# Regional Finance Program Attribution and Cost-effectiveness Study: Final Report

# Regional Finance Program Attribution and Cost-effectiveness Study: Final Report

Prepared under the direction of the **Energy Division** for the

## California Public Utilities Commission

Submitted by:

**Opinion Dynamics**
1 Kaiser Plaza, Suite 445
Oakland, CA 94612
aelliott@opiniondynamics.com
(510) 214-0180

Kevin Feizi, CPUC Project Manager
kevin.feizi@cpuc.ca.gov
(916) 928-2276

# Legal Notice

Opinion **Dynamics**

# Table of Contents

# Table of Tables

# Table of Figures

# 1.  Executive Summary

On behalf of the California Public Utilities Commission (CPUC), Opinion Dynamics and Dunsky Energy Consulting (the evaluation team) performed attribution and cost-effectiveness studies of three 2013-2015 Regional Finance Programs (RFPs): the emPower Central Coast Program, the Golden State Finance Authority (GSFA)[1] Residential Energy Retrofit Program, and the Southern California Regional Energy Network (SoCalREN) Home Energy Loans Program[2]. The programs provided loans that support Energy Upgrade California® (EUC) Home Upgrade and Advanced Home Upgrade projects (henceforth, "home upgrade projects").

The overarching purpose of this study is to gain a foundational understanding of the value of financing programs in achieving or increasing energy savings from whole home retrofits. Further, this study tests an experimental approach, the Latent Class Discrete Choice (LCDC) method, to estimating Net-to-Gross-Ratios (NTGRs) that reflect the incremental impact of the financing and EUC rebates (together and individually) on home upgrade project uptake likelihood. This study compared the LCDC results with self-report data to further the industry's knowledge of the pros and cons of LCDC vs. self-report methods to assess attribution from financing incentives.

Importantly, the attribution estimates from this study do not (and are not intended to) provide inputs into or alter any deemed savings calculations for the EUC or the RFP efforts. Further, the findings on the relative importance of rebates and financing are specific to whole home upgrade projects, and should not be extrapolated to other types of rebate programs (i.e., programs that support smaller project on average).

## LCDC Method Summary

While the primary goal of the study was to assess how much EUC energy savings can be attributed to the RFPs, the LCDC study addressed a wider spectrum of questions by incorporating relevant non-participants in the survey sample. Specifically, the model included customers who have recently completed or seriously considered a home upgrade. Our sample included the following survey groups:

- ■ **RFP participants:** These are customers who received loans from the RFPs to complete an EUC project.

- ■ **EUC-only participants:** These are customers who completed an EUC project but did not receive Regional Finance Program loans. Importantly, these participants may have received financing from other sources, which is confirmed in the survey.

- ■ **Finance Concierge Service (FCS) users:** The FCS is an online tool that helps customers who are considering a home upgrade. FCS users may not have completed home upgrade projects or received financing, but they have at least shopped for financing options online.[3]

---

[1] Originally called the California Homebuyers Fund (CHF)

[2] Also known as the SoCalREN Residential Loan Loss Reserve

[3] This sample was provided by the Center for Sustainable Energy (CSE) as a part of the CPUC Finance Marketing Education and Outreach Study being conducted by Opinion Dynamics.

■ **EUC Near-participants:** Customers who contacted PG&E or program implementation staff to inquire about PG&E's EUC program in 2014 or 2015 but ultimately did not participate.[4]

The LCDC analysis used 417 customers' stated preferences from survey-based "shopping exercises" to model the influence of various financing (e.g., interest rate), rebate, and project (e.g., size and savings) attributes on customer decisions to complete home upgrade projects. The results of the shopping exercise were inputs into simulated markets that predict customer preferences for a range of financing options to complete home upgrade projects (or none at all). Each market simulation represented the various type of financing available to customers looking to complete an energy-related home upgrade.

To collect inputs for the NTGR analysis, the evaluation team started with a market simulation that included an RFP option. Table 1 below shows attributes that define the RFPs, which are drawn from data received from the RFPs during the evaluation planning process. In subsequent simulations, the RFP was removed to assess the incremental effects of the RFP on project uptake, then set the rebate amount to zero to assess the combined effects of EUC rebate and the RFP on project uptake. Please see Chapter 3 for more detail on this approach.

### Table 1. RFP Attributes

| Attribute | emPower | GSFA | SoCalREN |
|---|---|---|---|
| Payment Method | Traditional Loan Payment | Traditional Loan Payment | Traditional Loan Payment |
| Minimum Cash Down | $0 | $0 | $0 |
| Interest Rate | 5.85% | 6.50% | 5.87% |
| Instant Qualification Possible Through Contractor | No | No | No |
| FICO Score Considered to Qualify | Yes | Yes | Yes |
| Loan Offered by Local Organization | Yes | Yes | Yes |

Note: Project cost, rebate amount, monthly payment, and energy bill savings varied depending on the simulation.

## LCDC NTGR Results

The RFPs entered into an existing market for energy-related home upgrades[5] that included utility rebates from EUC and a plethora of other financing options such as credit card and loans. This means that any attribution analysis of the RFPs would have to account for the possibility that customers could have gone to other options if the RFP were not available. In addition, the customer could have been attracted to the EUC program by the rebates offered alone. Overall, this means that estimating RFP influence means estimating the incremental increase in EUC program uptake caused by adding the RFPs.

Table 2 presents the NTGR estimates by project size for each RFP. The key findings from this analysis were:

■ The RFPs and EUC rebates combined resulted in low overall NTGRs.

---

[4] This sample was initially identified in the 2014-2015 EUC process evaluation: EMI Consulting. September 2016. Energy Upgrade California – Home Upgrade Program Process Evaluation 2014-2015.

[5] A 2012 study completed for PG&E that measured the market for such upgrades showed that 17% of the general home-owner population at that time was planning to do a full upgrade, covering about six measures, and 66% were considering at least a limited upgrade of two or more measures (Opinion Dynamics. 2014. PG&E Whole House Program: Marketing and Targeting Analysis. CALMAC Study ID: PGE0302.05.

- While the NTGRs remain low, the completion of larger, more expensive projects is clearly more influenced by both inducements than smaller, less expensive ones.

- The availability of the RFPs was much more important relative to EUC rebates.

**Table 2. NTGRs by RFP and Project Size (n=417)**

| Project Size | RFP NTGR | EUC Rebate NTGR | Combined NTGR |
|---|---|---|---|
| **Small ($10,000)** | | | |
| emPower | 20% | 9% | 28% |
| GSFA | 20% | 9% | 29% |
| SoCalREN | 20% | 9% | 29% |
| **Medium ($25,000)** | | | |
| emPower | 30% | 11% | 41% |
| GSFA | 30% | 11% | 41% |
| SoCalREN | 29% | 9% | 38% |
| **Large ($40,000)** | | | |
| emPower | 37% | 13% | 50% |
| GSFA | 37% | 13% | 50% |
| SoCalREN | 37% | 13% | 50% |

Importantly, these NTGRs reflect the influence of the RFPs and EUC rebates *on RFP participants*. The LCDC also provides insight into how these incentives move the entire market of "market-ready" homeowners (homeowners who have decided to do an upgrade, or are seriously considering it). From this perspective, the RFPs and EUC rebates have similar and small impacts on overall home upgrade project uptake. Figure 1 illustrates this concept visually for average-sized RFP project (approximately $20,000). This reflects two factors. First, as mentioned above, there are a plethora of residential financing products available in the market, so many participants would have other options in absence of the RFP financing. Second, the EUC rebate covers only a small portion of project cost (on average, about $2,700 dollars, with little variation by project size).

Figure 1. Incremental Percent Upgrade Uptake
Amongst Market-Ready Customers with EUC Rebates and RFP Financing Availability
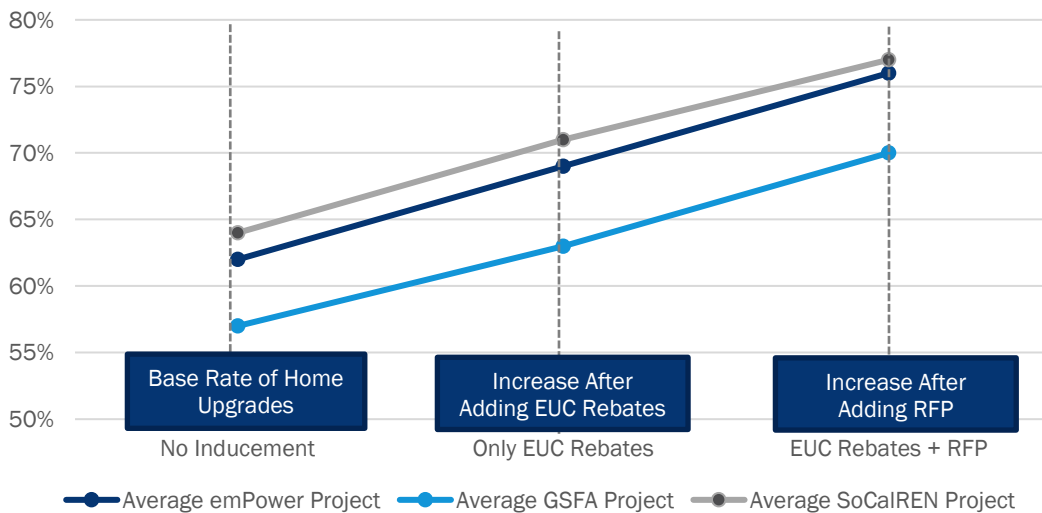


## Additional LCDC Insights– Segments

The LCDC approach involves characterizing target markets by categorizing them into latent classes or segments. The four segments revealed by the LCDC include:

- **Segment 1: Financially Savvy (37% of market ready customers):** These customers are not concerned about the cost of the upgrade project, and are sophisticated in thinking about financing. They are oriented to traditional loans or HELOCs, and sensitive to interest rates. Anything above 4% is unacceptable. They are not looking for convenience, and are middle-of-the-road on their level of motivation to do an upgrade.

- **Segment 2: Motivated Savers (25%):** These homeowners are very motivated to do an upgrade, they care a lot about energy savings, and they only want to do smaller projects. They are not concerned about monthly payments or convenience.

- **Segment 3: Unmotivated Convenience Seekers (25%):** These customers have to be convinced to do an upgrade. They want convenience, low monthly payments, and no cash down. They care about rebates, and are oriented to traditional loans. They likely have good credit because they prefer to have FICO scores considered in loan qualification.

- **Segment 4: Financially Solid, Locally Oriented (13%):** This group is expecting to pay cash for an upgrade project, maybe with some credit card help. If they do go for a loan, they are fine with their FICO scores being considered. They care about the connection of the program to local sources. They want good rebates, but don't care about energy savings. They are not concerned with interest rates, or about the convenience of getting loans, possibly because they will be paying with cash.

This study also explored which of these four segments were most influenced by the RFPs. For all three RFPs, the impact is more than twice as strong in the Unmotivated Convenience Seekers. In some cases, the difference is almost three times that in other segments.

## Additional LCDC Insights—Influential Financing Factors

One of the advantages of the LCDC method is that it helps to identify what specific features or attributes customers prefer when faced with many trade-offs and options. When faced with a full marketplace of options and features, the LCDC analysis revealed that payment method, the monthly payment amount, project cost and interest rate were the most important factors in a homeowner's decision to do a home upgrade project (Table 3).

### Table 3. Relative Importance of Features in Homeowner's Decision to do a Home Upgrade

| Attribute | Possible Values | Weighted %; Relative important of feature in decision to do a home upgrade (n=417) |
|---|---|---|
| Payment Method | Traditional Loan Payment, Mortgage Payment Add-On, Utility Bill Add-On, Property Tax Add-On, Cash, or Credit | 18% |
| Your Monthly Payment | $50, $200, $350, or $500 | 15% |
| Total Project Cost | $10,000, $20,000, $38,000, or $60,000 | 14% |
| Interest Rate | 0%, 4%, 10%, or 15% | 13% |
| Monthly Energy Bill Savings | $0, $20, or $40 | 8% |
| None | n/a | 7% |
| Rebate Amount | $0, $1,500, $3,000, or $6,000 | 6% |
| Instant Qualification Possible Through Contractor | No or Yes | 5% |
| FICO Score Considered to Qualify | No or Yes | 5% |
| Loan Offered by Local Organization | No or Yes | 5% |
| Minimum Cash Down | $0, $2,500, or $5,000 | 5% |

Regarding what payment method enticed homeowners to do a home upgrade project, most preferred a direct loan payment over other financing options (see Figure 2). Most respondents (78%) preferred to use financing versus paying cash or credit card. These findings suggest that the RFPs, which offer term loans, are a desirable program design for market-ready customers.

Figure 2. Payment Method Preferences for Doing a Home Upgrade (n=417)



### Insights from the Self-Report

Below are the key findings from the self-report.

- ■ The RFPs were extremely influential on many participants' decisions to complete the home upgrade project. The majority (62%) indicated that they would NOT have completed the home upgrade without the financing (see Figure 3).

Figure 3. Likelihood to Complete Same Project without the RFPs (n=76)
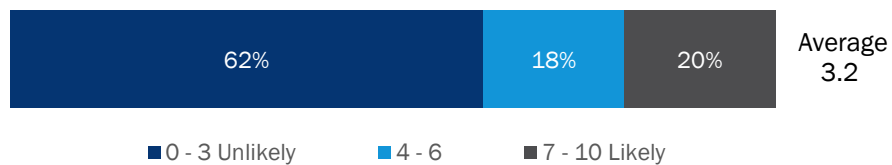


- ■ The RFP influenced 57% to do a larger project than they otherwise would have (notably, another 26% responded to this question by saying that they would not have done anything without the loan). Further, the RFP enabled almost all (92%) of them to complete a home upgrade project sooner than they would have otherwise. Amongst them, 79% would have waited at least one year to do the project. Below are several verbatim responses that emphasis these points:

> *Being able to finance our project into very manageable monthly payments was a no-brainer. We certainly did not have the up-front capital to install solar, new electric water heater, and insulation, but wanted to green and improve the efficiency of our new home.*

> *I did not have the $14,000 plus in savings to pay for the project. Without the loan, I would have been forced to do a band-aid fix of my A/C and keep the older, less efficient unit.*
>
> *Without the loan I would not have done the project to its entirety. It would have been broken into two different projects and different times. The loan helped me complete everything and more in one shot.*

- The most important RFP features to participants were the interest rate, the connection of the loan program to a rebate program (which includes association with emPower Central Coast, GSFA and SoCalREN energy retrofit programs), and the minimum cash amount required to close the loan. Notably, the convenience aspect of the RFPs and the loan terms offered were also important features.

- The majority of respondents said the RFP loan was more (48%) or equally (40%) important compare to the EUC rebate

**Figure 4. Relative Importance of RFPs versus EUC Rebates (Amongst RFP Participants, n=75)**

Survey Question: Which of the following statements best describes the influence of the rebate and the loan on your decision to complete a home upgrade project?

| Loan was SIGNIFICANTLY MORE important than rebate | Loan was SOMEWHAT MORE important than rebate | Loan and rebate were equally important | Rebate was SOMEWHAT MORE important than loan | Rebate was SIGNIFICANTLY MORE important than loan |
|---|---|---|---|---|
| 25% | 23% | 40% | 9% | 3% |

Note: Excludes one respondent who "did not know"

*Executive Summary*
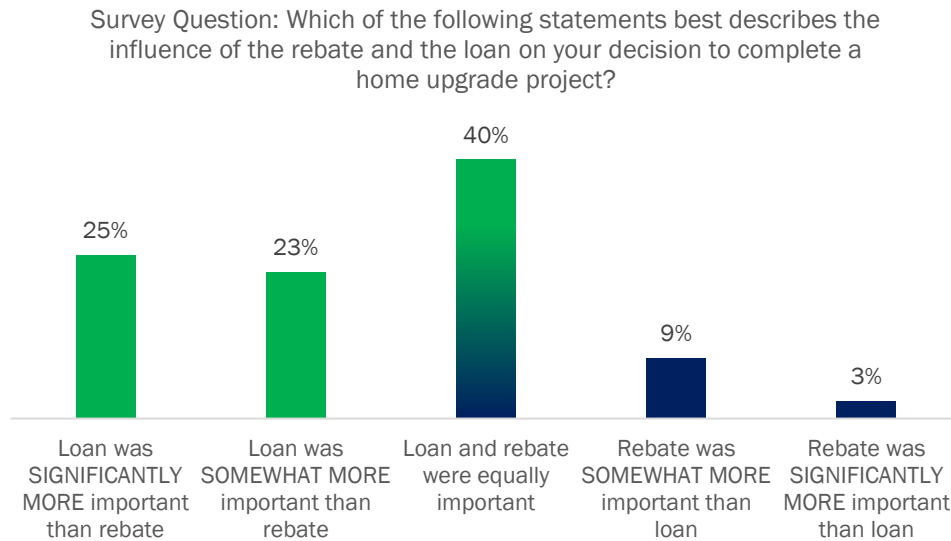
## Comparison of LCDC and Self-Report Results

While the findings are similar on many levels, it is important to note that these two methods explore attribution from different perspectives. The LCDC explores rebate and financing influence amongst market-ready homeowners; which includes a mix of homeowners who were interested in doing a home upgrade project and either did not do the project, did the project without incentives, did the project with EUC rebate alone, or did the project with both EUC rebate and RFP. The LCDC gathers data from this larger pool of market-ready homeowners and explores the hypothetical decisions they would make under different scenarios. Meanwhile, the self-report analysis focuses solely on homeowners who recently received both RFP financing and EUC rebates to do a home upgrade and the questions asked of them regarding the influence of these incentives on their decision-making process. Table 4 compares the key conclusions drawn from the LCDC and self-report analyses.

**Table 4. Summary of Findings from LCDC and Self-Report Analyses**

| Research Topic | LCDC | Self-Report |
|---|---|---|
| RFP and EUC Rebate Influence on Home Upgrade Projects | ■ The **base project uptake rate** (without EUC rebates or the RFPs) is about 55% to 65% for the average RFP project (~$20K), depending on region (Figure 6). This base rate reflects a market where a plethora of financing options are already available to market-ready homeowners. <br><br> ■ The **combined influence** of RFPs and EUC rebates can induce 28% of the market-ready homeowners to do a deep energy retrofit costing around $10K when they otherwise would not; and up to 50% of that market when the cost increases to the $40K range. (Table 20) <br><br> ■ Payment method (term loan), monthly payment amount, total project cost and interest rate are **the primary influencing factors** in homeowners' decisions to do home upgrades and use financing (Figure 7). <br><br> ■ The study identified **four segments** that have different sets of preferences compared to each other. One of these segments, **Unmotivated Convenience Seekers**, is much more influenced by the RFP compared to other segments. (Section 4.3). | ■ Self-report data suggests that the RFP financing was **very important to RFP participants;** 62% of RFP participants say they were unlikely to have done the EUC project at all without the RFP; 20% indicated they would have done it without the RFP; 12% were somewhere in-between (Figure 8). <br><br> ■ Over half (57%) say the RFP allowed them to do **a larger project** and 92% say the RFP allowed them to **do the project sooner**; most would have taken 2 years or more to the project (Table 24, Figure 9). <br><br> ■ Participants rated several features of the RFPs as almost equally important. The results were similar to the LCDC findings (e.g. attributes that determine monthly payment), but also capture the importance of **convenience**, **local endorsement, cash down, and the relationship between contractor and loan program** (Table 25)**.** |

| Research Topic | LCDC | Self-Report |
|---|---|---|
| What is the relative impact of the RFPs versus rebates on EUC project <u>energy savings</u>? | ■ The influence of financing **relative** to rebates has a direct relationship to project cost (and, thus, savings), with financing having increasing influence over rebates as the project cost increases. The **EUC rebate incentive is half as important** as the financing incentive for projects in the $10K level and the rebate influence is even smaller, one-third, when project costs are in the $40K range (Table 20). | ■ Over half (57%) say the RFP allowed them to do **a larger project than they otherwise would have** (if only EUC rebates were available) (Table 24). This suggests that the RFPs were highly influential on project savings, though rebates still influenced the overall decision to do a project |
| What is the relative impact of the RFPs versus rebates on EUC <u>customer participation</u>? | ■ Both inducements result in **small incremental increases** to overall market uptake of EUC projects, suggesting that EUC rebates and the RFPs have a limited influence on overall project uptake. However, the **RFPs have a slightly higher influence** relative to rebates. This relationship is consistent across project sizes (Table 21).<br><br>■ However, our planning NTGR analysis shows that the RFP loans were **much more influential** than EUC rebates amongst RFP participants specifically (Table 20). | ■ **The loan was equally or more important than the rebate** in the decision to do an upgrade. Almost half (48%) of participants say the loan was more important than the rebate; but 40% say they were equally important (Figure 10)<br><br>■ Only one responded said they would have needed EITHER the rebate or the loan to do an upgrade, but not both, suggesting that **dual-causality is rare** (Table 26). |

## Cost-Effectiveness Methods Summary

Mandated by the legislature (Public Utility Code Section 454.5), the CPUC must ensure all available energy efficiency and demand reduction resources be cost-effective. Cost effectiveness tests are applied to compare the relative lifetime costs and benefits accrued through a program intervention.

The objectives of the cost-effectiveness analysis in this study, included:

- Assess the cost effectiveness of energy efficiency financing when treated as a "resource" program;

- Assess the combined cost-effectiveness of the RFP with the EUC program rebates;

- Assess the impact the Financing Program Model (FPM) to interpret the cost-effectiveness tests described in the California Standard Practice Manual's (SPM) Cost-Effectiveness Framework. The proposed FPM captures a range of benefits and costs that are unique to financing programs such as loan loss reserve (LLR) costs, reduced participant borrowing costs, non-energy benefits, and market transformation benefits.

- Test how sensitive the RFP cost effectiveness results are to key program metrics using a sensitivity analysis. Metrics for the sensitivity include: discount rate, reduced borrowing costs, loan duration, savings attribution, non-energy benefits, and market effects.

Based on the cost-effectiveness model outputs, we analyzed and report on findings related to the following:

- Compare the cost effectiveness results of energy efficiency financing when treated as a "resource" program under the existing framework to results under a cost-effectiveness framework designed to capture the full range of financing-related costs and benefits;

- Compare the cost-effectiveness results of Financing plus the EUC Incentives and EUC Incentives only[6];

- Identify the key program metrics that the RFP cost effectiveness results are sensitive to; and

- Provide recommendations on cost-effectiveness testing of the Statewide Financing Pilots and future efficiency financing programs

As discussed further in Section 4.6, the study could not match a sufficient number of emPower files with the EUC database to conduct a cost-effectiveness analysis for emPower. Thus, the cost-effectiveness analysis is limited to the GSFA and SoCalREN programs.

## Cost-Effectiveness Results

We applied the SPM and the FPM adaptions to assess the cost-effectiveness of the combined Financing + EUC Incentives programs cost-effectiveness, compared to the EUC Rebate program alone. The tables below list the cost-effectiveness results of two of the three RFPs.

---

[6] Notably, the cost-effectiveness analysis did not include an examination of the RFP-only scenario. Thus, the cost-effectiveness results apply only to programs with incentives plus financing, not a standalone financing program.

Table 5 lists the mid-range results split by inducement, and cost test following the FPM adaptation.  Table 6 lists the same results following the SPM Framework. Cost-effective perspectives are highlighted in green.

