Install Process and Sales Process

12. In what ways do you come in contact with the businesses that you serve? [Probe for: cold calls, door-to-door, existing relationships, word-of-mouth, customer contacts them]
13. After your first contact with a business who may participate in the direct install program, what happens next? [Probe for: audit, equipment procurement, installation, etc.]
14. What proportion of customers are already aware of T8 LED replacement lamps when you first come in contact with them?
15. [If 14 > 0%] Where are they learning about T8 LED replacement lamps?
16. [If 14 > 0%] What do these customers know about T8 LED replacement lamps? What are their perceptions of T8 LED replacement lamps?
17. For customers with existing fixtures containing fluorescent T8 lamps, what options do you typically present? [Probe for: T8 LED replacement lamps; more efficient T8 lamps; fixture replacement; de-lamping]
18. How do you determine what to present to a customer? Do the options you present vary at all depending on characteristics of the business or building, or anything else?
19. How do you try to sell T8 LED replacement lamp installations to potential direct install customers? What types of messages do you use? [Probe for: return on investment, lifetime, ease of installation, light quality, efficiency, payback period, etc.]
20. How do you address potential ballast failures in your discussions with customers?

21. Do any customers decide against T8 LED replacement lamps due to your discussions regarding potential ballast failures? How frequently does this occur? [Probe for: percent of potential customers]

Benefits of Direct Install Approach

22. In your opinion, what are some of the benefits of the direct install approach, specifically for T8 LED replacement lamps?
23. [If not mentioned in 22] Are there installation challenges that you are able to address that may be difficult for customers to handle? Like what?

Customer Satisfaction

24. Have you received any complaints regarding the installed T8 LED replacement lamps? How many? What was the nature of these complaints?
25. In general, are customers satisfied or unsatisfied with the performance of the T8 LED replacement lamps? Why do you say that? [Probe for brightness of LED lamps compared to linear fluorescents]
26. If T8 LED replacement lamps were not available for you to install, would customers have upgraded their lighting with another technology or technologies? Like what? [Probe for: LED fixture replacement (clarify: LED or other technologies), LED retrofit kits, more efficient linear fluorescent lamps]
27. Are there certain installation applications that result in more or less satisfied customers? Like what? [Probe for: certain space types or fixture types]

Cost Considerations

28. For a typical project, how much does the customer pay for T8 LED replacement lamps? What about installation costs? Do either of these costs vary? How? [Probe for: cost per lamp, variance by business type]
29. [If 28 > $0] What is the typical payback period for the customer? Would you consider this a cost effective option for your customers?
30. Are there more cost effective solutions for upgrading fluorescent T8 products? Like what?

Technology Persistence

31. To the best of your knowledge, have any of your customers removed and replaced their T8 LED replacement lamps? How many customers, or what proportion of customers?
32. [If 31 = Yes] Why did they remove and replace their T8 LED replacement lamps? What did they install in their place?

33. [If 31 = No or Don't Know] Do you have any concerns about your customers removing and replacing the T8 LED replacement lamps? Like what?
34. How frequently are customers replacing their ballasts as part of the installation? Do they always replace all of their ballasts, or do some customers replace only certain ballasts? How do you or they determine which ballasts to replace?
35. What do you think customers will do when ballasts fail in the fixtures with TLEDs? [Probe for: replace ballast only, replace ballast and TLED, replace entire fixture] Why do you think this? [Probe for: customer education, lack of knowledge]

Thank you. Those are all of my questions. Is there anything else you think I should know about that I did not ask?

PG&E LED T8 Replacement Lamp Study
Commercial Manufacturer Interview Guide
February 1, 2017

Overview

Evergreen will attempt to conduct in-depth interviews eight manufacturers identified by PG&E at the initial project-scoping meeting.

The primary, overarching objectives of this research are:

1. To understand participating DI customers' decisions in selecting LED T8 lamp options.
2. To assess participating DI customers' overall satisfaction with installed LED T8 lamps.