### Table 5. Cost-Effectiveness Test Results (FPM Model)

| Cost Effectiveness | GFSA | | | SoCalREN | | |
|---|---|---|---|---|---|---|
| Program Evaluated | Program Administrator Cost (PAC) | Total Resource Cost (TRC) | Societal Cost Test (SCT) | PAC | TRC | SCT |
| Incentives[7] | 0.13 | 0.17 | 0.20 | 0.12 | 0.21 | 0.24 |
| Financing + Incentives | 0.34 | **1.43** | **1.51** | 0.27 | **1.02** | **1.08** |

### Table 6. Cost-Effectiveness Test Results (SPM Framework)

| Cost Effectiveness | GFSA | | | SoCalREN | | |
|---|---|---|---|---|---|---|
| Program Evaluated | PAC | TRC | SCT | PAC | TRC | SCT |
| Incentives | 0.13 | 0.12 | 0.13 | 0.12 | 0.14 | 0.16 |
| Financing + Incentives | 0.42 | 0.38 | 0.43 | 0.25 | 0.27 | 0.31 |

Based on these results the following conclusions are drawn:

- Using the FPM model, for both the SoCalREN and GFSA RFPs, the Financing + Incentives inducements under the TRC and SCT proved to be cost-effective.

- The Financing + Incentives inducements are more cost-effective than Incentives alone in all cases and under each framework.

- The influence of financing on participant decision-making helped to further increase the cost-effectiveness of the Financing + Incentive combinations, as compared to incentives alone.

- The impact of financing on the PAC is much less pronounced than for the TRC and SCT.

In addition, we conducted a key components analysis on five key variables of the model.  For the PAC test, 1st year covered losses, the discount rate, and the eligible energy efficiency measures (EEEM) market effects had a significant impact on the cost-effectiveness results.  For the TRC/SCT test, the annual percentage rate (APR) % benefit, EEEM Non-energy benefits, 1st year covered losses, and the discount rate had the most pronounced impact on the results.

To complement the analysis, we also calculated the NTG threshold that would be necessary for the non-cost-effective programs to be cost-effective.  For many of the scenarios to be cost-effective, the NTGR value would need to be approaching one or greater than one.  Also, under the PAC test, the utility benefits from the increased NTGR ratio due to increased benefits and static costs.

---

[7] The cost-effectiveness of the EUC Incentives program was calculated using the program evaluated program costs and impacts for years 2013-2015 and the EUC NTGR obtained through the LCDC analysis.

The takeaways from the cost-effectiveness results are as follows:

- Financing is a complementary tool when delivered alongside incentive programs: Incentives alone have a very low NTG, which leads to low cost-effectiveness results.

- Under the FPM adaptation, the financing programs (in combination with the incentive programs) pass the SCT and TRC cost-effectiveness tests.

These results also have the following implications for statewide future financing programs:

- The FPM adaptation provides a robust interpretation of the SPM framework, which could be appropriate to accurately capture financing program cost-effectiveness in the future:

- Data irregularities should be addressed to improve the accuracy of the cost-effectiveness results

- The financing programs offer non-energy benefits that greatly outweigh the energy benefits. The financial benefits accrued by the participants, mostly as a result of an APR reduction, are the primary factor supporting the program cost-effectiveness under the TRC and SCT. This calls into question the appropriateness of the TRC and SCT as cost-effectiveness tests for financing programs from a resource program perspective.

## Conclusions on Self -Report vs. LCDC Attribution Methods

In summary, the self-report approach is more appropriate for creating holistic NTGRs that can be applied to program ex-post gross savings. Compared to LCDC, self-report is less expensive to implement and analyze and requires fewer respondents. Further, the self-report questions are direct and simple for customers to answer. They can account for a wide range of financial and non-financial aspects of the programs. On the other hand, the LCDC is a powerful tool for financing program design, policy making, and marketers *before* a program is implemented, or where program design changes are being planned. Compared to self-report, it does a better job of showing what is most important about financing, who the key customer segments are, and what other financing options customers would seek (if any) absent the program. In this sense, it allows program planners to build a financing product tailored to attract the lowest number of free riders. However, the LCDC NTGR represents a "floor" for the NTGR in that it does not include spillover, partial free ridership (e.g., effects of on project timing), or non-financial factors such as the program marketing or salesmanship of the contractor. For these reasons, the LCDC NTGR in isolation is not appropriate to estimate ex-ante or ex-post NTGRs. Rather, it requires enhancements through self-report.

This study also produced several key lessons about LCDC specific to assessing financing program attribution:

- It is essential to represent the convenience factor and other non-financial attributes of the loan program exercise in a way that is understandable and visible to everyone. In this survey, the convenience factor (and other factors such as local representation) were placed at the bottom of an extensive list of attributes. There have been LCDC surveys in the past with larger numbers of attributes, but the complexity of financing decision-making can make it difficult to consider a large number of attributes at once, especially when taking surveys on small screens (e.g., mobile devices) has become more common. It may also be the case that the attribute by smaller screen sizes when a customer completes the survey on their smart phone.

- The method is not well-suited to account for differences in the timing of upgrade projects. The self-report and verbatim responses detected a big influence of RFP on project timing that the LCDC method

did not. If a stated-preference DC method is used in the future, provision should be made to generate an adjustment factor to the NTGR to account for timing issues.

■ The LCDC cannot account for the persuasive ability of the contractor or the effectiveness of other marketing efforts. It is both a pro and a con that the results will reflect "perfect" awareness of all the alternative products. This will not reflect reality in the case of large home upgrade projects and their financing options, but it has its own benefit in generating "pure" trade-offs instead of choices made under low awareness conditions.

■ LCDC cannot account for spillover if administered only once. Multiple administrations or just a follow-up, non-LCDC survey could.

Finally, the LCDC produces a great deal of information beyond NTGRs that can be very useful to program planners and marketers. Please refer to Section  5.3. for recommendations on future research that can be done with the existing LCDC dataset.

# 2.  Introduction

On behalf of the California Public Utilities Commission (CPUC), Opinion Dynamics and Dunsky Energy Consulting (the evaluation team) performed attribution and cost-effectiveness studies of three 2013-2015 Regional Finance Programs (RFPs): the emPower Central Coast Program, the Golden State Finance Authority (GSFA)[8] Residential Energy Retrofit Program, and the Southern California Regional Energy Network (SoCalREN) Home Energy Loans Program[9].

All three of the Finance Programs are Loan Loss Reserves (LLRs) that offer credit-enhanced financing to support energy efficiency whole-home retrofits through the Energy Upgrade California® Home Upgrade and Advanced Home Upgrade Programs (henceforth referred to as the "EUC Programs"). Each Finance Program partners with one or more financial institutions that issue and administer the loans while the LLR guarantees the loan amount in cases of default.

The overarching purpose of this study is to gain a foundational understanding of the value of financing programs in achieving or increasing energy savings from whole home retrofits. Further, this study tests an experimental approach to estimating the influence of financing relative EUC rebates, namely the Latent Class Discrete Choice (LCDC) analysis approach. Importantly, the attribution estimates developed through this study do not (and are not intended to) provide inputs into or alter any deemed savings calculations for EUC projects.

## 2.1  Study Objectives

This research addresses the objectives and research questions listed in Table 7. The table also indicates what report sections address them. Notably, the original evaluation plan included one additional objective— "Explore trends in EUC participation with and without the RFPs". As Section 4.6 details, it was not possible to answer this research question with the data available.

### Table 7. Study Research Objectives

| Study Objective | Research Question(s) | Report Section(s) |
|---|---|---|
| Objective 1: Assess data availability of the RFPs | How much information is available on customers, contractors, programs, measures installed, measure incentives, and costs? | 4.6 |
| Objective 2: Determine how much of EUC project energy savings is attributable to the RFPs | What energy efficient measures do the RFPs fund? | 2.2, 4.1 |
| | What is the relative impact of the RFPs versus rebates on EUC project energy savings and customer participation? | 4.2, 4.4 |
| | Which customer segments do the RFPs impact? | 4.3, 4.4 |
| Objective 3: Assess the cost-effectiveness of the RFPs | Are the RFPs cost-effective? | 4.5 |

---

[8] Originally called the California Homebuyers Fund (CHF)

[9] Also known as the SoCalREN Residential Loan Loss Reserve

Notably, the term Net-to-Gross Ratio (NTGR) in this study refers to a "Planning NTGR" that was calculated from the LCDC approach. As this report discusses later in Chapter 5, the NTGRs that come from this LCDC study can be thought of as forming the floor of the possible influence of financing and rebates given that it does not account for partial free ridership (e.g., effects on project timing and project size), non-financial influencing factors on customer decision-making such as the salesmanship of contractors, or spillover. Thus, the LCDC NTGRs described in this study should not be used in isolation to estimate ex-ante or ex-post NTGRs. Rather, these estimates should be compared or enhanced with self-report NTGR analysis to get a sense of the true possible range of the NTGRs.

The NTGRs and other findings from the LCDC provide useful information for planning and designing future financing programs. These include insights into what financing attributes are most important to market-ready customers, which types of market-ready customers are most impacted by financing programs, and how adjustments to rebate amounts and financing characteristics may affect home upgrade project adoption.

## 2.2    Comparison of Key Program Characteristics

Table 8 below summarizes each Finance Program's key characteristics, and Table 9 summarizes each program's 2013-2015 budget, LLR allocations, expenditures, and loans issued.

### Table 8. RFP Summary

| Program Design Details | emPower Central Coast Program | GSFA Energy Retrofit Program | SoCalREN Home Energy Loans |
|---|---|---|---|
| Program Administrator | emPower | GSFA | SoCalREN, BKi |
| Financial Institution Partnership(s) | Coast Hills Federal Credit Union and Ventura County Credit Union | Five Star Bank | Matadors Community Credit Union |
| IOU(s) Involved | PG&E, SCE, SCG | PG&E | SCE, SCG |
| Target Geography | Santa Barbara, San Luis Obispo, Ventura Counties | 44 California counties in PG&E territory | SCE/SCG joint territories; property owners in the counties of Santa Barbara, Ventura and San Luis Obispo are not eligible. |
| Programs Supported by Loans | Energy Upgrade California® Home Upgrade/Advanced Home Upgrade, Flex Path, and California Solar Initiative | Energy Upgrade California® Home Upgrade/Advanced Home Upgrade | Energy Upgrade California® Home Upgrade/Advanced Home Upgrade and California Solar Initiative |
| Program Start Date | Nov-11 | Sep-12 | Dec-13 |
| **Loan Details** | | | |
| Interest Rate | 3.90-12.5% (Average: 5.85%) | 6.50% fixed | 4.99-6.99% (Average: 5.87%) |
| Term | 5-15 years (Average: 14.5 years) | 15 years | 5-15 years (Average: 9.5 years/114 months) |
| Average Loan Amount | $20,809 (EUC only) | $25,612 | $18,087 |
| Minimum Loan Amount Allowed | $1,000 | None | $2,500 |
| Maximum Loan Amount Allowed | $30,000 | $50,000 | $50,000 |
| **Qualification Requirements** | | | |

| Program Design Details | emPower Central Coast Program | GSFA Energy Retrofit Program | SoCalREN Home Energy Loans |
|---|---|---|---|
| EUC Program Participation Required | No | Yes | Yes |
| Debt-to-Income Ratio | 60% or lower | 45% or lower | 50% or lower |
| Minimum FICO | 590 | 640 | 660 |

Source: Interviews with program staff in August 2016; data received from program staff in August and September 2016

### Table 9. 2013-2015 Achievements by Finance Program

| Metric | emPower Central Coast Program | GSFA Residential Energy Retrofit Program | SoCalREN Home Energy Loans |
|---|---|---|---|
| **Total Budget (millions)** | $5.05 | $1.00 | $5.21 |
| Funds available to support LLR | $1.00 | $0.92 | $3.83 |
| Non-Financing Program Budget (i.e., Administrative, Marketing) | 4.05 | $0.08 | $1.38 |
| **Total Expenditures/Allocations (millions)** | $3.20 | $0.48 | $1.19 |
| Total Allocated to the LLR Escrow Account | $0.60 | $0.40 | $0.50 |
| Non-Financing Expenditures | $2.60 | $0.08 | $0.69 |
| **Number of Completed Loans** | 52 | 201 | 100 |
| Loan Supporting Advanced Home Upgrade | 42 [a] | 176 | 13 |
| Loans Supporting Home Upgrade | | 25 | 87 |
| Loans Supporting Non-EUC Projects | 10 | N/A | N/A |
| Number of Loans in Default | 0 | 5 | 0 |
| **Total Loans Amount Issued [b]** | $1,019,083 | $5,148,031 | $1,808,728 |
| EUC Loans Amount | $873,997 | $5,148,031 | $1,808,728 |
| Other Program Loans Amount | $145,086 | N/A | N/A |

Source: Data received from emPower, GSFA, and SoCalREN in August and September 2016

[a] The data provided by emPower does not indicate which EUC Program each loan supports.

[b] This does not reflect the value of outstanding loans, which would account for repayment. This reflects the sum of original loan amounts issued.

# 3. Methods

Table 10 below summarizes the methods we used to answer each of the study objectives. Following the table, we provide a description of each research task.

Table 10. Research Task Summary

| Research Task | Research Objective(s) Addressed | Summary |
|---|---|---|
| Data inventory | 1, 2 | Reviewed data availability on RFP loans and associated EUC projects; assessed evaluability and implications for research tasks |
| Participant and Contractor Interviews | 2 | Interviewed seven RFP participants and five contractors who completed RFP-financed projects to understand the decision-making process for selecting financing and the most important financing attributes |
| Internet Survey | 2 | Surveys with 82 RFP participants and 335 relevant non-participants who completed or considered a home upgrade (417 total respondents); survey included a shopping exercise (inputs to LCDC) and self-report attribution questions |
| Attribution Analysis | 2 | LCDC analysis to estimate the relative influence of EUC rebates and RFP financing; calculated "Planning NTGRs" for use in the cost-effectiveness analysis. |
| Cost-effectiveness Analysis | 3 | Estimated cost-effectiveness of each of the RFP programs |

## 3.1.1 Data Inventory

We reviewed secondary data available from the RFPs and EUC program. Data sources included the RFP tracking databases, the EUC program tracking databases, and supplemental information provided by the IOUs via a data request. We reviewed these data to determine if sufficient data was available to support the study objectives, including:

■ Participant information, such as name, address, and contact information

■ RFP loan information, such as loan amount, interest rate, and term

■ EUC project information, such as measures, total cost, total rebate, and estimated savings

We provide inventory of data available and the implication on research tasks and study objectives in Section 4.6.

## 3.1.2 Participant and Contractor In-Depth Interviews

We interviewed five contractors and seven customers who completed EUC projects through the RFPs. The objectives of the interviews were to understand (a) what financing options were available to RFP participants, (b) the process participants went through to select financing, and (c) the most important factors that customers consider when choosing financing. We used the results of these interviews to aid in survey design, specifically, the process for identifying the financing attributes to include in the shopping exercise (see Appendix A for a full discussion). Table 6 below summarizes interview completes by RFP.

Table 11. In-Depth Interview Responses

| RFP | Population with Contact Information [A] | Completed Interviews |
|---|---|---|
| **Contractor Interviews** | | |
| GSFA Residential Energy Retrofit Program | 15 | 3 |
| SoCalREN Home Energy Loan Program | 14 | 2 |
| emPower Central Coast Program | 3 | 0 [B] |
| **Customer Interviews** | | |
| GSFA Residential Energy Retrofit Program | 32 | 3 |
| SoCalREN Home Energy Loan Program | 39 | 3 |
| emPower Central Coast Program | 4 | 1 |

A.   Represents available contact information at the time of data collection. Since then, we have collected additional contacts for customers.
B.   We attempted to reach all three contractors that assisted with emPower projects. However, none responded to our requests.

## 3.1.3   Internet Survey

We fielded an internet survey to RFP participants, EUC program participants who did not get RFP financing, and consumers who have considered an energy efficient home upgrade and/or financing for such a project. The primary goal of the survey was to provide planning net-to-gross ratios (NTGRs) for the Regional Finance Programs as well add additional qualitative depth to our findings. Table 12 summarizes the topics and purpose of each survey section.

Table 12. Survey Structure

| Section | Survey Groups | Purpose |
|---|---|---|
| Screener | All | • Confirm program participation and whether respondent did an energy-related upgrade |
| Project Financing | All | • Determine the total cost of the project<br>• Understand how the project was paid for (i.e., if financing was used)<br>• If applicable, determine financing type and financed portion of the project |
| Shopping Exercise | All | • Present an array of hypothetical project & financing options<br>• Collect data on upgrade & financing preferences for LCDC analysis |
| RFP Attribution | Regional Finance Program participants only | • Gauge likelihood of RFP participants to complete a home energy upgrade in the RFP program's absence<br>• Determine whether program loan influenced the timing, size, or energy efficiency of the home upgrade project<br>• Understand the relative influence of RFP financing and EUC rebates on customers' ability to afford home upgrade projects |
| Energy Efficiency Attitudes | All | • Determine awareness of Regional Finance Programs<br>• Understand motivations for and attitudes toward saving energy and participating in energy efficiency programs |
| Demographics | All | • Provide data for potential covariates in the LCDC analysis. For example, preferences may vary by income level or house size |

While the primary goal of the survey was to assess how much EUC energy savings can be attributed to the RFPs, the LCDC study addressed a wider spectrum of questions by incorporating relevant non-participants in the survey sample. This approach also improved the robustness of the LCDC model coefficients, since the models were built on a wider range of response values that represent a wider range of customer goals and experiences. Specifically, the model included customers who have made a variety of upgrade and financing decisions, whether they researched financing, received financing, completed energy upgrades using rebates only, or seriously considered an upgrade but did not complete it. Our sample included the following survey groups:

- **RFP participants:** These are customers who received loans from the RFPs to complete an EUC project.

- **EUC-only participants:** These are customers who completed an EUC project but did not receive Regional Finance Program loans. Importantly, these participants may have received financing from other sources, which is confirmed in the survey.

- **Finance Concierge Service (FCS) users:** The FCS is an online tool that helps customers who are considering a home upgrade. FCS users may not have completed home upgrade projects or received financing, but they have at least shopped for financing options online.[10]

- **EUC Near-participants:** Customers who contacted PG&E or program implementation staff to inquire about PG&E's EUC program in 2014 or 2015 but ultimately did not participate.[11]

Table 8 presents the size of each survey sample group and total survey completions. We used a census approach, attempting to contact every sample point to maximize the number of survey completions. Outreach was primarily by e-mail. However, as shown in Table 8, the data we received lacked enough e-mails to achieve sufficient completions from RFP participants. Thus, we used a mail-push-to-web outreach approach for most of this sub-group, while using e-mail addresses wherever possible. We offered a $50 incentive to all RFP and FCS subgroup respondents. To control costs, we offered a $50 incentive to the first 50 respondents amongst the EUC-only and EUC Near-participant subgroups.

As shown in Table 13, we completed surveys with over 400 respondents. Notably, 17 respondents did not recall the offering our records indicated they participated in (e.g., EUC or the RFP). However, all but one verified that they recently completed a home upgrade. Regardless of their verified sample group, we included them in the shopping exercise. However, only those who verified participating in the RFP (n=76) received self-report attribution questions regarding the RFP.

### Table 13. Participant Survey Sample

| Survey Group | Population | Number of Unique E-mails | Number of Unique Mailing Addresses | Total Completes (Sample Categories) | Total Completes (Verified Categories) |
|---|---|---|---|---|---|
| EUC-only | 10,645 | 4,161 | N/A [A] | 152 | 144 |
| EUC Near-participants | 8,439 | 3,714 | N/A [A] | 117 | 116 |
| FCS Participants | 211 | 211 | N/A [A] | 66 | 64 |
| GSFA RFP Participants | 201 | 32 | 201 | 42 | 38 |

---

[10] This sample was provided by the Center for Sustainable Energy (CSE) as a part of the CPUC Finance Marketing Education and Outreach Study being conducted by Opinion Dynamics.

[11] This sample was initially identified in the 2014-2015 EUC process evaluation: EMI Consulting. September 2016. Energy Upgrade California – Home Upgrade Program Process Evaluation 2014-2015.

| Survey Group | Population | Number of Unique E-mails | Number of Unique Mailing Addresses | Total Completes (Sample Categories) | Total Completes (Verified Categories) |
|---|---|---|---|---|---|
| SoCalREN RFP Participants | 100 | 39 | 100 | 21 | 21 |
| emPower RFP Participants | 42 | 4 | 40 | 19 | 17 |
| Other, completed home upgrade | N/A | N/A | N/A | N/A | 16 |
| Other, did not complete home upgrade | N/A | N/A | N/A | N/A | 1 |
| Total | 19,638 | 8,161 | 341 | 417 | 417 |

A. Not included because we had sufficient e-mails to execute the preferred e-mail outreach approach.

## Shopping Exercise

The LCDC approach (described further in Section 3.1.4) relies on inputs from stated-preference discrete choice survey questions, which consisted of a series of twelve "shopping exercises." In each exercise, we asked respondents to choose between different hypothetical project options, characterized by both home upgrade and financing characteristics. During each of the twelve exercises, we presented six project options on the screen. Each option was characterized by values or levels for each of ten key attributes, including project size, payment method, interest rate, monthly energy savings, and other potentially influential aspects of home energy upgrade projects. The survey design assigned different sets of attribute levels to each option such that the attribute levels appear in a balanced and uncorrelated manner within each set of choices and over the course of the full exercise.[12] We conducted significant upfront research to select the attributes to include and to ensure that the range of attribute values were realistic, and we provide additional detail on the design process in Appendix A. Table 14 provides the possible values shown for each of the ten attributes included in the shopping exercise.

### Table 14. LCDC Shopping Exercise Design Summary

| Attribute | Possible Values |
|---|---|
| Payment Method | Traditional Loan Payment, Mortgage Payment Add-On, Utility Bill Add-On, Property Tax Add-On, Cash, or Credit |
| Rebate Amount | $0, $1,500, $3,000, or $6,000 |
| Interest Rate | 0%, 4%, 10%, or 15% |
| Your Monthly Payment | $50, $200, $350, or $500 |
| Instant Qualification Possible Through Contractor | No or Yes |
| FICO Score Considered to Qualify | No or Yes |
| Loan Offered by Local Organization | No or Yes |
| Total Project Cost | $10,000, $20,000, $38,000, or $60,000 |
| Minimum Cash Down | $0, $2,500, or $5,000 |
| Monthly Energy Bill Savings | $0, $20, or $40 |

---

[12] However, in some logical cases, certain attributes were set to appear or not appear together. For instance, a cash option will never include interest rates or loan terms.

Along with the six options presented on each screen, respondents also had the ability to select "I would not do any of these projects". Including this choice helps ground the research and supports development of NTGRs, which depend on understanding the share of customers who would not complete a home energy project under varying market conditions. Table 15 below provides an example of one of the twelve sets of options in the overall shopping exercise included in the survey.

Table 15. Shopping Exercise Example

| Attribute | Option #1 | Option #2 | Option #3 | Option #4 | Option #5 | Option #6 | Option #7 |
|---|---|---|---|---|---|---|---|
| **The Project** | | | | | | | |
| Total Project Cost | $20,000 | $20,000 | $38,000 | $38,000 | $10,000 | $38,000 | I would not do any of these projects |
| Rebate Amount | $1,500 Rebate | $1,500 Rebate | $3,000 Rebate | $3,000 Rebate | $3,000 Rebate | No Rebate | |
| Monthly Energy Bill Savings | $20 Savings | $40 Savings | $0 Savings | $0 Savings | $0 Savings | $0 Savings | |
| **How You Pay for the Project** | | | | | | | |
| Payment Method | Traditional Loan Payment | Mortgage Payment Add-On | Utility Bill Add-On | Property Tax Add-On | Cash | Personal credit card | |
| Minimum Cash Down | $0 Down Payment | $5,000 Down Payment | $5,000 Down Payment | $2,500 Down Payment | N/A | N/A | |
| Interest Rate | 10% Interest | 15% Interest | 0% Interest | 4% Interest | N/A | Your personal credit card's interest rate | |
| Your Monthly Payment | $200 | $350 | $200 | $350 | N/A | N/A | |
| **Additional Details** | | | | | | | |
| Instant Qualification Possible Through Contractor | Yes | Yes | No | No | N/A | N/A | |
| FICO Score Considered to Qualify | Yes | No | Yes | No | N/A | N/A | |
| Loan Offered by Local Organization | No | Yes | No | Yes | N/A | N/A | |
| Which would you choose? | ❑ | ❑ | ❑ | ❑ | ❑ | ❑ | ❑ |

## Pre-Testing

Given the experimental nature of this method for the current purpose, we considered it wise to conduct a pre-test of the shopping exercise. There was little in the budget to allow for this, so we first did an internal pre-test with the evaluation team's personnel and relatives to get an idea of how successful the design would be. The research team was concerned that the exercise was too demanding, and created another, simpler, design. We

procured a panel sample of homeowners with no connection to the program and divided it in half, with one half receiving the simple design and the other half, the complex design. We wanted to be able to use the complex design because the results that flowed from it would be very rich and useful to program planners and regulators alike. However, this would not be beneficial if the task couldn't be meaningfully completed by respondents.

The results of the pre-test showed that either design provided sensible coefficients. Specifically, the cost, interest rate, and other quantitative variables were within expected ranges and showed an appropriate pattern of values. For example, respondents were less attracted to higher cost options and tended to focus on monthly payment or attributes that affected it (e.g., interest rate). The same pattern was true of all the quantitative variables. In addition, both designs showed customer segments that had different preference patterns and had adequate predictive ability. The complex design did have a slightly higher drop-out rate than the simple design, but we chose the complex design because it offered more analytical flexibility to answer the research questions.

## 3.1.4    Attribution Analysis

Below we provide a summary of our attribution analysis approach. A detailed technical discussion of the method, including specifics on the modeling, can be found in Appendix B. For this evaluation, our primary interest is in the relative influence of the EUC rebate and RFP financing offerings and the implications for net savings and cost-effectiveness. As part of our LCDC analysis, we developed Planning NTGR estimates for each program offering by comparing outcomes across several market simulations.

As noted earlier, the term "Planning NTGR" accounts for the fact that the data and analysis methods do not incorporate partial free ridership (e.g., effects on project timing), the effects of non-financial factors such as the salesmanship of contractors, or spillover.

LCDC analysis serves as the basis of our attribution approach. LCDC analysis uses customers' stated preferences from the shopping exercise (outlined above) to model the influence of each factor in the survey on their decisions regarding whether to complete and how to finance home energy upgrade projects. The method distinguishes between the influence of each attribute, such as product size, rebates offered, and financing availability, on those decisions. The results of the shopping exercise allow us to simulate markets under varying conditions and predict customer preferences for a range of financing options (e.g., options with varying loan terms and interest rates). Each market simulation provides estimated market shares (which can be interpreted as the probability of completing a home upgrade using each financing option) under specific market conditions.

Table 16 presents a conceptual example of a single market simulation. Each simulation is meant to represent a whole market of available "products" (in our case, home energy upgrades and financing options) and includes an opt-out "None" option. The columns reflect available products, and the rows represent attributes that define each product. Each cell therefore indicates the level or value of a given attribute for each product. The bottom row shows the predicted market share for each product represented (or the probability that a given customer would choose the product) given the available alternatives. Because each simulation is meant to represent a market in its entirety, the market shares always sum to one hundred percent.

Table 16. Conceptual Illustration of a Market Simulation

| Attribute | Option #1 | Option #2 | Option #3 | Option #4 | Option #5 | Option #6 | None |
|---|---|---|---|---|---|---|---|
| Total Project Cost | $20,000 | $20,000 | $20,000 | $38,000 | $10,000 | $38,000 | |
| Rebate Amount | $1,500 Rebate | $1,500 Rebate | $3,000 Rebate | $3,000 Rebate | $3,000 Rebate | No Rebate | |
| Monthly Energy Bill Savings | $20 | $40 | None | None | None | None | |
| Payment Method | Traditional Loan Payment | Mortgage Payment Add-On | Utility Bill Add-On | Property Tax Add-On | Cash | Personal Credit Card | |
| Minimum Cash Down | $0.00 | $5,000.00 | $5,000.00 | $2,500.00 | N/A | N/A | |
| Interest Rate | 10% | 15% | 0% | 4% | 0% | 26% | N/A |
| Your Monthly Payment | $200 | $350 | $200 | $350 | N/A | N/A | |
| Instant Qualification Possible Through Contractor | Yes | Yes | No | No | N/A | N/A | |
| FICO Score Considered to Qualify | Yes | No | Yes | No | N/A | N/A | |
| Loan Offered by Local Organization | No | Yes | No | Yes | N/A | N/A | |
| **Market Share** | **20%** | **10%** | **15%** | **20%** | **15%** | **5%** | **15%** |

We set up each market simulation so that the products included represent each basic type of financing option available to customers looking to complete an energy-related home upgrade. These options include paying cash, a traditional home-equity loan (HELOC), a credit card, an on-bill financing option, a PACE-type loan that adds the payment to the property tax bill, and a "None" option, which represents the decision not to complete a home upgrade at all. We set the attribute levels for each product to reflect the average of actual values for that type of financing. We based these values on the research the team completed on the financing options available on the market at the time of the survey.

To collect inputs for the NTGR analysis, we started with a market simulation that included an RFP option. Table 17 below shows attributes we used to define the RFPs, which are drawn from data received from the RFPs during the evaluation planning process. In subsequent simulations, we removed the RFP to assess the incremental effects of the RFP on project uptake, then set the rebate amount to zero to assess the combined effects of EUC rebate and the RFP on project uptake.

Table 17. RFP Attributes

| Attribute | emPower | GSFA | SoCalREN |
|---|---|---|---|
| Payment Method | Traditional Loan Payment | Traditional Loan Payment | Traditional Loan Payment |
| Minimum Cash Down | $0 | $0 | $0 |
| Interest Rate | 5.85% | 6.50% | 5.87% |
| Instant Qualification Possible Through Contractor | No | No | No |
| FICO Score Considered to Qualify | Yes | Yes | Yes |
| Loan Offered by Local Organization | Yes | Yes | Yes |

Note: Project cost, rebate amount, monthly payment, and energy bill savings varied depending on the simulation.

With the simulator set up this way, we can first observe the RFP gross market share (percentage of market-ready customers that choose this option). To calculate the net market share, the RFP column/product is removed from the market. The resulting change in the percentage selecting the "None" option (the last column in Table 16) represents the net market share of the RFP program. In other words, these are the RFP participants who would only have done the project if the RFP was present. The remaining participants would have done the project with another financing option (i.e., free riders). Thus, the NTGR is the ratio of that change in "None" to the gross market share (i.e., the share of the market originally shown for the RFP option). The process for teasing out the rebate effects from the RFP effects adds complexity to the process, but follows the same principles of using the simulator to calculate the gross and net impacts. The logic of the approach is represented later in this section with equations. An example of these simulator inputs can be found in Appendix B.

For each of the three RFPs, we used the simulations to predict market outcomes for four different project sizes under four different market conditions. For each RFP and project size, we simulated markets under four relevant conditions:

- **Condition 1:** Both RFP financing and EUC rebates offered;

- **Condition 2:** Only RFP financing offered;

- **Condition 3:** Only EUC rebates offered; and

- **Condition 4:** Neither inducement offered.

Although simulations under all four conditions are used to explore the implications of each inducement, only conditions 1, 3, and 4 are needed for our NTGR analysis. Conditions 1 and 3 provided the relevant inputs for the RFP NTGR, and conditions 3 and 4 provide the inputs for EUC NTGR. Because the current program environment treats RFP financing as an added inducement for EUC-rebated projects, the RFP NTGR reflects the incremental benefit of RFP financing relative to the market with only EUC rebates. Conversely, the NTGR for EUC rebates represents the added benefit of the rebates relative to a market with neither RFP financing nor EUC rebates. The respective NTGR estimates for each offering can therefore be summed to reflect the combined influence of both inducements. Figure 1 illustrates the incremental influence of EUC rebates and RFP financing that this analysis estimates.

Figure 5. Regional Finance Program Attribution Concept

EUC Project Energy Savings
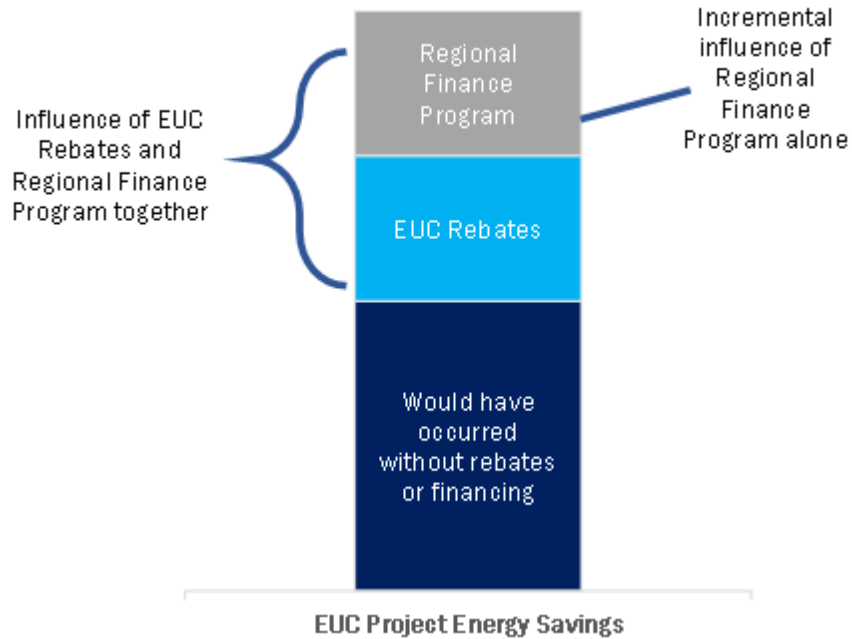
The formulas provided in Equation 1 and Equation 2 outline the development of each NTGR:

Equation 1. LCDC-based RFP Financing NTGR Formula

$$RFP\ NTGR = \frac{None_{c3} - None_{c1}}{RFP_{c1}}$$

Equation 2. LCDC-based EUC Rebate NTGR Formula

$$EUC\ NTGR = \frac{None_{c4} - None_{c3}}{EUC_{c3}}$$

Where:

$c1 =$ market conditions including both RFP Financing and EUC Rebate

$c3 =$ market conditions including only EUC rebate

$c4 =$ market conditions including neither RFP financing nor EUC rebate

$None =$ market share opting not to complete a home energy upgrade project

$RFP =$ market share completing home energy upgrade project with RFP financing

$EUC =$ market share completing home energy upgrade project with EUC rebate

Note that this approach allows for the movement of customers to regular market financing alternatives in the absence of the RFP program. Thus, the incremental impact of the RFP program is net of those possibilities. Based on these equations, the RFP NTGR represents the proportion of customers who would not have completed the target home upgrade project in the absence of the RFP program (i.e., if only EUC rebates were available). Conversely, free riders are defined as those who would have completed the target home upgrade using the other financing or payment options in the simulated market. The EUC Rebate NTGR represents a

similar concept, but with the inducement in question being the EUC rebates. Importantly, both NTGR estimates are meant to capture the influence of the financial inducement only and **do not** reflect the influence of any other program efforts such as marketing or contractor training. Thus, these NTGRs should not (and are not intended to be) interpreted as the full impact of the RFPs or EUC programs.

Finally, in addition to LCDC analysis, we included self-report survey question analysis to add qualitative depth to our findings and as a comparison point to the LCDC-based NTGR estimates. For instance, the self-report questions explore the effects of the RFPs on the timing, size, and rough statements of energy savings of projects (e.g. doing a project with standard equipment and no energy savings). Further, there is the possibility of "dual causality" such that, for some participants, only one inducement would be required and either would be equally sufficient. In other words, either financing or rebates would have resulted in participation in EUC.

## 3.1.5    Cost-Effectiveness Analysis

Mandated by the legislature (Public Utility Code Section 454.5), the CPUC must ensure all available energy efficiency and demand reduction resources be cost-effective. Cost effectiveness is simply a comparison of the relative costs and benefits (assigned a monetary value) of a program intervention – in this case the RFPs. The objectives of the cost-effectiveness analysis, in the context of this study, include:

- Assess the cost effectiveness of energy efficiency financing when treated as a "resource" program by determining the cost-effectiveness of the RFPs in conjunction with the EUC incentive program.[13]

- Assess the combined cost-effectiveness of the RFPs with the EUC program rebates by comparing the cost-effectiveness of the Financing plus the EUC Incentives and EUC Incentives only;

- Compare the cost-effectiveness results under the California Standard Practice Manual (SPM)'s current Cost-Effectiveness Framework to results under a cost-effectiveness Financing Program Model (FPM) adaptation designed to capture the full range of financing-related costs and benefits;

- Test how sensitive the RFP cost effectiveness results are to key program metrics. We present High and Low Scenarios to illustrate the extremes, or the sums of *all* sensitivities going one way or another.; and

- Provide recommendations on cost-effectiveness testing of the Statewide Financing Pilots[14] and future efficiency financing programs.

### Benefit/Cost Ratio

In its simplest form, a benefit cost ratio is used to define the value of a program intervention versus the cost of that intervention, considered from a variety of perspectives. This ratio provides a value of benefits and costs that are represented by actual dollars spent and gained. The basic algorithm is shown Equation 3.

<div align="center">

**Equation 3. Benefit Cost Ratio (BCR)**

$$BCR = Benefits / Costs$$

</div>

---

[13] Notably, the cost-effectiveness analysis did not include an examination of the RFP-only scenario. Thus, the cost-effectiveness results apply only to programs with incentives plus financing, not a standalone financing program.

[14] It is our understanding that the intent of the RFPs was to serve customers until the Statewide Financing Pilots was actively serving the same - and additional - customers

The benefit cost ratio is derived by converting the entire stream of current and future costs and benefits into present values. Detailed descriptions of inputs, assumptions and algorithms for each cost-effectiveness test and model is provided in Appendix C. Below we provide an overview of the cost-effectiveness methodologies, key inputs and assumptions, and sensitivity analysis performed by Dunsky.

## California Standard Practice Manual vs Financing Program Model

We assessed cost effectiveness of the RFPs using two methods:

1. **SPM:** The cost effectiveness policies of the CPUC are outlined in the 2001 California Standard Practice Manual[15]. The SPM provides official cost-effectiveness guidelines and procedures, developed in California for California utility-sponsored programs. The SPM provides the required method of evaluating energy saving investments using four tests from different stakeholder perspectives. These include, the Total Resource Cost (TRC), Program Administrator Cost (PAC), Ratepayer Impact Measure (RIM), and Participant Cost Test (PCT). The TRC and the PAC test are the most commonly used tests applied to evaluate cost effectiveness of "resource" programs in California. The SCT is a variation of the TRC that uses a modified discount rate.

2. **FPM:** Following the launch of the statewide Residential Energy Efficiency Loan (REEL) pilot, Dunsky prepared a white paper, *Cost-Effectiveness of Energy Efficiency Financing Programs – Methodology & Strategic Issues*, for the CPUC to address the implications for assessing the pilot's cost-effectiveness. Dunsky recommended ways to interpret the financing-specific costs and benefits within the SPM to ensure that they are appropriately treated by the cost-effectiveness tests. The white paper used REEL as a test case for the model, however the model can apply to other LLR-based financing programs, such as the RFPs. We applied the FPM in this analysis, adapting it to reflect inputs and assumptions that are appropriate for the RFPs.

Table 18 provides a list of key inputs used for the TRC and PAC and compares them between the SPM and FPM.

### Table 18. Comparison of Standard Practice Manual (SPM) and FPM Key Inputs

| Input | Description | TRC | | PAC | |
|---|---|---|---|---|---|
| | | SPM | FPM | SPM | FPM |
| Costs | | | | | |
| Administration | Non-financing expenditures including, overhead and program management, program support, evaluation, enabling strategies (communications, marketing and outreach, done by IOUs) and costs and fees for service (for the LLR contracted trustee and master service contractor, data management and others). These costs exclude set up costs.[16] | ● | ● | ● | ● |
| Loan Loss Reserve (LLR) | Costs associated with the LLR primarily incurred after loans are made. Cost include direct losses, lost opportunity cost of capital (the spread between the LLR fund's anticipated rate of return – and that capital's assumed value (or cost) if not used for an LLR (which we assume to be equal to the IOU weighted average cost of capital) | | ● | | ● |

---

[15] http://www.cpuc.ca.gov/uploadedFiles/CPUC_Public_Website/Content/Utilities_and_Industries/Energy_-_Electricity_and_Natural_Gas/CPUC_STANDARD_PRACTICE_MANUAL.pdf. Accessed on November 8th, 2017

[16] Prior to launching the RFPs, the IOUs will have incurred material setup costs, including costs relating to administration, overhead, and marketing and outreach to lenders and others. We have treated these as sunk costs for the purposes of this analysis.

| Input | Description | TRC | | PAC | |
|---|---|---|---|---|---|
| | | SPM | FPM | SPM | FPM |
| Participant Cost | The incremental cost of RFP driven measures, which are the total loan book times the attribution factor that reflects the share of savings attributed to the loan. The attribution factor was determined through the LCDC modelling. | ● | ● | | |
| **Benefits** | | | | | |
| Avoided Costs | Utility avoided costs related to generation and distribution of energy from conventional power plants and natural gas lines. Values are based on the 2017 Avoided Cost Model produced by Energy + Environmental Economics, Inc. (E3) for use in demand-side cost effectiveness proceedings at the CPUC. | ● | ● | ● | ● |
| Leveraging Effect of LLR | For an LLR that is maintained at 10% of the overall loan pool for the RFPs, thus a 10:1 leveraging ratio is applied for private loan capital to program capital. Similar leverage ratios can be calculated for other LLR coverage rates. | | ● | | ● |
| Attribution | The relative influence of the financing program versus of incentive programs that are also available. | ● | ● | ● | ● |
| Non-Energy Benefits | The environmental, economic and health related externalities. | | ● | | |
| Reduced Borrowing Cost | Consumers benefit from lower interest rates and/or longer loan terms. | | ● | | |
| Market Transformation | Assumes that the program/pilots will generate some degree of market effects (approximately 10% of EEEM benefits), leading to continued incremental activity after its initial 2-year life. | | | | |

As shown in the table above, the FPM includes the following considerations:

**The LLR.** A fundamental difference between innovative financing programs/pilots and conventional rebate programs relates to time. Specifically, while rebate costs are incurred as measures are adopted, costs associated with the loan loss reserve are primarily incurred after loans are made, typically over a period of many years, and at unknown amounts at the outset. For example, a rebate is issued following the purchase and installation of an eligible measure, whereas the LLR may have to cover a portion of a participating lender's losses if, when, and to the extent such losses occur over the life of the loan.

Furthermore, the LLR is expected to be used as leverage to increase the total loan book volume for both low-moderate income borrows and all other borrowers. Holding the funds in a LLR creates leveraging opportunity across the project lifetime (Benefit), but also results in lost opportunity cost of capital - the spread between the LLR fund's anticipated rate of return – and that capital's assumed value if not used for an LLR (Cost).

**Reduced Borrowing Costs.** Mitigating eligible loans for lenders (through an LLR that backstops 90%), of the total book value of loans. These consumers gain benefits from lower interest rates and/or longer loan terms.

**Non-Energy Benefits.** The CPUC does not historically account for non-energy benefits (NEBs). Since 2011, the avoided cost model includes an avoided GHG cost, so while not "strictly financial", other than this one non-energy impact, the energy efficiency cost effectiveness tests do not contain any non-energy impacts.[17] Neglecting NEBs would effectively allow the TRC[18] test to make an arguably weak assumption: that consumers would voluntarily assume debt for zero benefit. Studies elsewhere, commonly find weatherization-specific NEBs to exceed the value of energy avoided costs, including a 2014 Opinion Dynamics assessment of participating PG&E customers which showed NEBs were valued far more than bill savings. Even the RFP

---

[17] Societal Cost Test Workshop, Societal Cost Test Introduction (SCT): Background and Staff Research. September 22, 2016

[18] Non-energy benefits only apply to the TRC, since they provide no value to the program administrator.

participant survey conducted for this analysis showed that while the primary interest in energy efficiency programs is for the bill savings, participants also see value in the environmental and socio-economic benefits of energy efficiency programs. See section 4.5.

**Market Transformation benefits.** We note that while the RFPs are formally categorized as "resource" programs, they are partly driven by a desire to transform markets (specifically, energy efficiency lending practices). There is value in considering that the program/pilots will generate at least some degree of market effects, leading to continued incremental activity after the initial program/pilot period.

## Sensitivity Analysis

The appropriate choice of inputs and input components vary by program, project, and policy rules, particularly around externality values, such as NEBs. Without firm directional guidance on certain inputs, we conducted sensitivities to address assumptions and understand how sensitive results are to any one variable, including:

- **Discount rate:** The applicable discount rate for PAC, TRC and SCT

- **Reduced Borrowing Costs**: The difference between expected market lending rates, and the program APR

- **Loan Duration**: Average duration of loans

- **Savings Attribution**: Share of net savings driven by financing

- **NEBs:** Value of NEBs (% avoided costs)

- **Market Effects:** Continued activity beyond programs/pilots

## Reporting

Based on the cost-effectiveness model outputs, we analyzed and report on findings related to the following:

- Compare the cost effectiveness results of energy efficiency financing when treated as a "resource" program under the existing framework to results under a cost-effectiveness framework designed to capture the full range of financing-related costs and benefits;

- Compare the cost-effectiveness results of Financing only, Financing plus the EUC Incentives and EUC Incentives only;

- Identify the key program metrics that the RFP cost effectiveness results are sensitive to; and

- Provide recommendations on cost-effectiveness testing of the Statewide Financing Pilots and future efficiency financing programs

# 3.2 Study Limitations

The study's limitations fall into four categories, described below.

- **LCDC Findings:** All method choices require trade-offs. The LCDC method provides clean estimates of the relative influence of rebates and the RFP, and builds in the possibility of customers moving to other financing methods if the RFP is not available when the customer has all the information about all of

the options. As is true of any stated-preference discrete choice method, what it does not do is account for the limited knowledge that customers have, as well as the persuasive influence that a contractor can have in selling the project with rebates, energy savings, and financing as one convenient package. Where consumers don't have all of the information available on all alternatives, the persuasion of a contractor can be enhanced further. Spillover effects also can't be assessed with a one-time measurement of program influence using stated-preference discrete choice techniques. As a result, the NTGRs that come from these methods, such as LCDC, can be thought of as forming the floor of the possible program impacts. They are probably most useful for planning and re-designing programs. The relative influence of many potential program features (EUC and RFP attributes) are valuable for determining which are most and least important to customers, and how they trade them off against each other when making decisions about home upgrades. This can help the program planners design marketing and advertising plans, and can help contractors think about what is likely to be persuasive overall and for what customer groups. It can also provide an understanding of where free riders are likely to be found, and what NTGRs they can anticipate in the absence of salesmanship and market targeting.

- **Self-Report Findings:** The self-report battery of NTGR questions also had limitations in terms of providing an NTGR that could be applied to program savings. Specifically, the self-report questions focused on the influence of RFPs alone and the relative influence of EUC rebates and the RFPs. The purpose was to provide additional qualitative depth to the LCDC findings and not to develop a NTGR that could be applied to EUC savings associated with RFP projects. Considering this goal, and due to concerns with survey length, we did not include the full battery of self-report questions that would be needed to create a self-report NTGR comparable to the estimate for EUC from previous studies.