The specific study objectives for this research task include informing the following:

Objective Category	Specific Study Objectives
Sales process	• How are DI participating customers learning about LED T8 replacement lamp? • Who is making the energy efficiency value proposition to the customer?
Customer satisfaction	• Where did participating customers install LED T8 replacement lamps (in what types of fixture applications)? • Did this provide the customer satisfactory results? • In absence of the LED T8 replacement lamp option, what would or could the customer have done in these applications?
Cost Considerations	• Was there a more cost effective solution available?
Technology persistence	• How likely is the participating customer to continue the use and maintenance of installed LED T8 replacement lamps in their existing fixtures? • What conditions would lead the customer to remove the LED T8 lamp and change to another lamp or technology? • How frequently are participating customers replacing their ballasts as part of the LED T8 replacement lamp installation?

Benefits of direct install approach	• What worked well using the DI approach that may change if a different incentive mechanism is employed? • Does the DI approach have a significant impact on customer satisfaction and technology persistence?
Non-direct install approach feasibility	• What challenges would PG&E face from the lighting market—ballast issues, issues with product quality, free ridership—if incentives were provided through other channels in addition to DI (e.g., midstream channel)? • How would a switch to other potential incentive mechanisms impact overall (gross) sales and net savings? • How could this impact customer satisfaction and technology persistence?

Introduction

Hi, my name is _____, and I'm calling from Evergreen Economics on behalf Pacific Gas and Electric (PG&E). You should have recently received a letter explaining the study and letting you know that we would be contacting you.

We are an independent research firm hired to help PG&E to improve their programs for customers seeking lighting upgrades, specifically those involving LED T8 replacement lamps. My questions should take about 15 minutes. Can you discuss this now, or would it be better to schedule a different time to talk?

[Screen for correct person – person who knows most about T8 LED replacement lamps]
[Get contact's full name, email address and telephone number.]
[If scheduled, immediately send an email with the date and time of the call and an Outlook appointment (with reminder set for ½ hour before call).]
[Send reminder email one day prior to call if scheduled more than 3 days in advance. (Text for email will be provided.)]

Date:
Respondent:
Interviewer:
Length of interview:
Disposition:

Respondent and Firm Background Information

I'd like to start by finding out a bit about you and your job.

1. What does [Company] do? Anything else?
2. [If not mentioned in 1] Just to confirm, [Company] does manufacture LED T8 replacement lamps?
3. [If not mentioned in 1 or 2] Do you manufacture LED fixtures for use in the commercial sector?
4. Does [Company] serve a particular segment of the commercial market? What segment? [Probe for: business type, geography, etc.]
5. What is your position at [Company]? [Probe on: Title, and responsibilities/ description]
6. How long have you been at [Company]?
7. Since January 2015, approximately what percentage of your total sales—in terms of revenue—consisted of lighting products?

8. What percentage of your lighting sales since January 2015 consisted of LED T8 replacement lamps?

General Questions

9. Are commercial end-use customers more interested in LED T8 replacement lamps, in Type B or C linear LEDs, or or in replacing fluorescent fixtures with new LED fixtures?
10. What drives their decision in choosing one product type over the other? [Probe for: differences in applicability, ease of installation, cost, ROI.]
11. For upgrades to linear fluorescent lighting, what percent of commercial end-users prefer LED T8 replacement lamps as opposed to other lighting technologies, including Type B and C linear LEDs as well as other lighting solutions?
12. Are there any differences between commercial end-users who prefer LED T8 replacement lamps versus end-users who prefer to replace linear fluorescent fixtures with new LED fixtures? Like what? [Probe on business type, business size, own/lease, going through remodel]

Sales Process

13. Where are end-users learning about LED T8 replacement lamps?
14. What do these end-users know about LED T8 replacement lamps? What are their perceptions of LED T8 replacement lamps?
15. Do you sell directly to end-users, to other suppliers, such as installers or distributors, or some of both?
    a. ONLY end-users [CONTINUE]
    b. ONLY other suppliers [SKIP TO QUESTION 20]
    c. Both end-users and other suppliers [CONTINUE]
16. For end-users with existing fixtures containing fluorescent T8 lamps that are looking to upgrade, what options do your sales staff present to them? [Probe for: T8 LED replacement lamps; more efficient T8 lamps; fixture replacement; de-lamping]
17. How does your staff determine what to present to an end-user? Do the options they present vary at all depending on characteristics of the business or building, or anything else?
18. How does your staff try to sell LED T8 replacement lamp installations to end-users? What types of messages do you use? [Probe for: return on investment, lifetime, ease of installation, light quality, efficiency, payback period, etc.]
19. How do you address potential ballast failures in your discussions with end-users?