- **Data Availability and Quality:** Finally, this study also faced significant limitations related to data availability, which we describe further in Section 4.6.

- **The Standard Practice Manual Does Not Adequately Address Unique Challenges of Finance Programs:** While the RFPs are considered "resource" programs and subject to the cost effectiveness framework outlined in the Standard Practice Manual (SPM), the SPM was originally designed to assess the impacts of incentive programs (rebates) - not financing. Financing must be viewed from a different lens considering the various components of financing and to the extent they differ from standard program components, how to apply these inputs and adjust the algorithms accordingly. The goals of financing also differ from that of rebate programs, which are traditionally short-term resource acquisition programs, whereas financing is a longer-term market transformation program, specifically designed to increase energy efficiency lending practices with limited rate-payer dollars. We conduct the cost effectiveness analysis following the SPM guidelines, and compare the results with the results of FPM to evaluate the value of financing.

# 4. Key Findings

Below we present the key findings, organized by study objective.

## 4.1 Overview of the RFPs

Our primary[19] study population includes residential customers that participated in one of the EUC programs and used loans from one of the three RFPs to pay for their project. As shown in Table 19 below, our population includes 343 customers who participated in EUC programs offered by Pacific Gas & Electric (PG&E), Southern California Edison (SCE), Southern California Gas Company (SCG), and SoCalREN. For more information on how we selected these three Finance Programs, please see Appendix A.

### Table 19. RFP Participants

| RFP | Number of RFP Participants | Number of EUC Participants | EUC Programs |
|---|---|---|---|
| emPower Central Coast | 52* | 42 | • PG&E/SCG Home Upgrade<br>• PG&E/SCG Advanced Home Upgrade<br>• SCE/SCG Home Upgrade<br>• SCE/SCG Advanced Home Upgrade |
| GSFA Residential Energy Retrofit Program | 201 | 201 | • PG&E Home Upgrade<br>• PG&E Advanced Home Upgrade |
| SoCalREN Home Energy Loans | 100 | 100 | • SCE/SCG Advanced Home Upgrade<br>• SCE/SCG Home Upgrade<br>• SoCalREN Home Upgrade |
| Total | 353* | 343 | N/A |

*10 emPower participants did not participate in the EUC programs. See Section 2.2.1 for more detail.

Next, we provide a description of each RFP, including key program design elements and program performance metrics for 2013-2015.

### 4.1.1 emPower Central Coast Program

The goal of the emPower Central Coast Program is to help property owners overcome obstacles to making residential energy efficiency improvements and solar upgrades, through financing and a variety of other programming and services. The Coast Hills Federal Credit Union and Ventura County Credit Union issue and administer the loans. The LLR guarantees 90% the loans' value and maintains an LLR escrow[20] account equal to 5% of the loan portfolio's value. This program has received funding from several sources, including ratepayer (through SCG), American Recover and Reinvestment Act (ARRA), and the California Energy Commission (cost-effectivenessC) funds.

The majority of the loans support EUC projects but a few loans (10) supported other programs including California Solar Initiative projects and "Flex Path". We excluded these 10 customers from our study to allow

---

[19] We say "primary" because we leveraged survey data from relevant non-participants. Please see Chapter 3 for more.

[20] "Escrow" refers to funds deposited into the bank's LLR account. LLRs typically do not actually maintain 90% of the entire loan portfolio in the LLR account. Rather, they agree with the partner bank on a smaller percentage to keep in escrow based on risk calculations.

for a clean analysis of financing associated with the EUC program. Loans are available to homeowners in Santa Barbara, San Luis Obispo, and Ventura Counties. Customers must have FICO score of 590 or higher and a debt-to-income (DTI) ratio of 60% or lower to qualify.

During the study period, the program issued 52 loans, 42 of which supported EUC projects. The EUC loans totaled $873,997 and there have been no loan defaults. EUC loan amounts ranged from $10,843 to $30,000, with an average of $20,809. Interest rates varied, averaging 5.85%. A special rate of 3.90% was available only in Santa Barbara County, although not all loans in that county received that rate. Loan terms also varied, averaging about 15 years.

## 4.1.2 GSFA Residential Energy Retrofit Program

The goal of the GSFA Residential Energy Retrofit Program is to help PG&E residential homeowners cover the upfront cost of making energy efficiency improvements in their homes. Five Star Bank issues and administers the loans. The LLR guarantees 100% the loans' value and maintains an LLR escrow account equal to 10% of the loan portfolio value. Funding for this program is primarily through ratepayer dollars. However, the program is still using some remaining ARRA funding from 2012.

All of the loans support EUC projects. Loans are available to homeowners in PG&E territory who have a FICO score of 640 or higher and a DTI ratio of 45% or lower.

During the study period, the program issued 201 loans. The loans totaled $5,148,031 and five loans have defaulted. Loan amounts ranged from $4,620 to $50,000, with an average of $25,612 in project years 2013-2015. All loans had an interest rate of 6.50% and a term of 15 years.

## 4.1.3 SoCalREN Home Energy Loans

The goal of the SoCalREN Home Energy Loans program is to help single-family residential customers obtain home energy loans that support energy efficiency and solar upgrades[21]. Matadors Community Credit Union issues and administers the loans, and Bevilacqua-Knight, Inc. (BKi) administers the LLR. The LLR guarantees 90% the loans' value and maintains an LLR reserve account equal to 15% of the loan portfolio's value.[22] Funding for this program has been from ratepayer dollars since December 2013. Prior to this, ARRA funds supported the program.

All of the loans support EUC projects. Loans are available to homeowners in joint SCG/SCE territory, excluding Santa Barbara, San Luis Obispo, and Ventura Counties. Customers must have a FICO score of 660 or higher and a DTI ratio of 50% or lower to qualify.

During the study period, the program issued 100 loans. The loans totaled $1,808,728, and there have been no defaults. Loan amounts ranged from $3,318 to $50,000, with an average of $18,087. Interest rates ranged from 3.00% to 6.99% with an average of 5.87%. Loan terms varied, averaging about 10 years.

---

[21] Solar projects must be enrolled in the California Solar Initiative.

[22] According to SoCalREN, they placed 90% of the first five loans into the escrow account from the reserve account and then 10% of all subsequent loans. They regularly manage the reserve account to maintain a balance equal to 15% of outstanding loan value.

## 4.2     LCDC: Planning NTGR Analysis

In this section, we present the results of our LCDC analysis. We begin with our Planning NTGR findings, which represent the *incremental* influence of RFP financing as an addition to the EUC rebate ("RFP NTGR") and of EUC rebates as a standalone offering ("EUC Rebate NTGR"). This section also includes a discussion of trends by project cost. We then present additional findings regarding the relative influence of EUC rebates and RFP financing and potential dual-causality.

### 4.2.1     Planning NTGR Analysis

The RFP enters an existing market for energy-related home upgrades[23] that included utility rebates from EUC and a plethora of loan products, such traditional term loans, home equity lines of credit (HELOC), and Property Assessed Clean Energy (PACE) loans. This means that any evaluation of the RFP would have to take account of the possibility that customers considering an upgrade could have gone to other options if the RFP were not available. In addition, the customer could have been attracted to the EUC program by the rebates offered. Overall, this means that estimating RFP influence means estimating the incremental increase in EUC program uptake caused by adding the RFPs. This level of market complexity, together with the number of project and loan attributes available, is a major reason that we opted to use an LCDC method for disentangling these influences.

One final important element of context is the nature of the sample we used for the LCDC study. For several reasons, described in the method section, we did not restrict the shopping exercise to RFP or even EUC participants. We included near-participants, and customers who went so far as to sign into a program web site (Finance Concierge Service [FCS]) to investigate financing possibilities. We did not represent the general population of homeowners. We know from the Opinion Dynamics 2012 study that quite a large portion of northern CA residential customers, at least, have been seriously considering a home upgrade over recent years. Still, we are not tapping into the full breadth of the potential market. The percentages of respondents who, therefore, said they would choose to do an energy-related home upgrade with or without the program, should be thought to apply to "market-ready" customers[24]. The percentages could be different if looking at the larger pool of homeowners, including those not at all considering a home upgrade. However, we think there is no particular reason to think that the relative importance of rebates versus loans would be substantially different in this wider population.

Table 20 presents the NTGR estimates by project size for each RFP. Taken together, RFP financing and EUC rebates resulted in NTGRs between 28% and 50%, depending on project size.  The RFP NTGR is much higher than the EUC rebate NTGR, which indicates that the average RFP participant is much more dependent on RFP financing than on the EUC rebate. However, the NTGRs are low overall. This reflects two factors. First, as mentioned above, there are a plethora of residential financing products available in the market, so many participants would have other options in absence of the RFP financing. Second, the EUC rebate covers only a small portion of project cost (on average, about $2,700 dollars, with little variation by project size). While the NTGRs remain low, the completion of larger, more expensive projects is clearly more influenced by both inducements than smaller, less expensive ones.

---

[23] A 2012 study completed for PG&E that measured the market for such upgrades showed that 17% of the general home-owner population at that time was planning to do a full upgrade, covering about six measures, and 66% were considering at least a limited upgrade of two or more measures (Opinion Dynamics. 2014. PG&E Whole House Program: Marketing and Targeting Analysis. CALMAC Study ID: PGE0302.05.

[24] Customers who were considering a home upgrade or already decided to do a home upgrade.

Table 20. NTGRs by RFP and Project Size (n=417)

| Project Size | RFP NTGR | EUC Rebate NTGR | Combined NTGR |
|---|---|---|---|
| Small ($10,000) | | | |
| emPower | 20% | 9% | 28% |
| GSFA | 20% | 9% | 29% |
| SoCalREN | 20% | 9% | 29% |
| Medium ($25,000) | | | |
| emPower | 30% | 11% | 41% |
| GSFA | 30% | 11% | 41% |
| SoCalREN | 29% | 9% | 38% |
| Large ($40,000) | | | |
| emPower | 37% | 13% | 50% |
| GSFA | 37% | 13% | 50% |
| SoCalREN | 37% | 13% | 50% |

These NTGRs give us several valuable insights about the influence of financing and rebates on upgrade project decisions:

- **The combined incentive of financing and rebates have a direct relationship to project cost**, the larger the project cost, the more influential financing and rebates are to the decision. The combined incentives of RFPs and EUC rebates can induce 28% of the market-ready customer to do a deep energy retrofit costing around $10K that they would not otherwise; and up to 50% of the market when the cost increases to the $40K range.

- **The influence of financing relative to rebates also has a direct relationship to project cost**, with financing having more of an influence than rebates as the project cost increases. The EUC rebate incentive is approximately half as important as the financing incentive for projects in the $10K level and the rebate influence is even smaller, about one-third, when project costs are in the $40K range.

Importantly, it bears repeating that both NTGR estimates are meant to capture the influence of the financial inducement only and **do not** reflect the influence of any other program efforts such as marketing or contractor salesmanship.

## Calculation Steps

Table 21 shows the inputs for the NTGR estimates from market simulation outputs, as detailed in the methods section of this report.

- **RFP NTGR:** To calculate the RFP NTGR, we first calculate the market share for the RFP plus EUC rebates, given all other options; this is the gross effect of the programs. Then, we compare the percentage of respondents who would not do the project ("none" market share) when (1) the EUC Rebate and RFP financing are available to (2) when only the EUC rebate is available. The increase in "none market share" represents customers who would do nothing in absence of the RFP financing. This is the net effect of the RFP on the decision to do an upgrade. The rest would likely have used other financing options. We compare that percentage change to the gross RFP market share when both RFP and EUC inducements are available to calculate the NTGR. As an example, for a small project where emPower financing and EUC rebates are available, 27% of market-ready customers would

choose to do the project using the emPower financing (item D), the gross impact of the program on project uptake. At the same time, we find that 13% of respondents would not have done the project, even with the emPower financing and EUC rebates present (Item A). Then, if the emPower program was removed and only EUC rebates were available, 19% would not have done the project (Item B), which is an increase of 6%. Using these values, 6% of the 27% emPower market share needed the emPower loan to complete the project (20%[25]).

- ■ **EUC Rebate NTGR:** The calculation follows similar steps as the RFP NTGR, but compares percentages who completed the project, regardless of how they paid for it, with and without the EUC rebate. Importantly, the RFP is removed in this comparison in order to isolate the influence of the EUC rebate.

Table 21. Summary of Planning NTGR Development by RFP and Project Size (n=417)

| Regional Finance Program | Percentage of Market-Ready Customers Who Would *Not* Complete the Project ("None" Market Shares) | | | Base Project Uptake Rates Amongst Market-Ready Customers | | NTGR | |
| | RFP & EUC Rebate Available (A) | Only EUC Rebate Available (B) | Neither Inducement Available (C) | Using RFP with RFP & EUC Rebate Available (D) | Using Any Financing Option with EUC Rebate Available (E) | RFP NTGR ((B-A)/D) | EUC Rebate NTGR ((C-B)/E) |
|---|---|---|---|---|---|---|---|
| **emPower** | | | | | | | |
| Small ($10,000) | 13% | 19% | 26% | 27% | 81% | 20% | 9% |
| Medium ($25,000) | 29% | 35% | 42% | 22% | 65% | 30% | 11% |
| Large ($40,000) | 44% | 50% | 57% | 16% | 50% | 37% | 13% |
| **GSFA** | | | | | | | |
| Small ($10,000) | 13% | 19% | 26% | 26% | 81% | 20% | 9% |
| Medium ($25,000) | 29% | 35% | 42% | 21% | 65% | 30% | 11% |
| Large ($40,000) | 45% | 50% | 57% | 15% | 50% | 37% | 13% |
| **SoCalREN** | | | | | | | |
| Small ($10,000) | 14% | 19% | 26% | 26% | 81% | 20% | 9% |
| Medium ($25,000) | 31% | 36% | 42% | 19% | 64% | 29% | 9% |
| Large ($40,000) | 47% | 51% | 57% | 13% | 49% | 37% | 13% |

Figure 6 illustrates this concept visually for average-sized RFP project (approximately $20,000). It shows incremental, positive influence on upgrade decisions amongst market-ready customers. In all three regional programs, the same pattern shows itself. The decision to do an upgrade increases as we add EUC Rebates, and again, when we add the RFP to that.

---

[25] Note, exact value cannot be calculated by hand due to rounding.

Figure 6. Incremental Percent Upgrade Uptake
Amongst Market-Ready Customers with EUC Rebates and RFP Financing Availability
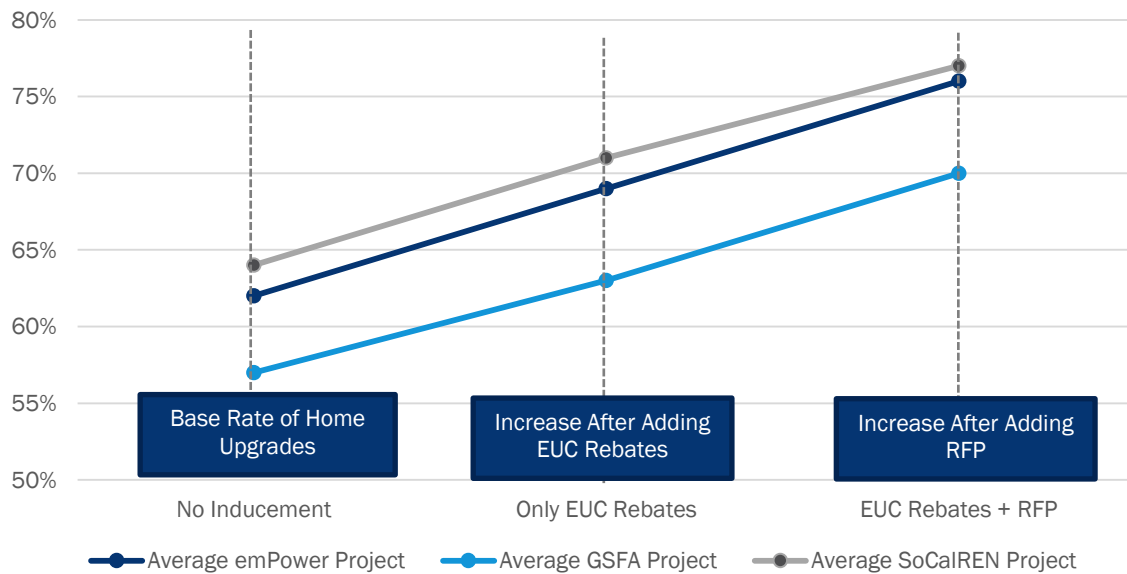


## 4.2.2    Influential Financing Factors

One of the advantages of the LCDC method is that it helps to identify what specific features or attributes customers prefer when faced with many trade-offs and options. In other words, it can help to determine the most important factors in a customer's decision to upgrade their home. As presented in Table 22, when faced with a full marketplace of options and features, the LCDC analysis revealed that payment method, the monthly payment amount, project cost and interest rate were the most important factors in a homeowner's decision to do a home upgrade project or not.

Table 22. Relative Importance of Features in Homeowner's Decision to do a Home Upgrade

| Attribute | Possible Values | Weighted %; Relative important of feature in decision to do a home upgrade (n=417) |
|---|---|---|
| Payment Method | Traditional Loan Payment, Mortgage Payment Add-On, Utility Bill Add-On, Property Tax Add-On, Cash, or Credit | 18% |
| Your Monthly Payment | $50, $200, $350, or $500 | 15% |
| Total Project Cost | $10,000, $20,000, $38,000, or $60,000 | 14% |
| Interest Rate | 0%, 4%, 10%, or 15% | 13% |
| Monthly Energy Bill Savings | $0, $20, or $40 | 8% |
| None | n/a | 7% |
| Rebate Amount | $0, $1,500, $3,000, or $6,000 | 6% |

| Attribute | Possible Values | Weighted %; Relative important of feature in decision to do a home upgrade (n=417) |
|---|---|---|
| Instant Qualification Possible Through Contractor | No or Yes | 5% |
| FICO Score Considered to Qualify | No or Yes | 5% |
| Loan Offered by Local Organization | No or Yes | 5% |
| Minimum Cash Down | $0, $2,500, or $5,000 | 5% |

Regarding what payment method enticed homeowners to do a home upgrade project, most preferred a direct loan payment over other financing options (see Figure 7). Most respondents (78%) preferred to use financing versus paying cash or credit card, likely because they did not have the necessary cash on-hand (or didn't want to use their savings), and loan interest rates are typically favorable compared to credit cards. These findings suggest that the RFPs, which offer term loans through an LLR, are a desirable program design for market-ready customers. However, these preference patterns differ by customer groups. This is explored in the next section.

**Figure 7. Payment Method Preferences for Doing a Home Upgrade (n=417)**
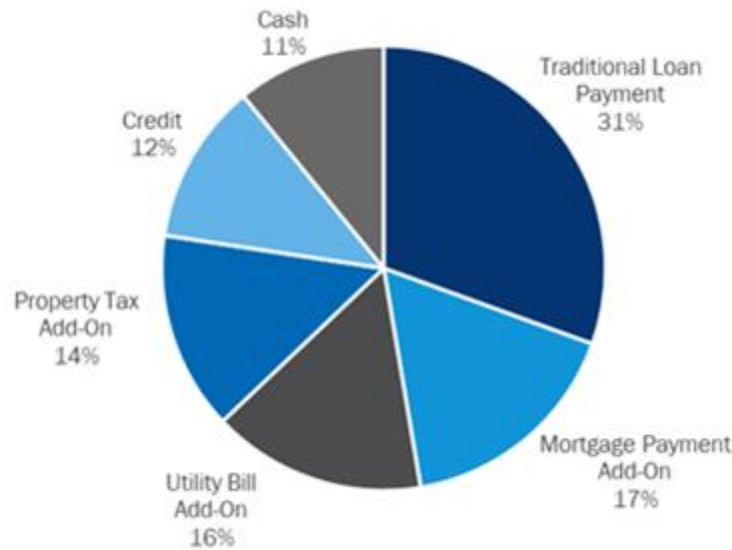


## 4.3 What customer segments do the RFPs impact?

The LCDC approach goes beyond the familiar discrete choice experiment in that it simultaneously creates segments based solely on choice patterns of respondents. i.e., different groups of customers can and often do reveal different choice priorities across the available product attributes. This feature has several advantages over standard discrete choice approaches. The most obvious one is that is allows us to see and study the different customer choice patterns. Another advantage is that a method that is able to model systematic variation beyond the overall patterns does a better job of explaining the variance in the sample. This section explores the former; we have, of course, benefitted from the latter, but that is less obvious.

The LCDC software provides multiple models to choose from, each with a different number of segments identified. We chose the model that identifies four segments as it was the one that was both fit the data well and had the most useful segments. Below, we describe the segments, along with short, descriptive names and the percent of the sample that they represent.

**Segment 1: Financially Savvy (37% of market ready customers):** These customers are not concerned about the cost of the upgrade project, and are sophisticated in thinking about financing. They are oriented to traditional loans or HELOCs, and sensitive to interest rates. Anything above 4% is unacceptable. They are not looking for convenience, and are middle-of-the-road on their level of motivation to do an upgrade.

**Segment 2: Motivated Savers (25%):** These homeowners are very motivated to do an upgrade, they care a lot about energy savings, and they only want to do smaller projects. They are not concerned about monthly payments or convenience.

**Segment 3: Unmotivated Convenience Seekers (25%):** These customers have to be convinced to do an upgrade. They want convenience, low monthly payments, and no cash down. They care about rebates, and are oriented to traditional loans. They likely have good credit because they prefer to have FICO scores considered in loan qualification.

**Segment 4: Financially Solid, Locally Oriented (13%):** This group is expecting to pay cash for an upgrade project, maybe with some credit card help. If they do go for a loan, they are fine with their FICO scores being considered. They care about the connection of the program to local sources. They want good rebates, but don't care about energy savings. They are not concerned with interest rates, or about the convenience of getting loans, possibly because they will be paying with cash.

We also explored which of these four segments were most influenced by the RFPs. Table 23 shows the change in the rate of deciding to do a home upgrade if the RFP is removed from the market, holding constant the rest of the market. In other words, if the rate of positive upgrade decisions is 42% with the RFP in the market, and is 27% without the RFP, the change in uptake rate, due to the RFP, would be 14 percentage points (pts.). There is one segment that is clearly most impacted by the program. For all three RFPs, the impact is more than twice as strong in the Unmotivated Convenience Seekers. In some cases, the difference is almost three times that in other segments. Other segments have higher home upgrade project uptake rates overall (not shown), but are less affected by the addition of the RFP to the market, which indicates that other segments are likely to contain more free riders.

**Table 23. Change in Home Upgrade Decision When RFP Added to Market, by Segment**

| Segment | emPower | GSFA | SoCalREN |
|---|---|---|---|
| Unmotivated Convenience Seekers | -14 pts. | -12 pts. | -13 pts. |
| Financially Solid, Locally Oriented | -5 pts. | -4 pts. | -4 pts. |
| Financially Savvy | -4 pts. | -5 pts. | -3 pts. |
| Motivated Savers | -4 pts. | -5 pts. | -3 pts. |

# 4.4    Self-Reported Influence Amongst RFP Participants

This section describes the self-reported influence of both the regional financing and the EUC rebate on the customer's decision to do a home upgrade project. This data reflects the experience, motivations and decision-making process amongst direct participants in the RFPs. These participants received both a loan from one of the RFPs and a rebate incentive through the EUC Program.

## What customer segments are participating in RFPs?

The participant survey included demographic and attitudinal questions that help characterize the RFP participants (n=76). We provide a summary of our findings below.

RFP participants tended to be higher-income households with good credit and substantial home equity. Most respondents (82%) had household income of 75,000 or more in 2016 (n=65, excluding 11 refusals), 92% reported having "good" or "excellent" credit (n=75), and the average home equity was about $211K (n=46). The participants were most often middle-aged (64% were between 40 to 69 years of age, n=70) and lived in households of four of fewer members (89%, n=72), suggesting that most participants were working families or early retirees. Their homes were most often moderately-sized (60% between 1,000 and 1,999 square feet) but tended to be older (80% of homes were at least 50 years old and 65% were 50 to 70 years old; n=75). This suggests that many participant's homes needed upgrades.
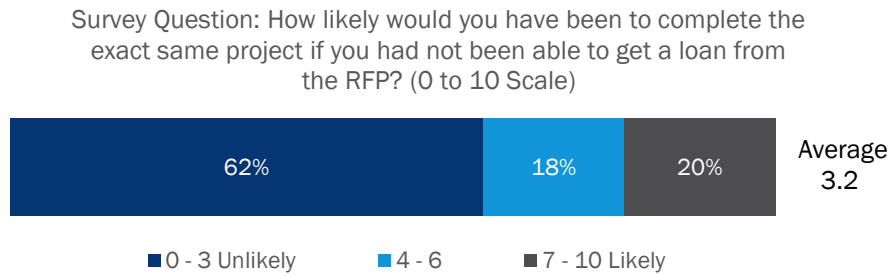
RFP participants appear to be highly interested in energy efficiency programs and products. The vast majority (92%) typically seek out the Energy Star label when shopping for appliances. They are primarily interested in energy efficiency programs for the bill savings (average score of 9.5 out of 10, where 10 is "very valuable"), but also see value in the environmental (i.e., climate change) and economic (i.e., reduced energy prices) benefits of energy efficiency programs, giving average value scores of 7.9 and 7.8 out of 10, respectively. Overall, respondents reported that they feel a personal responsibility to conserve energy, giving an average score of 8.6 out of 10, where 10 is "strongly agree" (n=73, three "did not know").

Participants also tended to be comparison shoppers. Respondents gave an average score of 9.6 out of 10 (where 10 is "strongly agree") when asked if they compare the prices of several brands before selecting a product (n=72, four "did not know"). This finding suggests that RFP participants likely inquired about or researched alternative financing options and ultimately chose the RFP. Considering that RFP participants tended to be higher-income households with good credit scores, it's likely that they would have qualified for other financing options. This suggests that they valued RFP above other options, which we discuss further in the sections below.

## Insights from Self-Report Data on RFP Influence

The self-report data indicates that the RFPs were extremely influential on many participants' decisions to complete the home upgrade project. We asked the 76 respondents to the survey who did receive regional financing for an EUC project a battery of questions to understand the influence of the financing on their decision to do an EUC project. Amongst the 76 respondents that did receive financing through one of the RFPs, the majority (62%) indicated that they would NOT have completed the home upgrade without the financing; 20% indicated that they would have done the project without the financing; and the remaining 18% were somewhere in the middle.

## Figure 8. Likelihood to Complete Same Project without the RFPs (n=76)

Survey Question: How likely would you have been to complete the
exact same project if you had not been able to get a loan from
the RFP? (0 to 10 Scale)

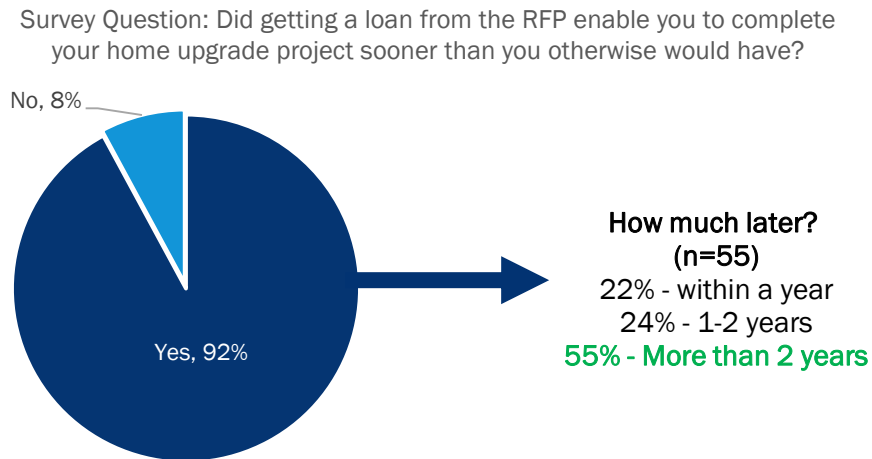| 62% | 18% | 20% | Average 3.2 |

■ 0 - 3 Unlikely  ■ 4 - 6  ■ 7 - 10 Likely

Exploring the influence of financing on the size of the project, we asked RFP participants more directly whether they would have completed the exact same project or some variation without the RFP loan. Only one in ten respondents (12%) indicated no influence of the loan and would have done the exact same project. One-quarter of participants (26%) would not have done the project at all and slightly more than half of participants (57%) indicated that they would have done a smaller project. This indicates that the RFP influenced one-quarter of participants to do a project and another 57% to do a larger project; suggesting that the RFP program had a significant influence on the both the incidence of homeowners doing a home upgrade project and on the depth of the projects.

## Table 24. Influence of RFP on Project Size (Amongst RFP Participants)

| Survey question: If you had not received a loan from the RFP, would you have done a smaller project (for example, doing less construction or fewer upgrades) or the same project? | Percentage (n=76) |
|---|---|
| Would not have done a project | 26% |
| Would have done a much smaller home upgrade project | 45% |
| Would have done a slightly smaller home upgrade project | 12% |
| Would have done the exact same project | 12% |
| Don't know | 5% |
| Total | 100% |

Exploring the influence of financing on project timing, self-report data from RFP participants revealed that the RFP enabled almost all (92%) of them to complete a home upgrade project sooner than they would have otherwise. Amongst them, 79% would have waited at least one year to do the project.

### Figure 9. Influence of Loan on Project Timing (n=76)

Survey Question: Did getting a loan from the RFP enable you to complete your home upgrade project sooner than you otherwise would have?

No, 8%

Yes, 92%

**How much later?**
**(n=55)**
22% - within a year
24% - 1-2 years
55% - More than 2 years

## Important Features of Regional Financing Programs

As discussed above, the RFP appeared to have a significant influence on the decision-making process of most homeowners to do a home upgrade project. The RFPs had multiple features that could have influenced the homeowner's decision to choose RFP financing over other options in the marketplace. Therefore, the survey was designed to help identify what RFP features were important to customers given that homeowners have multiple financing options available to them beyond the RFPs. There are several features of the RFPs that were more important than others. Notably, the top RFP features that were very important to customers were the interest rate, the connection of the loan program to a rebate program (which includes association with emPower Central Coast, GSFA and SoCalREN energy retrofit programs that all offered loans in conjunction with EUC Rebate Program Administrators), and the minimum cash amount required to close the loan. These features stood out to participants as the top reasons for why they chose to finance through the RFPs. Notably, the convenience aspect of the RFPs and the loan terms offered were also important features. The interest and loan terms produced affordable monthly payments for these homeowners and propelled their decision to upgrade their homes. Interestingly the connection of the RFPs to local banks and credit unions was not of great importance to participants.

### Table 25. Importance Ranking of Key Features Offered through RFPs (amongst RFP participants)

| Please rate the importance of each of these features in your decision to finance the project through the RFP: Where "0" is "not important at all" and "10" is "very important") | Average Score |
|---|---|
| The interest rate | 8.6 |
| The connection of the loan program to a rebate program | 8.5 |
| Minimum cash down required to close the loan | 8.5 |
| The convenience of the loan qualification process | 8.4 |
| The convenience of the loan application process | 8.3 |
| The loan term, in years | 8.2 |
| The relationship between your contractor and the loan program | 7.8 |
| What qualified you for the loan (e.g., credit score, financial history) | 7.4 |

| Please rate the importance of each of these features in your decision to finance the project through the RFP: Where "0" is "not important at all" and "10" is "very important") | Average Score |
|---|---|
| The requirement to install energy-related measures to qualify for the loan | 7.4 |
| The connection of the loan program to [BANK] | 5.0 |

The relationship between the contractor and the loan program received a fairly high rating of 7.8, and 44% of respondents rated this feature as 9 or 10 out of 10. That factor could represent at least two aspects of the financing. One is the convenience factor that is also endorsed specifically in other items. An additional possibility for the contractor connection to the loan program is that some participants valued the implicit endorsement of the contractor by trusted organizations like the RFP, the local utility, or lending institutions. A contractor associated with these organizations is highly unlikely to be an unreliable or fly-by-night operation. This could be part of the fairly high overall rating. This participant feeling is illustrated by some of the verbatim responses as well. An example of a level of trust based on the program connection is this customer comment:

> *Without the loan being tied into the emPower program I don't think we would have pursued the project. We would have likely done a much smaller portion of the project at a later time with cash.*

When asked to describe the influence of the loan in their decision to complete the project, in their own words, almost all participants described how important the RFP loan was to their ability to a project at all, to their ability to do as many upgrades as they did at one time, and/or to their ability to do the project at the time that they did. Speaking to the role of the RFPs in their ability to do a project at all, some respondents mentioned that they did not have the means to pay cash for the project and the regional financing had some attractive features over other financing options, such as the interest rate, manageable/affordable monthly payments, and the convenience associated with the regional financing products:

> *The loan was the most influential part of the decision process. Because the interest and other considerations made it possible.*

> *Being able to finance our project into very manageable monthly payments was a no-brainer. We certainly did not have the up-front capital to install solar, new electric water heater, and insulation, but wanted to green and improve the efficiency of our new home.*

> *This was during a time of payouts/furloughs and finances were tight, my credit had suffered due to high credit usage and I was beginning to emerge from those times. Absent this loan It would have been highly unlikely I would have been able to do the project.*

Speaking to the role of the RFPs on the timing and scope of the projects, many respondents mentioned that the RFPs allowed them to do more measures or a more efficient project.

*I did not have the $14,000 plus in savings to pay for the project. Without the loan, I would have been forced to do a band-aid fix of my A/C and keep the older, less efficient unit.*

*I was able to afford dual paned windows for my entire home plus added new insulation and ducting throughout the house and new HVAC and in-line water heater. Without the loan I would have likely only replaced the windows.*

Speaking to the role of the RFPs on the timing and scope of the projects, many respondents mentioned that the RFPs allowed them to do a larger project all at one time instead of piecemeal over a longer time period.

*Without the loan, we wouldn't have been able to do the whole project at once. Spreading out a project like new windows, sliders and heating would have taken years and been way more inconvenient and slowed down other home improvement projects that needed to be completed afterwards. All of our windows and heating system was about 40 years old and was one of the most "leaky" homes the contractor had ever seen.*

*With out the loan I would not have done the project to its entirety. It would have been broken into two different projects and different times. The loan helped me complete everything and more in one shot.*

While there are other financing options available, verbatim responses revealed that participants felt the RFPs had several advantages over other options including the lower interest rate, convenience and the ability to not tap into existing assets such as home equity or retirement accounts.

*The interest rate was lower than market, the loan did not utilize the equity in our home and increased the equity at the same time, and the contractor was able to complete the loan for the project. All these reasons convinced us to use the energy loan from the county. Thank you!*

*Having just recently purchased the house, we didn't have any significant equity built up yet. So home equity loans were not a possibility. Most unsecured home improvement loans have terrible interest rates. If it hadn't been for the emPower loan we probably would have had to wait a few years to build enough equity to borrow against the house. The emPower loan allowed us to move forward with the project immediately.*

*It allowed me to not have to pull my retirement assets, use credit cards at higher interest or have to refinance the home in order to replace my roof and air conditioner.*

## Relative Influence

While the LCDC results estimate the relative influence of EUC rebates and RFP financing on overall EUC project uptake amongst market-ready respondents, our self-report survey questions also provide insight into the relative influence of rebate and financing specifically for the RFP participants. Amongst survey respondents who completed home upgrades with RFP financing, almost half (48%) reported that the loan was more important than the rebate in their decision to complete a home upgrade, compared with only 12% who said the rebate was more important. Four in ten respondents rated the loan and rebate equally in their decision to do the project.

**Figure 10. Relative Importance of RFPs versus EUC Rebates (Amongst RFP Participants, n=75)**

Survey Question: Which of the following statements best describes the influence of the rebate and the loan on your decision to complete a home upgrade project?

| Loan was SIGNIFICANTLY MORE important than rebate | Loan was SOMEWHAT MORE important than rebate | Loan and rebate were equally important | Rebate was SOMEWHAT MORE important than loan | Rebate was SIGNIFICANTLY MORE important than loan |
|---|---|---|---|---|
| 25% | 23% | 40% | 9% | 3% |
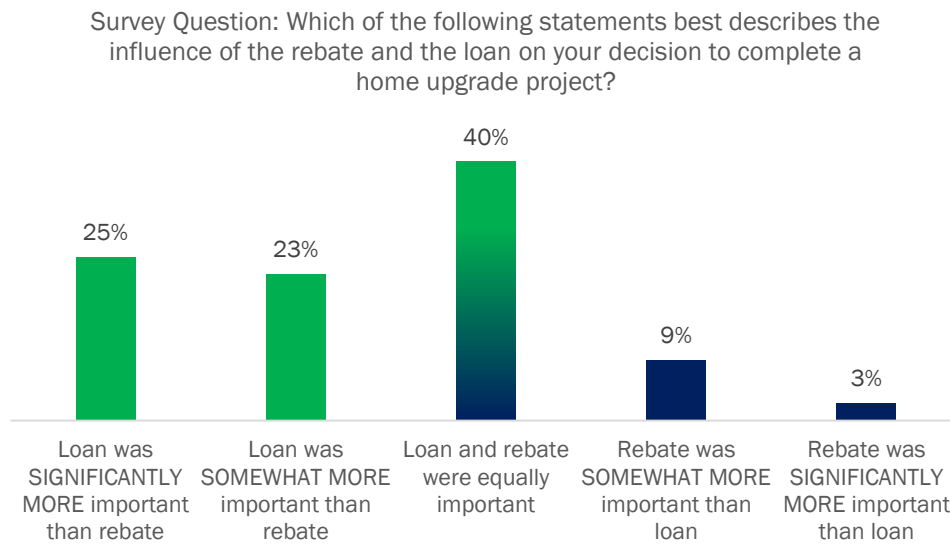
Note: Excludes one respondent who "did not know"

In verbatim responses describing the influence of the loan on the project decision, some respondents described the loan as a highly critical factor but acknowledged that the incentive was still a factor. One respondent described the loan as the catalyst for the project while acknowledging that the rebate played a role but to a lesser degree.

> *The loan was the catalyst that made the project happen, it was the most critical element, followed closely by the incentive of the rebate.*

Analysis by size shows no statistically significant differences by project size in how important the loan is relative to rebates. However, this is likely because there is little variance in project size amongst our RFP participants, as most completed larger projects. We would expect that financing becomes increasingly more important as project cost increases.

## Dual-Causality

While this study has focused on measuring the incremental impacts of adding each inducement, it is important to acknowledge that some participants may just need one inducement and are agnostic about which one they receive. We explored this concept of "dual-causality" using self-report survey results. In the same vein, 15% said they only needed the loan for their home upgrade, whereas only 4% said they only needed the rebate. Still, more than two thirds of respondents (69%) claimed they would not have been able to complete their project without both the rebate and loan. The option in this survey question that most directly addresses the issue of dual-causality is the "I needed either rebate or loan, but not both" response. This option was selected by only one person, implying very few customers who would classify themselves as agnostic as to which benefit they receive.

Table 26. Dual-Causality of Financing and Rebates (amongst RFP participants)

| Survey Question: Which of the following statements best describes the influence of the rebate and the loan on your decision to complete a home upgrade project? | Percentage (n=72) |
|---|---|
| Needed both rebate and loan | 69% |
| Needed loan, but not rebate | 15% |
| Needed neither rebate or loan | 10% |
| Needed rebate, but not loan | 4% |
| Needed either rebate or loan, but not both | 1% |
| **Total** | **100%** |

Note: Excludes four respondents who "did not know"

## 4.5    Financing Program Cost-Effectiveness

Cost-effectiveness analyses give program planners and policymakers a metric with which to evaluate the economic feasibility of a program. We assessed the RFP cost-effectiveness under three cost tests (PAC, TRC, and SCT), applying two frameworks (FPM and SPM).  We then analyzed the sensitivity of the results under three input levels (low, mid and high) to determine the relative impact of the cost-effectiveness test results to key program factors.

As discussed further in Section 4.6, the study could not match a sufficient number of emPower files with the EUC database to conduct a cost-effectiveness analysis for emPower. Thus, the cost-effectiveness analysis is limited to the GSFA and SoCalREN programs.

### 4.5.1    Cost-Effectiveness Results

We applied the SPM and the FPM model adaption to assess the cost-effectiveness of the combined Financing + Incentive programs cost-effectiveness, to the EUC incentive program alone.  While it was an objective to assess the cost-effectiveness of the Financing programs alone, as is the practice for resource programs, the RFP did not include any participants who received financing but did not also access the EUC program incentives.  Therefore, it was not feasible to assess the cost-effectiveness of the financing programs alone.

Using GFSA as an example, Figure 11 presents the principle cost-effectiveness components using the FPM and SPM frameworks where financing + incentives are considered.

Figure 11. GFSA Financing + Incentives Principle Components
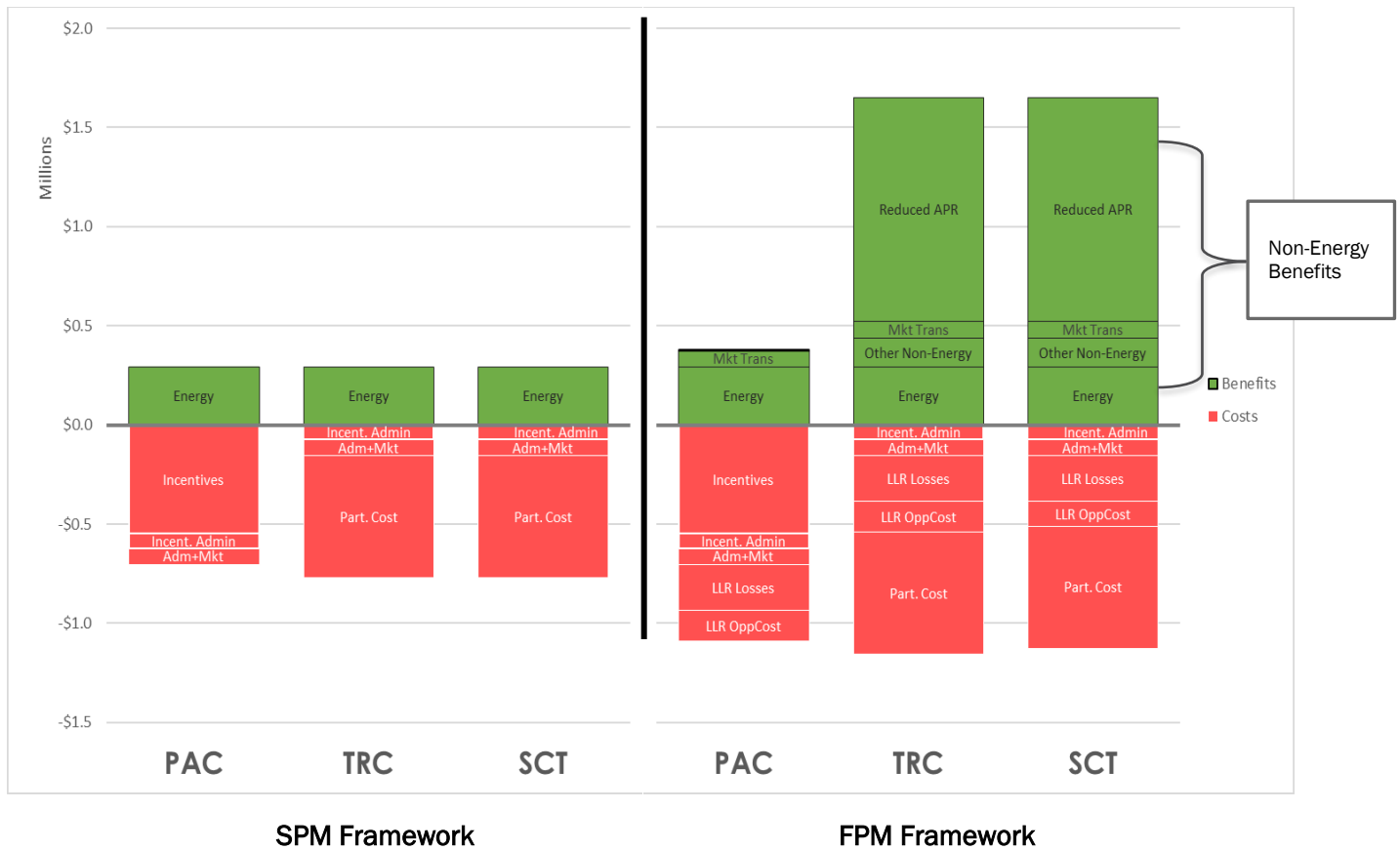
The results show distinct differences between the two, notably:

- **Using the FPM model**, the principle benefits are the non-energy benefits, specifically the Reduced APR (reduced borrowing costs). Energy makes up a much smaller proportion of the benefits. Overall, the benefits are heavily weighted towards the participant as the utility gains no benefit from non-energy benefits. The principle costs were the incentives and their administration fees for the PAC test and the participant costs for the TRC and SCT tests. *Recognizing that the non-energy (financial) benefits far outweigh the energy benefits under the TRC and SCT calls into question the appropriateness of using these tests to assess the program cost-effective within an energy efficiency program framework.*

- **Using the SPM framework**, the principle benefits under all cost-effectiveness tests was energy. Under the PAC test the principle costs were the incentives whereas the principle costs under the TRC and SCT was the participant cost. Note, these results apply to SoCalREN as well.

The tables below list the cost-effectiveness results of the two RFPs. Table 27 lists the mid-range results split by inducement, and cost test following the FPM Framework. The low and high scenario results are shown in parentheses underneath the mid-range result. Table 28 lists the same results following the SPM Framework. Cost effective perspectives are highlighted in green.

Table 27. Cost-Effectiveness Test Results (FPM Model)

| Cost Effectiveness | GFSA | | | SoCalREN | | |
|---|---|---|---|---|---|---|
| Program Evaluated | PAC | TRC | SCT | PAC | TRC | SCT |
| Incentives[26] | 0.13 | 0.17 | 0.20 | 0.12 | 0.21 | 0.24 |
| Financing + Incentives | 0.34 | **1.43** | **1.51** | 0.27 | **1.02** | **1.08** |

Table 28. Cost-Effectiveness Test Results (SPM Framework)

| Cost Effectiveness | GFSA | | | SoCalREN | | |
|---|---|---|---|---|---|---|
| Program Evaluated | PAC | TRC | SCT | PAC | TRC | SCT |
| Incentives | 0.13 | 0.12 | 0.13 | 0.12 | 0.14 | 0.16 |
| Financing + Incentives | 0.42 | 0.38 | 0.43 | 0.25 | 0.27 | 0.31 |

Based on these results the following conclusions are drawn:

- Using the FPM model, for both SoCalREN and GFSA the Financing + Incentives inducements under the TRC and SCT proved to be cost-effective. The FPM model considers a complete view of the financing programs by capturing additional costs and benefits associated with the LLR including direct losses, lost-opportunity cost of capital, leveraging affects, the relative influence of financing vs incentives, APR reduction, market transformation effects and other non-energy benefits.

- Under the TRC and SCT, Financing + Incentives inducements are more cost-effective than Incentives alone in all cases and under each framework.  This is largely due to the relative costs and benefits of the LLR feature, which reduces borrowing costs in a far greater amount than the lost opportunity costs associated with maintaining the reserve funds.