20. [SKIP IF Q 15 = a] Thinking of the other suppliers that you sell to, are you aware of what they present to their customers—the end-users—that are looking to upgrade existing fluorescent T8s? [If YES] What options do they present? [Probe for: T8 LED replacement lamps; more efficient T8 lamps; fixture replacement; de-lamping]
21. [SKIP IF Q 15 = a] How do these other suppliers determine what to present to an end-user? Do the options they present vary at all depending on characteristics of the business or building, or anything else?
22. [SKIP IF Q 15 = a] Still thinking of the other suppliers that you sell to, how do they try to sell LED T8 replacement lamp installations to end-users? What types of messages do they use? [Probe for: return on investment, lifetime, ease of installation, light quality, efficiency, payback period, etc.]
23. [SKIP IF Q 15 = a] How do these other suppliers address potential ballast failures in their discussions with end-users?

Benefits of Direct Install Approach

Next I have a couple of questions about PG&E's direct install programs. If you are unaware, for these programs PG&E hires third parties to provide low- or no-cost lighting and other equipment efficiency upgrades to small commercial customers in PG&E's service territory.

24. In your opinion, what are some of the benefits of PG&E's direct install approach, specifically for LED T8 replacement lamps?
25. [If not mentioned in 24] Are there installation challenges that may be difficult for end-users to handle? Like what?

Customer Satisfaction

26. Have you received any complaints from end-users regarding LED T8 replacement lamps? How many? What was the nature of these complaints?
27. In general, are end-users satisfied or unsatisfied with the performance of the LED T8 replacement lamps? Why do you say that? [Probe for brightness of LED lamps compared to linear fluorescents]
28. Have you received any complaints from installers regarding LED T8 replacement lamps? How many? What was the nature of these complaints?
29. If LED T8 replacement lamps were not available for low- or no-cost, do you think end-users who have received LED T8s through PG&E's direct install programs would have upgraded their lighting with another technology or technologies? Like what? [Probe for: fixture replacement, more efficient linear fluorescent lamps, LED retrofit kits. Also probe for: some customers, no customers, or all customers]

30. Are there certain installation applications that result in more or less satisfied end-users? Like what? [Probe for: certain space types or fixture types]

Cost Considerations

31. Are there more cost effective solutions—for the end-users—for upgrading fluorescent T8 products than LED T8s? Like what?

Technology Persistence

32. To the best of your knowledge, what percentage of end-users removes or replaces their LED T8 replacement lamps after installing them? Why do you say that?
33. [If 31 = Yes] Why would they remove or replace their LED T8 replacement lamps? What other alternatives might they install in their place?
34. How frequently are end-users replacing their ballasts as part of LED T8 installations? Do they always replace all of their ballasts, or do some end-users replace only certain ballasts? How do they determine which ballasts to replace?
35. What do you think customers will do when ballasts fail in the fixtures with LED T8s? [Probe for: replace ballast only, replace ballast and LED T8, replace entire fixture] Why do you think this? [Probe for: customer education, lack of knowledge]

Non-Direct Install Approach Feasibility

36. What do you think would happen if PG&E were to provide rebates to the end-user for purchasing LED T8s and installing them themselves, as opposed to relying on the direct install programs and their installers? [Probe on: ballast issues, issues with product quality, free ridership]
37. Does this differ at all based on the type of end-user, or, for example, if they have their own maintenance staff?
38. How would providing incentives in the form of rebates to the end-user impact overall sales of LED T8s, in your opinion? Are there any risks related to customer satisfaction?
39. Now, thinking of a different change, how would providing incentives in the form of rebates to distributors or to manufacturers like your company impact the overall sales of LED T8s, in your opinion? Are there any risks related to customer satisfaction?

Thank you. Those are all of my questions. Is there anything else you think I should know about that I did not ask?

PG&E LED T8 Replacement Lamp Study
Commercial Distributor Interview Guide
February 1, 2017

Overview

Evergreen will attempt to conduct in-depth interviews with eight to twelve distributors identified by PG&E at the initial project-scoping meeting.

The primary, overarching objectives of this research are:

1. To understand participating DI customers' decisions in selecting LED T8 lamp options.
2. To assess participating DI customers' overall satisfaction with installed LED T8 lamps.

The specific study objectives for this research task include informing the following:

Objective Category	Specific Study Objectives
Sales process	• How are DI participating customers learning about LED T8 replacement lamp? • Who is making the energy efficiency value proposition to the customer?
Customer satisfaction	• Where did participating customers install LED T8 replacement lamps (in what types of fixture applications)? • Did this provide the customer satisfactory results? • In absence of the LED T8 replacement lamp option, what would or could the customer have done in these applications?
Cost Considerations	• Was there a more cost effective solution available?
Technology persistence	• How likely is the participating customer to continue the use and maintenance of installed LED T8 replacement lamps in their existing fixtures? • What conditions would lead the customer to remove the LED T8 lamp and change to another lamp or technology? • How frequently are participating customers replacing their ballasts as part of the LED T8 replacement lamp installation?

Benefits of direct install approach	• What worked well using the DI approach that may change if a different incentive mechanism is employed? • Does the DI approach have a significant impact on customer satisfaction and technology persistence?
Non-direct install approach feasibility	• What challenges would PG&E face from the lighting market—ballast issues, issues with product quality, free ridership—if incentives were provided through other channels in addition to DI (e.g., midstream channel)? • How would a switch to other potential incentive mechanisms impact overall (gross) sales and net savings? • How could this impact customer satisfaction and technology persistence?

Introduction

Hi, my name is _____, and I'm calling from Evergreen Economics on behalf Pacific Gas and Electric (PG&E). You should have recently received a letter explaining the study and letting you know that we would be contacting you.

We are an independent research firm hired to help PG&E to improve their programs for customers seeking lighting upgrades, specifically those involving LED T8 replacement lamps. My questions should take about 15 minutes. Can you discuss this now, or would it be better to schedule a different time to talk?

[Screen for correct person – person who knows most about lighting equipment]
[Get contact's full name, email address and telephone number.]
[If scheduled, immediately send an email with the date and time of the call and an Outlook appointment (with reminder set for ½ hour before call).]
[Send reminder email one day prior to call if scheduled more than 3 days in advance. (Text for email will be provided.)]

Date:
Respondent:
Interviewer:
Length of interview:
Disposition:

Respondent and Firm Background Information

I'd like to start by finding out a bit about you and your job.

1. What does [Company] do? Anything else?
2. [If not mentioned in 1] Just to confirm, since January 2015, has [Company] sold LED T8 replacement lamps for commercial applications?

   [IF NOT, RECORD RESPONSE AND TERMINATE: "At the moment we are only conducting interviews with distributors that have sold LED T8 replacement lamps since January 2015. Thank you for your time."]

3. [If not mentioned in 1 or 2] Does your company offer LED fixtures for the commercial sector?
4. Does [Company] serve a particular segment of the commercial market? What segment? [Probe for: business type, geography, etc.]
5. What is your position at [Company]? [Probe on: Title, and responsibilities/ description]
6. How long have you been at [Company]?

7. Since January 2015, approximately what percentage of your total sales—in terms of revenue—consisted of lighting equipment?
8. What percentage of your lighting sales since January 2015 consisted of LED T8 replacement lamps?

General Questions

9. Are commercial end-use customers more interested in LED T8 replacement lamps, in Type B or C linear LEDs, or in replacing fluorescent fixtures with new LED fixtures?
10. What drives their decision in choosing one product type over the other? [Probe for: differences in applicability, ease of installation, cost, ROI.]
11. For upgrades to linear fluorescent lighting, what percent of commercial end-users prefer LED T8 replacement lamps as opposed to other lighting technologies, including Type B and C linear LEDs as well as other lighting solutions?
12. Are there any differences between commercial end-users who prefer LED T8 replacement lamps versus end-users who prefer to replace linear fluorescent fixtures with new LED fixtures? Like what? [Probe on business type, business size, own/lease, going through remodel]

Sales Process

13. Where are end-users learning about LED T8 replacement lamps?
14. What do these end-users know about LED T8 replacement lamps? What are their perceptions of LED T8 replacement lamps?
15. Do you sell directly to end-users, to installers, or some of both?
    a. ONLY end-users [CONTINUE]
    b. ONLY installers [SKIP TO QUESTION 20]
    c. Both end-users and installers [CONTINUE]
16. For end-users with existing fixtures containing fluorescent T8 lamps that are looking to upgrade, what options do your sales staff present to them? [Probe for: T8 LED replacement lamps; more efficient T8 lamps; fixture replacement; de-lamping]
17. How does your staff determine what to present to an end-user? Do the options they present vary at all depending on characteristics of the business or building, or anything else?
18. How does your staff try to sell LED T8 replacement lamp installations to end-users? What types of messages do you use? [Probe for: return on investment, lifetime, ease of installation, light quality, efficiency, payback period, etc.]
19. How do you address potential ballast failures in your discussions with end-users?