- The influence of financing on participant decision-making helped to further increase the cost-effectiveness of the Financing + Incentive combinations, as compared to incentives alone:  cost-effectiveness results align with the attribution results from the LCDC analysis, which showed the average RFP participant is much more dependent on the RFP financing than the average EUC participant is on the rebate. Moreover, the incremental project uptake identified earlier shows that RFP + EUC combined had a much greater effect on uptake than the stand-alone programs.

- The impact of financing on the PAC is much less pronounced than for the TRC and SCT:  The PAC does not account for the APR reduction, which is a benefit to the participant only, and therefore the increase in PAC test results when financing is added to the incentive program is much less than for the other tests that do capture the APR reduction benefits.  In all cases the programs were not considered cost-effective under the PAC test.

## 4.5.2    Key Components Analysis

The cost-effectiveness of a program is composed of individual cost and benefits components. This analysis identified the key components under the various scenarios and frameworks. Table 29 below gives a

---

[26] The CE of the EUC Incentives program was calculated using the program evaluated program costs and impacts for years 2013-2015 and the EUC NTGR obtained through the LCDC analysis.

description of the components of the financing and financing + incentives scenarios by cost or benefit.  The components with an asterisk are those that are considered in both the FPM model and SPM Frameworks.

### Table 29. Model Variable Reference

| Benefits | | Costs | |
|---|---|---|---|
| Component | Description | Component | Description |
| Energy* | Net Energy Benefits from EEEMs | Incentives* | Incentive Costs[27] |
| Mkt Trans | Net Benefits from market Transformation | Incent. Admin* | Incentive Program Administrative and Marketing Costs[28] |
| Reduced APR | Reduced APR Benefits | Adm+Mkt* | Financing Program Administrative and Marketing Costs |
| Leveraging Effects | Leveraging effect of LLR | Part. Cost* | Net Participant Cost |
| Non-Energy | Other Net Non-Energy benefits (including comfort, utility, and environmental externalities) | LLR Losses | LLR Default Losses |
| | | LLR OppCost | LLR Opportunity Costs (Cost for encumbered capital) |

As a case study, we analyzed the NPV of the principle components for the GFSA RFP under the FPM Framework. The results also apply to SoCalREN RFP as its cost and benefit structure is similar.  Sensitivity Analysis

We engaged in a sensitivity analysis for the inputs that contained uncertainty.  The High and Low Scenarios are the extremes, or the sums of *all* sensitivities going one way or another.

For the tests, we ran sensitivities on the following variables detailed in Table 30 below:

### Table 30. Variables for Sensitivity Analysis

| Variable Name | Description |
|---|---|
| Discount Rate | Applicable DR rate for PAC, TRC & SCT tests |
| Covered Losses | Year-1 LLR-Covered Losses. |
| EEEM NEBs | Value of NEBs for EEEMs as a % avoided costs. |
| EEEMs: Market Effects | Benefits of program on market. |
| APR % Benefit | Reduced consumer APR due to program. |

Figure 12 below summarizes the sensitivity analysis under the FPM Financing + Incentive scenario for each program. It reflects impacts of each sensitivity test as a % impact on overall B/C ratios. Each green bar reflects the impact of the "High" scenario of each variable alone, with all other things being equal, on total cost-effectiveness, while each red bar reflects the impact of the "Low" scenario for each such variable.

---

[27] Source: http://eestats.cpuc.ca.gov/Views/EEDataShelf.aspx

[28] Ibid.

## Figure 12. Impacts of Key Variables
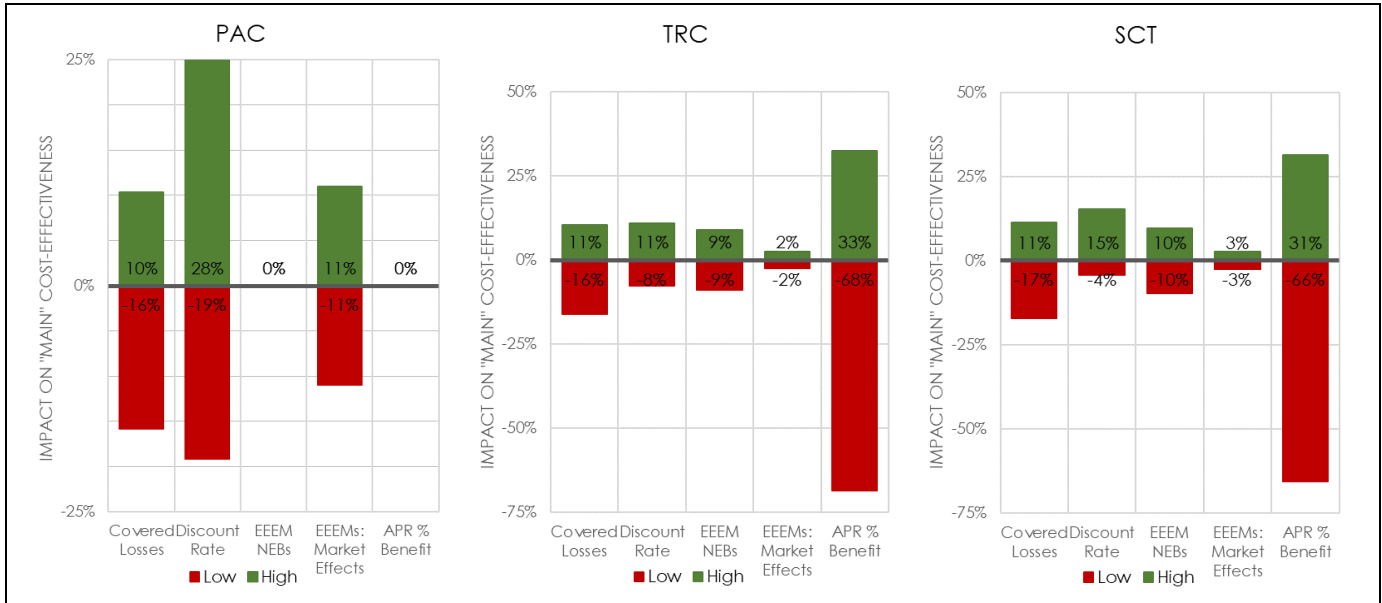


The results show various sensitivities of interest.

1.  The **PAC test** results are affected by three key variables:

    a.  **1ˢᵗ Year Covered Losses:** The first-year covered losses scenario had a significant effect on the model, as the initial set rate determines the baseline for the following years losses.  For the High scenario, the expected losses were halved compared to the mid scenario, which led to a cost-effectiveness increase of 10 percentage points; for the low scenario, the expected losses were doubled, which led to a decrease of 16 percentage points.

    b.  **Discount Rate**: The choice of discount rate has a significant impact on the model.  (See Appendix D for the rationale on the rates chosen.)  The High scenario, a decrease of 2.25 percentage points from the "Mid" scenario, increased cost-effectiveness by 28% while the low scenario, an increase of 2.25 percentage points lowered cost-effectiveness only by 19%.

    c.  **EEEMs: Market Effects:**  The extent to which the program generates market effects beyond its three-year timeframe has a significant impact as well under our sensitivity ranges. Increasing or decreasing annual REEL-generated impacts that recur and persist over the project period by 5%, augments or reduces PAC results by 11% in each direction.

2.  For the **TRC and SCT tests**, four variables affected results.

    a.  **APR % Benefit:**  The program's ability to deliver lower interest rates has a significant effect on the TRC/SCT results. The difference between lenders passing all savings to consumers, the high scenario, increases the cost-effectiveness of the model by 31 percentage points.  Passing on zero savings in the low scenario, an unlikely scenario given the lower than average APRs

through REEL (~6%) versus the average APR's for both secured and unsecured loans available in the market at the time[29], lowers cost effectiveness by more than 65 percentage points.

b. **EEEM NEBs:** This variable, tests the extent to which participants will benefit from the non-EEEM portion of their investment. Specifically, the low scenario assumes they receive zero value for their money and the high scenario assumes they value their investment (not including energy savings benefits) at 100% the level of debt they incur. These variables swing the TRC/SCT results by 9%/10%. Further research could help refine this sensitivity.

c. **1st Year Covered Losses:** Similar to the PAC test, the magnitude of first year covered losses effects were similar.

d. **Discount Rate:** Here again, the choice of discount rate has an impact on the model. (See Appendix D for the rationale on the rates chosen.) The High scenario, a decrease of 2.25 percentage points from the "Mid" scenario, increased cost-effectiveness by 11% and 15% for the TRC and SCT respectively, while the low scenario, an increase of 2.25 percentage points lowered cost-effectiveness only by 8% (TRC) and 4% (SCT).

## 4.5.3 Net-to-Gross Ratio Discussion

The NTG ratios affect energy benefits, non-energy benefits, market transformation benefits and net attributed investment costs (to the participant). As is shown in Table 20 earlier, the maximum combined Financing + Incentives NTG ratio for the programs was 50%. The EUC rebate program had quite low NTGRs, ranging from 9-13%. This was a primary factor for the EUC only program not being cost-effective under the PAC test.

To highlight the effect that NTGRs had on the model, for each non-cost-effective mid-range scenario, we calculated the NTG value that would be necessary to make the scenario cost-effective. This is presented in

Table 31 and Table 32 below. In some cases, the current NTGR are sufficient to render the programs cost-effective under certain tests and frameworks.

**Table 31. NTGR required for Cost-Effectiveness (FPM Model)**

| Cost Effectiveness | GFSA | | | SoCalREN | | |
|---|---|---|---|---|---|---|
| Program Evaluated | PAC | TRC | SCT | PAC | TRC | SCT |
| Incentives | .87 | .65 | .57 | .82 | .48 | .42 |
| Financing + Incentives | 1.19 | < Current NTGR | < Current NTGR | 1.47 | < Current NTGR | < Current NTGR |

**Table 32. NTGR Value Required for Cost-Effectiveness (SPM Framework)**

| Cost Effectiveness | GFSA | | | SoCalREN | | |
|---|---|---|---|---|---|---|
| Program Evaluated | PAC | TRC | SCT | PAC | TRC | SCT |
| Incentives | .87 | .98 | .85 | .82 | .71 | .63 |
| Financing + Incentives | .99 | 1.08 | .95 | 1.55 | 1.44 | 1.27 |

---

[29] A 2016 residential market baseline study by Opinion Dynamics Corporation and Dunsky Energy Consulting found that in general, the APR offered by credit unions ranges from 3.75% to 23% for small loans and 3.25% to 24.99% for large loan depending on the project size and FICO score. PY2014 Finance Residential Market Baseline Study (Volume II). March 2016. Calmac ID: CPU0131. Accessed at: https://pda.energydataweb.com/#/

There are a few important takeaways from this analysis:

- **For ~30% of the non-cost-effective scenarios to be cost-effective, the NTGR value would need to be approaching one or greater than one**.  For the SCT and TRC tests that are currently not cost-effective, the NTG values needs to be almost exclusively over 1.  While having a NTGR over one is unlikely, it does bring to light an important point.  For the SCT and TRC tests, as the NTG values goes up, the attributed energy savings go up.  However, in lockstep, the attributed costs to the consumer due to the program also goes up under the TRC and SCT test.  Therefore, the NTGR value has less effect on the cost-effectiveness in these tests than in the PAC test.

- **Under the PAC test, the utility benefits from the increased NTGR ratio.**  For a marginal (0.01% in the case of GFSA Financing using the FPM Model) to significant (almost double for Financing + Incentives using the SPM framework) increase in NTGR, the energy benefits attributed to the program rise, while the costs remain static.

## 4.5.4    Results Discussion

From our cost-effectiveness analysis, the RFPs were cost effective under certain frameworks and tests.  Under the FPM Framework the TRC and SCT for Financing and Financing + Incentives inducements were cost-effective.  (This is true in every case minus the Financing only TRC test for SoCALREN.) Under the SPM framework, GFSA was only cost-effective under the PAC test for Financing only.  This is due to the reported low program administration costs.

The following take-aways should be considered from these results.

- **Financing is a complementary tool alongside incentive programs:** Financing and incentives are most effective when combined in influencing homeowner's decisions to do a home upgrade. Coupling financing with incentives raises the overall NTGR results, because financing helps to overcome a significant barrier to undertaking whole home upgrades.  Moreover, financing programs offer participants broader benefits, through the APR reduction in particular. Together these factors greatly enhance the cost-effective of the financing + incentive combinations.

- **Under the FPM model adaptation, the financing programs (in combination with the incentive programs) pass the SCT and TRC cost-effectiveness tests.**  This is a result of the FPM capturing a range of costs and benefits that are not typically accounted for using the SPM.  These results illustrate how conventional application of the SPM, that may fail to account for the LLR benefits and costs, may underestimate the cost-effectiveness of the programs.

### Implications for Statewide Financing and Future Financing Programs

- **The FPM Model provides a robust interpretation of the SPM framework, which could be appropriate to accurately capture financing program cost-effectiveness in the future:** Failing to apply the FPM model to the SPM framework interpretation of financing costs and benefits leads to an underestimated cost-effectiveness result, under the tests applied here.  Our results suggest that interpreting the SPM Framework to include the FPM Model, would allow for a more comprehensive view of the program costs and benefits.

- **Data irregularities should be addressed to improve the accuracy of the cost-effectiveness results:** Solutions are needed to establish systems that can tie financing program participants to EUC upgrade

incentive recipients, through an anonymized ID marker. This should be standard in all financing programs to facilitate evaluations in the future.

- **The financing programs offer non-energy benefits that greatly outweigh the energy benefits, which calls into question the appropriateness of applying the TRC and SCT cost-effectiveness tests for these programs.** The financial benefits accrued by the participants, mostly as a result in an APR reduction, are the primary factor supporting the program cost-effectiveness under the TRC and SCT. This calls into question the appropriateness of the TRC and SCT as cost-effectiveness tests for financing programs from a resource program perspective.

## 4.6 Data Availability from Regional Finance Programs

One objective of this study was to assess data availability from the RFPs. Given that loan and personal finance information is often classified, we expected limited access to RFP participant information. Overall, we were able to obtain loan information (i.e. loan amounts, terms, and interest rates) for all participants, but we could not connect the loan data to personal and/or project information in some cases. Thus, where possible, we utilized the EUC tracking database to retrieve additional participant and project information, such as projected energy savings and contact information. Table 33 presents a summary of pertinent variables and the level of data availability for each. This inventory includes data from both the RFP loan database and 2013-2015 EUC tracking databases.

**Table 33. Data Inventory for Regional Finance Program Participants**

| Data Type | emPower (n=42) Availability | GSFA (n=201) Availability | SoCalREN (n=100) Availability |
|---|---|---|---|
| **Loan Information** | | | |
| Date loan funds released | Most or all (>90%) | Most or all (>90%) | Most or all (>90%) |
| Loan status | Most or all (>90%) | Most or all (>90%) | Most or all (>90%) |
| Loan amount | Most or all (>90%) | Most or all (>90%) | Most or all (>90%) |
| Interest rate | Most or all (>90%) | Most or all (>90%) | Most or all (>90%) |
| Loan term | Most or all (>90%) | Most or all (>90%) | Most or all (>90%) |
| **Participant Information** | | | |
| FICO score | Most or all (>90%) | Most or all (>90%) | Most or all (>90%) |
| Income | Most or all (>90%) | Most or all (>90%) | Data unavailable |
| Debt to income ratio | Most or all (>90%) | Data unavailable | Data unavailable |
| Name | Some (> 50%) | Some (> 50%) | Most or all (>90%) |
| Full Mailing Address | Most or all (>90%) | Most or all (>90%) | Most or all (>90%) |
| Contact e-mail | Few (< 50%) | Few (< 50%) | Few (< 50%) |
| Contact phone | Some (> 50%) | Some (> 50%) | Some (> 50%) |
| **EUC Project Information** | | | |
| Flag for Advanced vs. Home Upgrade project | Some (> 50%) | Most or all (>90%) | Most or all (>90%) |
| Predicted energy savings | Most or all (>90%) | Some (> 50%) | Most or all (>90%) |
| Installed measures | Most or all (>90%) | Data unavailable | Data unavailable |
| Rebate amount | Most or all (>90%) | Some (> 50%) | Most or all (>90%) |
| Housing characteristics | Some (> 50%) | Data unavailable | Data unavailable |
| Project Cost | Some (> 50%) | Some (> 50%) | Most or all (>90%) |

## 4.6.1    Data Limitations and Quality

As noted above, we did not have access to personal information such as email addresses and home addresses. However, this information is critical to fielding a program attribution survey. To resolve this issue, we attempted to match RFP participants to the EUC tracking database using project ID numbers to retrieve contact information through the more comprehensive dataset. We matched approximately half of the RFP participants to the broader EUC tracking database and obtained contact information for projects that had complete records. However, the inability to match all participants along with missing data in the EUC database resulted in missing contact information for a considerable number of participants. Table 34 presents the final number of emails and mailing addresses that we obtained for each program.

### Table 34. Participant Contact Information Counts by Program

| Program | Number of Program Participants | Number of E-mails | Number of Mailing Addresses |
|---|---|---|---|
| GSFA Residential Energy Retrofit Program | 201 | 32 | 201 |
| SoCalREN Home Energy Loan Program | 100 | 39 | 100 |
| emPower Central Coast | 42 | 4 | 40 |

We reviewed the 2013-2015 EUC database and could not verify the data quality, which limited our use of the dataset to procuring participant contact information. For example, we did not utilize project cost and rebate data to inform our survey design because ranges included unrealistically high values (i.e., project costs reaching nearly seven million and rebates reaching $300k, Table 35). As explained in detail in Appendix A, attributes presented in the survey shopping exercise were informed by in-depth interviews, the RFP database, EUC and financing program websites, and data from the U.S. Energy Information Administration (EIA) on average residential energy consumption.

### Table 35. Variable Ranges in the 2013-2015 EUC Tracking Database

| | First Year Gross Measure Cost | Gross Incentive | EUC Project Savings | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | First Year Gross kWh | First Year Ex-Post Net kWh | First Year Gross kW | First Year Ex-Post Net kW | First Year Gross Therms | First Year Ex-Post Net Therms |
| Minimum | 0 | 0 | -9,976.81 | -8,041.60 | -12.84 | -3.96 | -273.27 | -232.28 |
| Maximum | 6,965,723 | 300,350 | 223,164.90 | 26,978.15 | 269.20 | 97.58 | 16,188.20 | 6,123.18 |
| Average | 14,014 | 2,174 | 836.00 | 369.26 | 0.96 | 0.42 | 155.87 | 78.00 |

A final attempt was made to retrieve RFP participant data and EUC claims data directly from the utilities, and SCG and PG&E met the data requests. However, only a fraction of RFP participants was matched to the utility claims databases, resulting in only small updates to our data. Of note, we retrieved more email addresses and participant names, and the final counts are reported in Table 34 above. Upgrade measure information was lacking across all utilities. PG&E was able to match some RFP participants to their claims database and did return measure information for those matched, however, the measures reported seem incomplete. For example, some costly projects only have one or two measures listed, which do not match the price point of the project.

EUC file could not be found in the tracking database. In addition, the customer information received in the emPower tracking database was limited compared to the information received from the other two programs. As a result, only five RFP files could be matched with EUC files. The five files are not considered a representative sample; therefore, Dunsky could not conduct a cost effectiveness analysis on the emPower program.

Table 36 identifies the number of files in the RFP tracking database, files flagged as RFP participants in the EUC tracking databases and the proportion of files that could be matched. As shown below, the study could not match a sufficient number of emPower files with the EUC database to conduct a cost-effectiveness analysis for emPower.

### Table 36. RFP and EUC Matched Files

| Program Tracking Database | emPower | GSFA | SoCalREN |
|---|---|---|---|
| Number of RFP files | 42 | 201 | 100 |
| Number of EUC files flagged as loans | 23 | 115 | 74 |
| % RFP files in the EUC tracking database | 55% | 57% | 74% |
| RFP files matched with EUC files | 5 | 117 | 73 |
| % Matched | 12% | 58% | 73% |

From the files that were matched for GFSA and SoCalREN, Dunsky calculated the average first year gross measure costs, incentive costs, quantity of measures, and first-year gross ex-ante savings. The results are in Table 40 below.

### Table 37. Average RFP Program Metrics for Matched Files

| Files | GSFA | SoCalREN |
|---|---|---|
| Files Matched | 117 | 73 |
| Average First Year Gross Measure Cost | $25,223 | $14,997 |
| Average Gross Incentive | $2,732 | $2,513 |
| Average Quantity of Measures | 3.26 | 1.48 |
| Average Gross kWh Savings | 973 | 935 |
| Average First Year Gross kW Savings | 1.26 | 1.11 |
| Average First Year Gross Therms Savings | 230 | 226 |
| Average Ex-Ante MMBtu | 26.3 | 25.8 |

Dunsky extended the average metrics calculated for the matched files to the remaining participants in the RFP tracking database (files that could not be matched) to estimate the total program metrics. The total estimated program metrics are provided in Table 38.

### Table 38. RFP Estimated Population Metrics

| Results | GFSA | SoCalREN |
|---|---|---|
| Total Files | 201 | 100 |
| Estimated First Year Gross Measure Cost | $5,069,742 | $1,499,722 |
| Estimated Gross Incentive Cost | $549,181 | $251,272 |
| Estimated Total Quantity of Measures | 656 | 148 |

| Results | GFSA | SoCalREN |
|---|---|---|
| Estimated Total First Year Gross kWh Savings | 195,611 | 93,488 |
| Estimated Total First Year Gross kW Savings | 253 | 111 |
| Estimated Total First Year Gross Therms Savings | 46,150 | 22,621 |
| Estimated Total First Year Ex-Ante MMBtu Savings | 5,282 | 2,581 |
| Average Loan APR | 6.50% | 5.93% |
| Average Loan Term | 15.00 | 9.86 |
| Full Program Loan Amount (Tracking Sheets) | $5,148,031 | $1,808,728 |
| Average Loan Amount (Tracking Sheets) | $25,612 | $18,087 |

## EUC Incentive Program Cost-Effectiveness Analysis

Dunsky calculated the cost-effectiveness of the EUC Incentive only program using the EUC evaluated results for program years 2013-2015 found on the California Energy Efficiency Statistics website.[30]to compare the cost-effectiveness results of the Financing only inducement, Financing plus EUC Incentives and EUC Incentives only.

## Summary of Data Limitations

There are various conclusions to highlight from these limitations.

- **emPower was not included in the analysis due to the limited number of files that could be matched.** Due to the multitude of inputs specific to emPower, it would be a stretch to infer anything of its cost-effectiveness by using the results from the other two RFPs.

- **The EUC tracking database captured all the ex-ante savings, however most files were missing ex-post savings.** Ex-post savings is preferred because it captures the evaluated savings of a measure. Because the ex-post savings could not be confirmed, Dunsky performed the cost effectiveness analysis using ex-ante savings. This is a limitation to the accuracy of the results that can be rectified if and when a full set of ex-poste savings is made available.

- **In the case of both programs, the total loan amount in the tracking database is somewhat higher than the estimated first year measure costs.** SoCalREN, is particularly high, where the total loan amount in the tracking database is approximately 20% higher than the estimated first year measure cost. While we do not believe that this biases the results, it could reflect the non-EEEMs that were required to support the installation of EEEMs (for example, patching drywall after insulation was installed).

- **To help inform and benchmark the model, we used average default rates across the two programs.** While we were provided with the total number of defaulted loans to date, the loan values associated with charge-offs to date was not provided. Moreover, defaults were reported only for the GFSA program. To determine annual average charge-off rates for both programs, we applied the average loan amount to the number of defaults, and took the ratio of this to the combined total loan pool from both programs. This assumes that the programs carry equivalent credit risk rates over the long term.

---

[30] http://eestats.cpuc.ca.gov/Views/EEDataShelf.aspx

## Recommendations

There are various recommendations to be made to reduce the limitations encountered in the study.

- **For each participant, creating a unique identifier.** This would guarantee privacy and facilitate any matching process between the different data sets. With the unique ID, other potentially sensitive information can be removed, like participant name, address and zip code.

- **Identify and address the discrepancy between the files in the RFP tracking database and the EUC tracking database.** It is not clear the source of this discrepancy, although it could be human error or a lag time issue. However, this evaluation is for the period 2013-2015, in which case we would expect all data on RFP files to be in the EUC tracking database. Adding in other metadata such as such as data entry timestamps or unique IDs across programs can minimize such issues. Establishing internal control processes, including a requirement for regular data checks may also help to identify and address data discrepancies early on.

- **Merge data so that the participant level is the basic data point.** A single file in the EUC tracking database is presented multiple times if there are electric and gas savings. While this is important to track separately, a single file on each participant would facilitate evaluation while still allowing information for electric and gas savings to be tracked separately.

- **Re-assess the cost-effectiveness of the RFPs using ex-post data.** Once the impact evaluation is completed for the 2013-2015 period, and the programs have evaluated ex-post savings, there may be value in re-assessing the cost-effectiveness of the RFPs. This may provide more accuracy than using ex-ante data.

# 5.   Conclusions and Recommendations for Future Research

In this chapter, we first summarize and compare the LCDC and self-report attribution findings. Following that, we discuss lessons learned about the pros and cons of LCDC versus self-report. Last, we provide recommendations for future finance program attribution research.

## 5.1    Conclusions on RFP and EUC Rebate Influence

Table 39 compares the key conclusions drawn from the LCDC and self-report analyses. While the findings are similar on many levels, it is important to note that these two methods explore attribution from different perspectives. The LCDC explores rebate and financing influence amongst market-ready homeowners; which includes a mix of homeowners who were interested in doing a home upgrade project and either did not do the project, did the project without incentives, did the project with EUC incentives alone, or did the project with both EUC incentives and Regional Financing. The LCDC gathers data from this larger pool of market-ready homeowners and explores the hypothetical decisions they would make under different scenarios. Meanwhile, the self-report analysis focuses solely on homeowners who recently received both Regional Financing and EUC incentives to do a home upgrade and the questions asked of them regarding the influence of these incentives on their decision-making process. As such, the LCDC results indicate that RFP loans and rebates have low to moderate influence on market-ready homeowners' decision to do a home upgrade; the influence is greater on larger projects; and the two incentive types have small influence on home upgrade adoption in the market overall, though the RFP loans have a slightly higher influence relative to rebates. The self-report analysis shows that RFP participants were highly influenced by both incentives, though financing was much more influential in many cases. The LCDC results support this finding in that the NTGR for RFP financing combined with EUC rebates was much higher than the NTGR for the EUC rebates alone.

**Table 39. Summary of Findings from LCDC and Self-Report Analyses**

| Topic | LCDC | Self-Report |
|---|---|---|
| RFP and EUC Rebate Influence on Home Upgrade Projects | ▪ The **base project uptake rate** (without EUC rebates or the RFPs) is about 55% to 65% for the average RFP project (~$20K), depending on region (Figure 6). This base rate decreases as project size increases (Table 21) but generally reflects a market where a plethora of financing options are already available to market-ready homeowners. | ▪ Self-report data suggests that the RFP financing was **very important to RFP participants;** 62% of RFP participants say they were unlikely to have done the EUC project at all without the RFP; 20% indicated they would have done it without the RFP; 12% were somewhere in-between (Figure 8).<br><br>▪ Over half (57%) say the RFP allowed them to do **a larger project** and 92% say the RFP allowed them to **do the project sooner**; most would have taken 2 years or more |

| Topic | LCDC | Self-Report |
|-------|------|-------------|
| | ■ The **combined influence** of RFPs and EUC rebates can induce 28% of the market-ready homeowners to do a deep energy retrofit costing around $10K when they otherwise wouldn't; and up to 50% of that market when the cost increases to the $40K range. (Table 20)<br><br>■ The **combined influence** of financing and rebate incentives have a direct relationship to project cost; the larger the project cost, the more influential financing and rebates are (Table 20, Table 21).<br><br>■ Payment method (term loan), monthly payment amount, total project cost and interest rate are **the primary influencing factors** in homeowners' decisions to do home upgrades and use financing (Figure 7). These factors combined translate into a monthly payment and if that monthly payment is considered affordable to the market-ready homeowner, then they are likely to upgrade their home.<br><br>■ We identified **four segments** that have different sets of preferences compared to each other. Some are more motivated than others; some are more oriented to overall cost, and others to monthly payments; some to interest rates, and some to convenience; some care about saving the environment, and some not. One of these segments, **Unmotivated Convenience Seekers**, is much more influenced by the RFP compared to other segments.  (Section 4.3). | to the project (Table 24, Figure 9). Verbatim responses also give the impression that the loans were critical to the size and timing of the projects.<br><br>■ Participants rated several features of the RFPs as almost equally important. The results were similar to the LCDC findings (e.g. attributes that determine monthly payment), but also capture the importance of **convenience**, **local endorsement, cash down, and the relationship between contractor and loan program** (Table 25)**.**<br><br>■ RFP participants tended to be **financially sound** (higher income, good credit, high home equity). They tended to be **middle-aged or in early retirement** and have **positive attitudes towards energy efficiency** (Section 4.4). |

| Topic | LCDC | Self-Report |
|-------|------|-------------|
| What is the relative impact of the RFPs versus rebates on EUC project <u>energy savings</u>? | ■ The influence of financing **relative** to rebates has a direct relationship to project cost (and, thus, savings), with financing having increasing influence over rebates as the project cost increases. The **EUC rebate incentive is half as important** as the financing incentive for projects in the $10K level and the rebate influence is even smaller, one-third, when project costs are in the $40K range (Table 20). | ■ Over half (57%) say the RFP allowed them to do **a larger project than they otherwise would have** (if only EUC rebates were available) (Table 24). This suggests that the RFP were highly influential on project savings, though rebates still influenced the overall decision to do a project |
| What is the relative impact of the RFPs versus rebates on EUC <u>customer participation</u>? | ■ Both inducements result in **small incremental increases** to overall market uptake of EUC projects, suggesting that EUC rebates and the RFPs have a limited influence on overall project uptake. However, the **RFPs have a slightly higher influence** relative to rebates.  This relationship is consistent across project sizes (Table 21).<br><br>■ However, our planning NTGR analysis shows that the RFP loans were **much more influential** than EUC rebates amongst RFP participants specifically (Table 20). | ■ **The loan was equally or more important than the rebate** in the decision to do an upgrade. Almost half (48%) of participants say the loan was more important than the rebate; but 40% say they were equally important (Figure 10)<br><br>■ Only one responded said they would have needed EITHER the rebate or the loan to do an upgrade, but not both, suggesting that **dual-causality is rare** (Table 26). |

## 5.2    Conclusions on Financing Attribution Methods

Table 40 lists the pros and cons of the self-report and LCDC attribution methods, many of which were known before this study began. In summary, the self-report approach is more appropriate for creating holistic NTGRs that can be applied to program ex-post gross savings. Compared to LCDC, self-report is less expensive to implement and analyze and requires fewer respondents. Further, the self-report questions are direct and simple for customers to answer. They can account for a wide range of financial and non-financial aspects of the programs. On the other hand, the LCDC is a powerful tool for financing program design, policy making, and marketers *before* a program is implemented, or where program design changes are being planned. Compared to self-report, it does a better job of showing what is most important about financing, who the key customer segments are, and what other financing options customers would seek (if any) absent the program. In this sense, it allows program planners to build a financing product tailored to attract the lowest number of free riders. However, the LCDC NTGR represents a "floor" for the NTGR in that it does not include spillover, partial free ridership (e.g., effects of on project timing), or non-financial factors such as the program marketing or salesmanship of the contractor. For these reasons, the LCDC NTGR in isolation is not appropriate to estimate ex-ante or ex-post NTGRs. Rather, it requires enhancements through self-report.

### Table 40. Comparison of Attribution Methods

| Advantages | Disadvantages |
|---|---|
| **Self-Report** | |
| 1. Direct & simple<br>2. Established & understood<br>3. NTGRs can be weighted by project size<br>4. Accounts for program influence beyond financial incentives<br>5. Cost<br>6. Requires fewer respondents | 1. Biases from social desirability & to favor program<br>2. Hypothetical bias (i.e., what would have happened without the program)<br>3. Does not show what was important or what would happen if the program changed<br>4. Does not show what features customers trade off against others. Several attributes have virtually the same mean rating, and the effect of one cannot be separated out from the others. |
| **LCDC or Other Stated-Preference Discrete Choice Approaches** | |
| 1. Cleanly separates influence of two or more programs or features<br>2. Can be used prior to program rollout or before design changes<br>3. Great flexibility in study of program features<br>4. Shows what features & bundles of features most appealing<br>5. Reveals segments w/different preference patterns (LCDC only)<br>6. Shows elasticities & importance of each program feature<br>7. Shows where free riders are likely to be (i.e., which revealed segments, LCDC only)<br>8. Shows what customers will choose when all options are made clear at the time of decision, without the influence of the sales person/contractor. | 1. Excludes influence of marketing/contractor sales pitch<br>2. Does not capture partial free ridership factors, such as project timing influence.<br>3. Requires about 300 respondents<br>4. Hypothetical bias and the potential for model misspecification (can be identified or minimized by various standard statistical methods)<br>5. Weighting a NTGR by savings associated with individual upgrades is less straightforward than with self-report.<br>6. Shows what customers will choose when all options are made clear at the time of decision, without the influence of the sales person/contractor; this likely does not reflect the actual situation customers face |

Through the course of this study, we also learned several key lessons about LCDC specific to assessing financing program attribution:

- It is essential to represent the convenience factor and other non-financial attributes of the loan program exercise in a way that is understandable and visible to everyone. In our survey, the convenience factor (and other factors such as local representation) were placed at the bottom of an extensive list of attributes. There have been LCDC surveys in the past with larger numbers of attributes, but the complexity of financing decision-making can make it difficult to consider a large number of attributes at once, especially when taking surveys on small screens (e.g., mobile devices) has become more common. The purpose of LCDC is to understand which attributes the respondents focus on, but attributes at the bottom of the list might be overlooked. Randomization is often used to avoid this type of issue, but this study did not randomize in favor of a consistent attribute order to reduce respondent confusion and survey time.

- The method is not well-suited to account for differences in the timing of upgrade projects. The self-report and verbatim responses detected a big influence of RFP on project timing that the LCDC method did not. If a stated-preference DC method is used in the future, provision should be made to generate an adjustment factor to the NTGR to account for timing issues.

- The LCDC cannot account for the persuasive ability of the contractor or the effectiveness of other marketing efforts, or that customers may only consider the financing options that contractors present to them. Thus, the LCDC shopping exercise approach, which assumes a customer knows all their options, may not reflect reality in the case of large home upgrade projects and their financing options.

- LCDC cannot account for spillover if administered only once. Multiple administrations or a follow-up, non-LCDC method, could account for spillover in the future.

## 5.3 Recommendations for Future Research

LCDC produces a great deal of information beyond NTGRs that can be very useful to program planners and marketers. We strongly recommend taking advantage of the rich dataset already available and pursuing these areas, especially the segmentation analysis.

- **Segmentation analysis:** One area that could not be pursued within the scope of this study is the full definition and description of customers segments that pertain specifically to home upgrade decisions. This study focused on the impact of the RFPs combined with EUC, but the data collected already could support additional analysis. For instance, what are the characteristics of homeowners and their homes that accompany their reasons to do an energy-related home upgrade or not? What segments are the most promising for the RFP or the EUC or both? Which subgroups focus on what aspects of the upgrade and the program(s) in their decisions? Which segments are most likely to help the program optimize net program impacts rather than gross? Further analyses of the existing dataset can provide rich answers to those questions and more. Thus, we would recommend further segmentation analyses.

- **Diffusion Curves:** Another area of further data analysis is the production of innovation diffusion curves. The simulator that is based on the current dataset and the predictive model, which identifies four segments that are related to the upgrade decision, can produce a Bass Diffusion Curve overall, or by segment. Also, for varying program design and conditions, additional curves can be produced.

- **Simulations:** Another useful analysis would be to explore the impact of possible changes in program design on home upgrade uptake. For instance, what would be the effect of decreasing or increasing

interest rates by 1 point? Or, what would be the effect of requiring larger projects? Answering these types of questions could be useful for future program planning.

# Appendix A.   Detailed Shopping Exercise Design Methods

To develop the shopping exercise, we sought out information on three key aspects of home upgrade projects: how the projects are paid for, the size and scope of completed projects, and participant preferences for financing options. These data inputs to the shopping exercise were collected through in-depth interviews with RFP participants and contractors, database reviews, and reviews of various EUC home upgrade programs.

## Primary Data Collection

In keeping with Task 2a of our evaluation plan, we interviewed five contractors and seven customers who completed EUC projects through the RFPs. The objectives of the interviews were to understand (a) what financing options were available to RFP participants, (b) the process participants went through to select financing, and (c) the most important factors that customers consider when choosing financing. Table 41 below summarizes interview completes by Regional Finance Program.

### Table 41. In-Depth Interview Responses

| RFP | Population with Contact Information* | Completed Interviews |
|---|---|---|
| **Contractor Interviews** | | |
| Golden State Financing Authority | 15 | 3 |
| Southern California Regional Energy Network | 14 | 2 |
| emPower Central Coast Program | 3 | 0 |
| **Customer Interviews** | | |
| Golden State Financing Authority | 32 | 3 |
| Southern California Regional Energy Network | 39 | 3 |
| emPower Central Coast Program | 4 | 1 |

*Represents available contact information at the time of data collection. Since then, we have collected additional contacts for customers.

## Secondary Data Collection

In addition to conducting interviews, we reviewed several secondary data sources to collect additional information on EUC project characteristics and financing options available for completing home upgrade projects. Secondary data sources included the following:

1. Regional Finance Program tracking data, which we used to determine the range of home upgrade project costs;

2. Evaluation results from the 2010-2011 EUC program[31], which we used to determine the range of energy savings achieved by EUC programs;

3. Data from the U.S. Energy Information Administration (EIA) on average residential energy consumption and billing rates in PG&E territory[32]; and

---

[31] Specifically, we reviewed results of the "Saver Analysis" in the 2010-11 PG&E Whole House Program Evaluation (Opinion Dynamics, 2014).

[32] https://www.eia.gov/electricity/sales_revenue_price/. Table 6.

4. EUC program and financing program websites, which we used to verify and research program attributes and rebate amounts

Notably, while we also reviewed the 2013-2015 EUC tracking databases, noted several data limitations. For instance, portions of the data were missing, we could not link many RFP participants to their respective EUC projects, and other concerns about the quality and reliability of the data (for example, extraordinarily high measure costs and rebate amounts and some potential multifamily properties included in the data).

## Inputs to the Shopping Exercise

### Finance Product Characteristics

Through our research, we identified nine applicable financing products/programs that are available to Californians who are considering financing a home upgrade project (Table 42). Based on these findings, we determined the types of financing to include and the lower and upper bounds of the interest rates in the shopping exercise. Loans varied in terms of whether they require a minimum FICO score, thus we added a "FICO score considered to qualify" binary (Yes/No) attribute to the design. Further, some loans also have significant upfront costs (such as origination and application fees), thus we included a "minimum cash down" attribute to the design.

**Table 42. Financing Products Available for Completing Home Upgrade Projects in California**

| Product Type | Program | Interest Rate | Financing Term | Origination Fee/Program Administration Fee | Qualification Requirements (i.e., FICO, credit history, delinquency) |
|---|---|---|---|---|---|
| HELOCs* | Varies by mortgage institution | 4.00 - 5.10% | 10 years | 1% of credit allowance plus variable fees and closing costs | Must have home equity |
| On-Bill Financing | PG&E On-Bill Financing | Zero interest | 5 years | None | Must be current with utility bill for past year |
| PACE | YGreneWorks | 5.99 - 7.75% | 5 - 20 years | $700 | Based on property value, must have 10% equity in home |
| | Home Energy Renovation Opportunity (HERO) | 6.75 - 8.35% | 5 - 20 years | 4.99% of principle | Based on property value, must have 10% equity in home |
| | CaliforniaFIRST | 6.75 - 8.39% | 5 - 25 years | $\leq$ 6.4% of principle | Based on property value, must have 10% equity in home |
| Term Loans | emPower | 3.90 - 12.50% | 5 - 15 years | None | 590 FICO minimum |
| | SoCalRen | 4.99 - 6.99% | 5 - 15 years | None | 660 FICO minimum |
| | GSFA | 6.50% | 15 years | None | 640 FICO minimum |
| | SMUD Residential Loan Program | 6.99 - 10.75% | 10 - 15 years | $100 | Credit check |

*The features of HELOC loans were determined from three banks that operate in California: Matadors Community Credit Union, Bank of the West, and California Bank & Trust.

## Participant Processes and Preferences

We asked contractors and participants about the decision processes for choosing to complete a home upgrade project with financing. Six out of seven participants reported that they *needed* to make home upgrades because of the condition of their home, a lack of home comfort, or high energy bills. For example, several participants noted that they had older homes that lacked proper insulation, while one participant noted that her household electric utility bill ranged from $500 to $600 per month during the summer. Based on this finding, we designed the shopping exercise to assume that the respondent *needs* to complete a home upgrade.

Further, we asked contractors and customers what attributes of financing products were most important to customers (Table 43). Based on this data, we included several additional attributes of financing options in the design. Specifically, we determined that, while interest rate is important, monthly payment amount may ultimately be what drives some customers' choices. Loan term was relatively unimportant to respondents and was, thus, excluded from the shopping exercise. Further, "ease of program participation" was also important to several customers, suggesting that the contractor's ability to rapidly approve financing is important to include in the design. Finally, association with a trusted utility or local lender was important to some respondents and we included a binary "loan offered by local organization" attribute in the design.

### Table 43. Financing Attributes Most Important to Participants

| Mentioned by Contractors (n=5) | Mentioned by Participants (n=7) |
|---|---|
| • Interest rate (n=5) | • Interest rate (n=4) |
| • Credit qualifications (n=2) | • Monthly payment (n=3) |
| • Program fees (n=1) | • Ease of program participation (n=3) |
| • Grace period before payments (n=1) | • Giving business to a small, local bank (n=2) |
| • Monthly payment (n=1) | • Association with a trusted utility (n=2) |
| • Ease of program participation (n=1) | • Loan term (n=1) |

Note: Respondents were allowed multiple responses

Notably, at the request of the CPUC, we added one additional attribute that represents the finance non-energy upgrades up to a certain proportion of the project cost. This attribute is of particular interest since it is a key component of Residential Energy Efficiency Loan (REEL) pilot.

## EUC Project Characteristics

We also collected data from several relevant databases to inform the whole home retrofit project attributes and levels presented in the shopping exercise. Specifically, we used the data in Table 44 to inform the upper and lower bounds of project costs and rebates. Further, while there were some data quality concerns, we reviewed cost and rebate distributions in the EUC tracking data to verify the reasonableness of the ranges. Further, we used 2010-11 PG&E Whole Building Program evaluation results to get a sense of potential savings from whole building retrofits. We compared savings percentages with data on the average PG&E residential electric bills to determine the appropriate monthly energy bill savings levels. Notably, while the data we reviewed showed that it is certainly possible that home upgrades can result in negative savings (i.e., from adding additional load), it is unlikely that contractors would propose projects with negative savings. For instance, we know that Advanced Home Upgrade projects require at least 10% modeled savings for approval. Thus, because our design should accurately reflect the information available when the customer chooses the project, we do not include negative savings in our design.

Table 44. EUC Project Characteristics Summary

| Metric | Data Source | | | Range | Average | Median | Number of Records Reviewed (n) |
|---|---|---|---|---|---|---|---|
| | RFP Data | 2010-11 PG&E Evaluation Results | EUC Program Websites | | | | |
| Cost of EUC Projects ($) | ✓ | ✗ | ✗ | $11K - $55K | $25K | $33K | 42 |
| Rebates for EUC Projects ($) | ✗ | ✗ | ✓ | $1K - $5.5K | N/A | $3K | N/A |
| Electric Savings (%) | ✗ | ✓ | ✗ | -94% - +62% | 1.8% | 33% | 912 |

*Detailed Shopping Exercise Design Methods*

## Final Design

Based the findings above, our final shopping exercise design includes the attributes and levels shown in Table 45. Each attribute has between two and six levels that will be randomized across options. Following the table, we describe the key methodological considerations for the design and present an example of the shopping exercise that would be presented in the survey.

### Table 45. List of Shopping Exercise Attributes and Levels

| Attribute | Payment Method | Rebate Amount | Interest Rate | Your Monthly Payment | Min. Cash Down | Total Project Cost | Monthly Energy Bill Savings | Instant Qualification Possible Through Contractor | FICO Score Considered to Qualify | Loan Offered by Local Organization |
|---|---|---|---|---|---|---|---|---|---|---|
| Level One | Trad. Monthly Payment | $0 | 0% | $50 | $0 | $10,000 | $0 | Yes | Yes | Yes |
| Level Two | Mortgage Add-on | $1,500 | 4% | $200 | $2,500 | $20,000 | $20 | No | No | No |
| Level Three | Utility Bill Add-on | $3,000 | 10% | $350 | $5,000 | $38,000 | $40 | | | |
| Level Four | Property Tax Add-on | $6,000 | 15% | $500 | | $60,000 | | | | |
| Level Five | Cash | | | | | | | | | |
| Level Six | Personal Credit Card | | | | | | | | | |

Note: This table does not show the attribute combinations that will be presented in the "contractor offers."

Below are the key methodological considerations that inform the design.

**Attribute Ranges:** A key concern of LCDC design and analysis is ensuring that the results are applicable to the population of interest. In addition, the range of attribute levels should be wide enough to produce strong coefficients[33]. As such, it is preferable for the range of attribute values to go beyond the bounds of what respondents would likely encounter in the real world. For this study, we selected attributes values that were just beyond the border of the minimum and maximum values we found through our research to balance the need to generate robust estimates of customer preferences with the realism of the exercise.

**Randomization of Attributes:** One of the necessary elements of the LCDC is that values must be allowed to vary in a balanced and orthogonal manner, even if the resulting combinations do not exist in reality. Introducing limitations to ensure more realistic combos unfortunately jeopardizes the efficiency of the design. Thus, some combinations (e.g. a property tax add-on with 0% interest in Table 46 below) will seem unrealistic. This compromise between realism and efficiency (see "Efficiency" below) makes it especially important to ask the respondent to treat each offer like it comes from a real contractor (see more in "Setting the Stage" below).

**Exclusion of Loan Duration:** While it is critical that the attribute levels be allowed to randomize, this potentially creates situations where, if the respondent were to calculate it, the monthly payment would not align with the loan amount, loan duration, and interest rate. To avoid confusion, it was necessary to eliminate one of these attributes. As discussed earlier, we chose to exclude loan duration from the exercise because we found that it was relatively unimportant to customers decisions about financing.

**Efficiency:** Another consideration is the efficiency of the LCDC design. In the context of LCDC, efficiency is an indicator of the balance and orthogonality[34] of the attributes that ranges from 0 to 100. Having values that are correlated with each other reduces the effectiveness of the design because it reduces our ability to distinguish the influence of different characteristics on customer preferences. The efficiency of our final design was 100 (maximum efficiency).