20. [SKIP IF Q 15 = a] Thinking of the installers that you sell to, are you aware of what they present to their customers—the end-users—that are looking to upgrade existing fluorescent T8s? [If YES] What options do they present? [Probe for: T8 LED replacement lamps; more efficient T8 lamps; fixture replacement; de-lamping]
21. [SKIP IF Q 15 = a] How do these installers determine what to present to an end-user? Do the options they present vary at all depending on characteristics of the business or building, or anything else?
22. [SKIP IF Q 15 = a] Still thinking of the installers that you sell to, how do they try to sell LED T8 replacement lamp installations to end-users? What types of messages do they use? [Probe for: return on investment, lifetime, ease of installation, light quality, efficiency, payback period, etc.]
23. [SKIP IF Q 15 = a] How do these installers address potential ballast failures in their discussions with end-users?

Benefits of Direct Install Approach

Next I have a couple of questions about PG&E's direct install programs. If you are unaware, for these programs PG&E hires third parties to provide low- or no-cost lighting and other equipment efficiency upgrades to small commercial customers in PG&E's service territory.

24. In your opinion, what are some of the benefits of PG&E's direct install approach, specifically for LED T8 replacement lamps?
25. [If not mentioned in 24] Are there installation challenges that may be difficult for end-users to handle? Like what?

Customer Satisfaction

26. Have you received any complaints from end-users regarding LED T8 replacement lamps? How many? What was the nature of these complaints? [Probe for: product complaints versus installation complaints, i.e., is it the product's fault or the installers?]
27. In general, are end-users satisfied or unsatisfied with the performance of the LED T8 replacement lamps? Why do you say that? [Probe for brightness of LED lamps compared to linear fluorescents]
28. Have you received any complaints from installers regarding LED T8 replacement lamps? How many? What was the nature of these complaints?
29. If LED T8 replacement lamps were not available for low- or no-cost, do you think end-users who have received LED T8s through PG&E's direct install programs would have upgraded their lighting with another technology or technologies? Like

what? [Probe for: fixture replacement, more efficient linear fluorescent lamps, LED retrofit kits. Also probe for: some customers, no customers, or all customers]

30. Are there certain installation applications that result in more or less satisfied end-users? Like what? [Probe for: certain space types or fixture types]

Cost Considerations

31. Are there more cost effective solutions—for the end-users—for upgrading fluorescent T8 products than LED T8s? Like what?

Technology Persistence

32. To the best of your knowledge, what percentage of end-users removes or replaces their LED T8 replacement lamps after installing them?
33. [If 31 = Yes] Why would they remove or replace their LED T8 replacement lamps? What other alternatives might they install in their place?
34. How frequently are end-users replacing their ballasts as part of LED T8 installations? Do they always replace all of their ballasts, or do some end-users replace only certain ballasts? How do they determine which ballasts to replace?
35. What do you think customers will do when ballasts fail in the fixtures with LED T8s? [Probe for: replace ballast only, replace ballast and LED T8, replace entire fixture] Why do you think this? [Probe for: customer education, lack of knowledge]

Non-Direct Install Approach Feasibility

36. What do you think would happen if PG&E were to provide rebates to the end-user for purchasing LED T8s and installing them themselves, as opposed to relying on the direct install programs and their installers? [Probe on: ballast issues, issues with product quality, free ridership]
37. Does this differ at all based on the type of end-user, or, for example, if they have their own maintenance staff?
38. How would providing incentives in the form of rebates to the end-user impact overall sales of LED T8s, in your opinion? Are there any risks related to customer satisfaction?
39. Now, thinking of a different change, how would providing incentives in the form of rebates to manufacturers or to distributors like your company impact the overall sales of LED T8s, in your opinion? Are there any risks related to customer satisfaction?

Thank you. Those are all of my questions. Is there anything else you think I should know about that I did not ask?