**Number of "Contractor Offers":** Given the number of attributes and levels of interest to this study, if we were to use a full factorial design (i.e., one that includes every possible combination of attributes and levels) it would require hundreds of "contractor offers". However, because we want to reduce respondent burden and decrease the likelihood of survey drop-off, we chose to use a partial-factorial design that produced 12 unique "contractor offers". Based on previous research conducted by Opinion Dynamics and discussions with LCDC experts, this number is ideal: (a) because it will allow respondents to become sufficiently familiar with the shopping exercise (research shows that a "warm-up" period is often helpful with these types of designs before respondents' underlying preferences will become apparent); and (b) It is low enough that respondent burden should not be excessive, which should minimize survey drop-off rates during this section of the survey. If, during pilot testing of the survey, we notice a pattern wherein there are high levels of drop off during this section, we will consider dropping the number of "contractor offers" to ten.

**Realistic Opt-Outs:** Including realistic alternatives to the whole home retrofit is critical to understanding whether a customer would actually pick a whole home retrofit at all, regardless of rebates or financing. Thus, we will provide respondents with the option to select "I would do none of these projects".

---

[33]The incremental change in the dependent variable based on a change in an independent variable.

[34]Balance refers to the extent to which the design equally represents all attributes in the various "contractor offers"; orthogonality refers to the correlation amongst attributes.

**Setting the Stage:** Before respondents begin the exercise, it is important to set the stage appropriately to encourage thoughtful decision-making and increase the accuracy of results. We will begin the shopping exercise by describing the hypothetical context of the decision and providing detailed instructions:

Next, we will ask you to complete a virtual "shopping exercise." Imagine that your home needs upgrading to improve its comfort and energy efficiency. A contractor offers you several project options with different benefits, costs, and ways to pay for them. We will ask you to choose between six home upgrade options on each screen. You will also have the option of choosing "none of these," if you would not select any of the options shown. Please consider all the information we show you to make your decision. Although this exercise does not involve any actual purchases, please try to *imagine* you are using real money.

If you hover the cursor over each option, it will give you an idea of the kinds of upgrades that could be accomplished at that price point. The options are just examples, so please don't reject an option based on one item that you don't need.

When making your selections, please follow these instructions:

■ Some options may not seem realistic. Please assume that the upgrades proposed by the contractor are appropriate to your home.

■ Do not "comparison shop" **between screens**. Try to "start over" on each screen and make selections only based on the project options presented on that screen.

■ If you don't see an attractive option, simply select the "I would not do any of these projects" option.

Finally, remember, there are no right or wrong answers.

An example of one of the shopping exercises is provided in Table 46

### Table 46. Shopping Exercise Example

| Attribute | Option #1 | Option #2 | Option #3 | Option #4 | Option #5 | Option #6 | Option #7 |
|---|---|---|---|---|---|---|---|
| **The Project** | | | | | | | |
| **Total Project Cost** | $60,000 | $10,000 | $20,000 | $38,000 | $10,000 | $60,000 | |
| **Rebate Amount** | $0 Rebate | $6,000 Rebate | $0 Rebate | $3,000 Rebate | $3,000 Rebate | $6,000 Rebate | |
| **Monthly Energy Bill Savings** | $40 Savings | $40 Savings | $20 Savings | $0 Savings | $20 Savings | $0 Savings | |
| **How You Pay for the Project** | | | | | | | |
| **Payment Method** | Mortgage Payment Add-on | Utility Bill Add-on | Property Tax Add-on | Traditional Loan Payment | Cash | Personal Credit Card | I would not do any of these projects |
| **Minimum Cash Down** | $5,000 Down Payment | $0 Down Payment | $2,500 Down Payment | $5,000 Down Payment | n/a | n/a | |
| **Interest Rate** | 10% Interest | 4% Interest | 0% Interest | 15% Interest | n/a | Your personal credit card's interest rate | |
| **Your Monthly Payment** | $50 | $500 | $350 | $200 | n/a | n/a | |

| Attribute | Option #1 | Option #2 | Option #3 | Option #4 | Option #5 | Option #6 | Option #7 |
|---|---|---|---|---|---|---|---|
| **Additional Details** | | | | | | | |
| Instant Qualification Possible Through Contractor | No | Yes | Yes | No | n/a | n/a | |
| FICO Score Considered to Qualify | Yes | No | Yes | No | n/a | n/a | |
| Loan Offered by Local Organization | Yes | No | No | Yes | n/a | n/a | |
| Which would you choose? | ❑ | ❑ | ❑ | ❑ | ❑ | ❑ | ❑ |

Notably, respondents may not have been familiar with some of the terms used in the exercise. Further, respondents may have been unsure what they would be purchasing at each price point. To address this potential issue, we created "hover-over" definitions of the terms and prices (i.e., the definitions appear when the respondent touches the term with their mouse). The definitions we used are included in Table 47 below.

### Table 47. Shopping Exercise Definitions

| Project Price Points | Example Measures |
|---|---|
| $10,000 | Replace or add:<br>-Central AC<br>-Central heat<br>-Whole house fans |
| $20,000 | Replace or add:<br>-Central AC<br>-Central heat<br>-Whole house fans<br>-Air sealing<br>-Duct sealing<br>-Duct insulation<br>-Water heater |
| $38,000 | Replace or add:<br>-Central AC<br>-Central heat<br>-Whole house fans<br>-Air sealing<br>-Duct sealing<br>-Duct insulation<br>-Water heater<br>-Efficient lighting and electrical upgrades<br>-Insulation-wall, floor, or ceiling |

| Project Price Points | Example Measures |
|---|---|
| $60,000 | Replace or add:<br>-Central AC<br>-Central heat<br>-Whole house fans<br>-Air sealing<br>-Duct sealing<br>-Duct insulation<br>-Water heater<br>-Efficient lighting and<br>  electrical upgrades<br>-Insulation-wall, floor,<br>  or ceiling<br>-New roof<br>-New double-pane<br>  windows |
| **The Project** | |
| Total Project Cost | The total cost of the project you will finance |
| Rebate Amount | A rebate is a partial refund you would receive after the project is complete. |
| Monthly Energy Bill Savings | The savings on your energy bill that your contractor estimates you will gain after the project is complete |
| Percentage of Project Cost That Must Be Related to Energy Use | Some loans require that a certain amount of the project cost be related to saving energy. For example, some loans may have limits on how much of the cost they cover for installing a deck or improving a driveway. |
| **How You Pay for the Project** | |
| Payment Method | The method used to pay for the project. |
| Minimum Cash Down | The amount of money that must be paid at the start of the project, before any construction is done. |
| Interest Rate | Annual percentage of the outstanding loan that will be charged as interest. |
| Your Monthly Payment | The total monthly payment for the project, including the principal and interest on the loan. |
| **Additional Details** | |
| Instant Qualification Possible Through Contractor | Rather than contacting the lender yourself, your contractor can instantly determine whether you qualify for the loan. |
| FICO Score Considered to Qualify | A FICO score is a credit score. Some lenders use credit scores to help determine if a borrower is eligible for a loan. |
| Loan Offered by Local Organization | The loan is offered by a local organization like a credit union, your city or county, or your energy utility. |

# Appendix B.    LCDC Analysis Technical Discussion

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

A major task of the project was to generate LCDC models of the probabilities that market-ready homeowners will choose to upgrade their homes with and without the RFPs. This methodology combines the strengths of latent-class analysis and discrete-choice estimation in a single analytical framework. The discrete-choice component helps inform the relationship between independent variables such as project cost, loan types, interest rates, and respondent characteristics such as gender and credit worthiness. The latent-class component tested for the existence of separate customer groups who respond to these variables in distinct ways.

## Statistical Theory

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

To estimate customer uptake groups, we employed an LCDC methodology developed by Jay Magidson and Jeroen Vermunt (2003). For notation, $i$ represents one respondent amongst the total number of respondents $I$. We presented each subject $i$ with $S$ choice sets consisting of $K$ alternatives, where $k$ is a particular alternative in choice set $s$. Each alternative $k$ is described by a set of attributes $A$, where $a$ is a single attribute. Let $y_{is}$ represent the choice respondent $i$ makes amongst the $K$ alternatives in choice set $s$. More generally, let vectors $\mathbf{y}_i$, $\mathbf{z}_{iatt}$ and $\mathbf{z}_{icov}$ refer respectively to all responses, attributes and covariates for individual $i$. In this sense, attributes are characteristics of alternatives presented to respondents, and covariates are characteristics of the subjects themselves.[35] Within this context, $z_{iasatt}$ represents the attributes of a single alternative $k$ evaluated by subject $i$ in choice set $s$, and $z_{icov}$ represents the set of $R$ covariates describing subject $i$. We also estimate the probability that each respondent falls into a latent class $x$, where $x$ is an integer value $1 \leq x \leq C$, where $C$ is the total number of latent classes.

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

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

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

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

---

[35] In this analysis we did not incorporate covariates into the model. We leave covariates in the description of the modeling process for the reader to understand their place in the process. Further work could be done to incorporate them, but they were left out of this first analysis of the data since full descriptions of how covariates are related to the identified segments was not the focus of this effort.

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

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

$$P\left(y_{is} = k \mid x, z_{is}^{att}\right) = \frac{e^{V_{k \mid x, z_{is}}}}{\sum_{k'=1}^{K} e^{V_{k' \mid x, z_{is}}}}$$

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

$$V_{k \mid z_{is}} = \sum_{a=1}^{A} \beta_a^{att} z_{iask}^{att} + \varepsilon$$

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

The probability density associated with the LCDC model is:

$$P(y_i \mid z_i) = \sum_{x=1}^{C} P(x) \prod_{k=1}^{K} P(y_{is} \mid x, z_{is}^{att})$$

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

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

## Estimation

Latent-class models assume that a sample or population consists of discrete segments, each of which is characterized by a separate logit model relating upgrade uptake to a set of independent variables, and within each of which the IID assumption[36] holds. Not only are these models less restrictive than aggregate logit, they also can reveal insights into marketing strategy that aggregate models miss. In essence, they assume that individual tastes are homogeneous within classes but heterogeneous between classes.

Latent-class choice models describe relationships between a number of elements such as program attributes, covariates that describe individual respondents, and segment membership. For each segment, a logit model relating upgrade and financing attributes to uptake decision is estimated, while simultaneously calculating at the individual level probabilities of membership in each segment. When using covariate values (they were not in our selected model) separate logit models are estimated concurrently to predict membership in each segment. This entire process is repeated for different segment counts, assuming that the total number of

---

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

segments is 1, 2, 3 … n, and the "best" model is chosen based on the calculated Bayesian Information Criterion (BIC) for each iteration. Significance tests are applied to each parameter, as are Wald tests for equality of parameters across all segments.

## Model Statistics and Selection

The LCDC output shows model characteristics and customer preferences overall and by segment simultaneously. Thus, we present the necessary statistics for choosing the best model and the segment statistics together in this section. We start with model selection, then go on to a description how we defined and described the segments.

Table 48 shows the diagnostics we used to select the best model for our purposes. Figure 13 reflects the BIC values in Table 48 for each model. The most general rule of thumb that modelers use to select a final model is the one with the smallest BIC. But other factors can be used as well, and we found that to be necessary in this case. The lowest BIC is associated with the 6-class model, and the next lowest is for the 5-class model. We ultimately settled on the 4-class model for several reasons. First, it is very close to the 5- and 6-class models in all diagnostics, and better than them in the classification errors observed. But most important is the fact that the models with more classes were less usable than the selected model. It is often true that when segments (classes) are added, they are different from other classes by very small amounts on one variable, and these differences are not important for understanding the segments, and they just increase the complexity of the picture unnecessarily. Such was the case here, so we settled on the 4-class model.

### Table 48. Key Diagnostics for the LCDC Model

| | LL | BIC(LL) | Npar | $L^2$ | df | p-value | Class.Err. | $R^2(0)$ | $R^2$ |
|---|---|---|---|---|---|---|---|---|---|
| 1-Class Choice | -8389 | 17159 | 63 | 12106 | 354 | 2.8e-2284 | 0.0689 | 0.1385 | 0.1463 |
| 2-Class Choice | -8254 | 17010 | 83 | 11836 | 334 | 8.2e-2243 | 0.0845 | 0.166 | 0.1753 |
| 3-Class Choice | -8180 | 17006 | 107 | 11688 | 310 | 2.9e-2230 | 0.0793 | 0.1855 | 0.1956 |
| **4-Class Choice** | **-8114** | **16977** | **124** | **11556** | **293** | **9.6e-2216** | **0.0851** | **0.1959** | **0.2072** |
| 5-Class Choice | -8063 | 17000 | 145 | 11453 | 272 | 7.0e-2211 | 0.096 | 0.2114 | 0.2233 |
| 6-Class Choice | -8010 | 16992 | 161 | 11348 | 256 | 8.9e-2202 | 0.095 | 0.2173 | 0.2296 |

Figure 13. Relationship of BIC to Models with Different Numbers of Classes
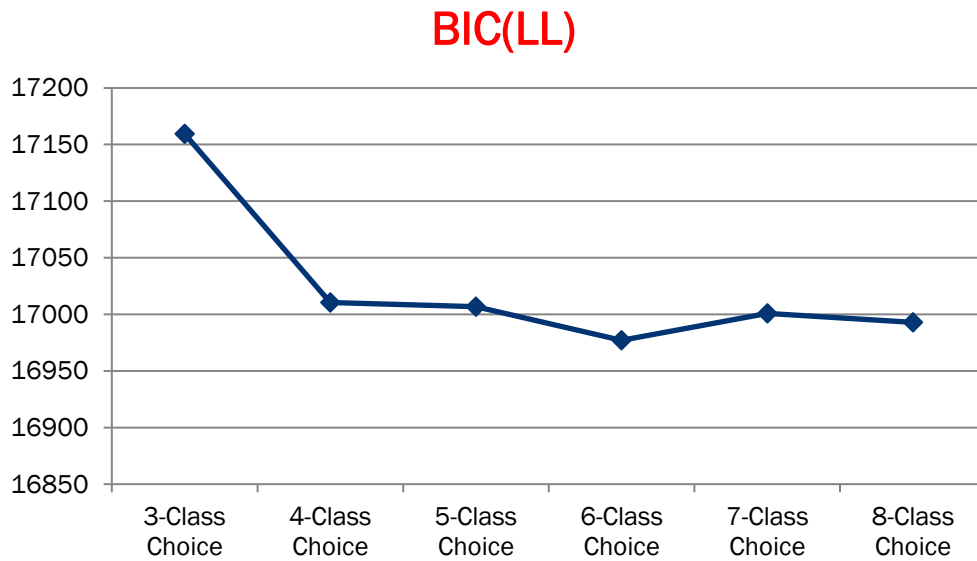


## Simulation Inputs

As reported in Section 3.1.4, after model selection, we created a simulator based on the 4-class model to represent the model's prediction of uptake rates under various conditions. The logic and process of running simulations on the 4-class model are described in the body of this report. Here, in Table 49, we show the values we assigned to each attribute for each option, using the emPower program as an example. Note that the project cost is the same for all options, though of course the shopping exercise portrayed multiple, realistic options. The $20,809 value is the mean cost over all actual emPower participants' projects. We kept this value, and other program values (rebate amount, and monthly energy bill savings, consistent across all options in order to isolate the impact of the presence or absence of the rebates and the regional program. Other values were allowed to vary appropriately for each option. The values shown in this table represent realistic attribute levels for each option type.

Table 49. Example of Market Simulator Inputs (Average Cost Includes emPower RFP & EUC Rebate Participants)

| Attribute | Option 1 | Option 2 | Option 3 | Option 4 | Option 5 | Option 6 | Option 7 |
|---|---|---|---|---|---|---|---|
| Payment Method | emPower | Traditional Loan | Mortgage Payment Add-On | Utility Bill Add-On | Property Tax Add-On | Cash | Credit |
| Total Project Cost | $20,809 | $20,809 | $20,809 | $20,809 | $20,809 | $20,809 | $20,809 |
| Rebate Amount | $2,669 | $2,669 | $2,669 | $2,669 | $2,669 | $2,669 | $2,669 |
| Monthly Energy Bill Savings | $13 | $13 | $13 | $13 | $13 | $13 | $13 |
| Payment Method | Traditional Loan Payment | Traditional Loan Payment | Mortgage Payment Add-On | Utility Bill Add-On | Property Tax Add-On | Cash | Credit |
| Minimum Cash Down | $0 | $100 | $150 | $0 | $869 | $18,140 | $0 |
| Interest Rate | 5.85% | 8.87% | 4.55% | 0.00% | 7.33% | 0.00% | 15.00% |
| Your Monthly Payment | $157 | $188 | $190 | $302 | $173 | $0 | $261 |
| Instant Qualification Possible Through Contractor | No | No | No | No | No | No | No |
| FICO Score Considered to Qualify | Yes | Yes | Yes | Yes | No | No | Yes |
| Loan Offered by Local Organization | Yes | No | No | No | No | No | No |

## Analyzing the Segments

Segment descriptions come from a careful analysis of the unique characteristics of each segment, and that information can come from several sources of the LCDC output. Because we have not incorporated covariates into the model, our description is limited to one of the three major tables of data available to judge and describe segments. The Profile table is the basis for our segment descriptions, and is depicted in Table 50. Table 50 displays a special kind of choice probability that varies only with respect to the attribute concerned. These values are calculated as follows. If $a$ is a level of attribute $p$, where $A_p$ is the total number of levels, and $U$ is the utility associated with level $a$ for latent class $x$, then the isolated choice probabilities for attribute $p$ are

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

For every attribute, taking "Expected Monthly Savings" in Table 50 as an example, the vertical probabilities associated with the levels $a$ of attribute $p$ within class $x$ sum to 1. In those cases where the attribute takes on numeric values rather than discrete categories, the mean of the probabilities for that attribute is also displayed.

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

We see, for example, that the conditional probability for a respondent in class 2 to do an upgrade is 68%, and the conditional probability of doing an upgrade if the savings is $40 per month is about 61%. These are major factors in why this was branded the "Motivated Savers" segment. Conversely, respondents in Class 3 ("Unmotivated Convenience Seekers") show an 11% conditional probability of doing an upgrade, and 19% of doing so if the savings were $40 per month.

The Profile table is also easily represented by charts, which allow a more visual experience of the numbers. We reproduce them as Figure 14.

## Table 50. Segment Profile Table

| Profile | Financially Savvy | Motivated Savers | Unmotivated Convenience Seekers | Financially Solid, Locally Oriented | | |
|---|---|---|---|---|---|---|
| | Class1 | Class2 | Class3 | Class4 | High | |
| | | | | | Low | |
| | | | | | Above avg. | |
| Class Size | 37.3% | 25.3% | 24.8% | 12.6% | | |
| *Attributes* | | | | | | |
| **FinType** | Type of Financing | | | | | |
| Traditional Loan | 0.3245 | 0.3188 | 0.3538 | 0.1259 | | |
| Mortgage Add-On | 0.277 | 0.1482 | 0.0964 | 0.0265 | | |
| Utility Bill Add-On | 0.1893 | 0.114 | 0.1931 | 0.0685 | | |
| Property Tax Add-On | 0.1556 | 0.1107 | 0.2211 | 0.0293 | | |
| Cash | 0.025 | 0.1164 | 0.0825 | 0.3932 | | |
| Credit Card | 0.0285 | 0.1919 | 0.0532 | 0.3567 | | |
| **Rebate** | Rebate Level | | | | | |
| 0 | 0.2421 | 0.1208 | 0.1393 | 0.1588 | | |
| 1500 | 0.2465 | 0.1697 | 0.1848 | 0.1991 | | |
| 3000 | 0.251 | 0.2385 | 0.245 | 0.2496 | | |
| 6000 | 0.2604 | 0.471 | 0.4309 | 0.3925 | | |
| Mean | 2685.0343 | 3796.2768 | 3597.7044 | 3402.7605 | | |
| **Interest** | Interest Rate | | | | | |
| NA | 0.3769 | 0.4124 | 0.2689 | 0.3093 | | |
| 0.04 | 0.2719 | 0.2789 | 0.2355 | 0.2519 | | |
| 0.1 | 0.1667 | 0.1551 | 0.1931 | 0.185 | | |
| 0.15 | 0.1108 | 0.0952 | 0.1637 | 0.1431 | | |
| 0.2 | 0.0737 | 0.0584 | 0.1387 | 0.1107 | | |
| Mean | 0.0589 | 0.0526 | 0.081 | 0.0722 | | |
| **Monthly** | Monthly Payment | | | | | |
| NA | 0.3499 | 0.2413 | 0.4626 | 0.4046 | | |
| 50 | 0.2961 | 0.2305 | 0.3371 | 0.32 | | |
| 200 | 0.1794 | 0.2008 | 0.1304 | 0.1583 | | |
| 350 | 0.1087 | 0.1749 | 0.0504 | 0.0783 | | |
| 500 | 0.0659 | 0.1524 | 0.0195 | 0.0388 | | |
| Mean | 121.6876 | 189.1291 | 70.3381 | 94.4681 | | |
| **Contrctr** | Convenience of Loan Thru Contractor | | | | | |
| NA | 0.2375 | 0.2985 | 0.1481 | 0.2 | | |
| Yes | 0.3782 | 0.3257 | 0.3525 | 0.4108 | | |
| No | 0.3843 | 0.3758 | 0.4994 | 0.3892 | | |
| **FICO** | FICO Score Used | | | | | |
| NA | 0.251 | 0.2725 | 0.312 | 0.3062 | | |
| Yes | 0.4092 | 0.323 | 0.4868 | 0.4308 | | |
| No | 0.3398 | 0.4045 | 0.2012 | 0.2631 | | |
| **Utility** | Local Sponsorship | | | | | |
| NA | 0.2432 | 0.431 | 0.2858 | 0.363 | | |
| Yes | 0.4101 | 0.308 | 0.4474 | 0.4304 | | |
| No | 0.3467 | 0.261 | 0.2669 | 0.2066 | | |
| **Cost** | Cost of Upgrade | | | | | |
| 10000 | 0.3109 | 0.5925 | 0.4958 | 0.4039 | | |
| 20000 | 0.279 | 0.2998 | 0.3146 | 0.3068 | | |
| 38000 | 0.2294 | 0.088 | 0.1387 | 0.1871 | | |
| 60000 | 0.1807 | 0.0197 | 0.051 | 0.1022 | | |
| Mean | 28247.0794 | 16445.9232 | 19578.6107 | 23417.8981 | | |
| **CashDown** | Required Cash Down | | | | | |
| 0 | 0.4486 | 0.3333 | 0.4763 | 0.468 | | |
| 2500 | 0.3213 | 0.3333 | 0.3152 | 0.3171 | | |
| 5000 | 0.2301 | 0.3333 | 0.2086 | 0.2149 | | |
| Mean | 1953.779 | 2500 | 1830.6816 | 1867.0741 | | |
| **Esavings** | Expected Monthly Bill Savings | | | | | |
| 0 | 0.2248 | 0.1202 | 0.1926 | 0.2588 | | |
| 20 | 0.3199 | 0.2706 | 0.3096 | 0.3273 | | |
| 40 | 0.4553 | 0.6092 | 0.4978 | 0.4139 | | |
| Mean | 24.6112 | 29.7806 | 26.1038 | 23.101 | | |
| **None** | Upgrade Inclination | | | | | |
| Upgrade | 0.6048 | 0.6823 | 0.1146 | 0.4392 | | |
| Don't Upgrade | 0.3952 | 0.3177 | 0.8854 | 0.5608 | | |
| Mean | 0.3952 | 0.3177 | 0.8854 | 0.5608 | | |

Figure 14. Relationships Between Attributes and Segments

Convenience of Loan Thru Contractor



FICO Score Used



Local Sponsorship



Cost of Upgrade

## Required Cash Down



## Expected Monthly Bill Savings



## Upgrade Inclination
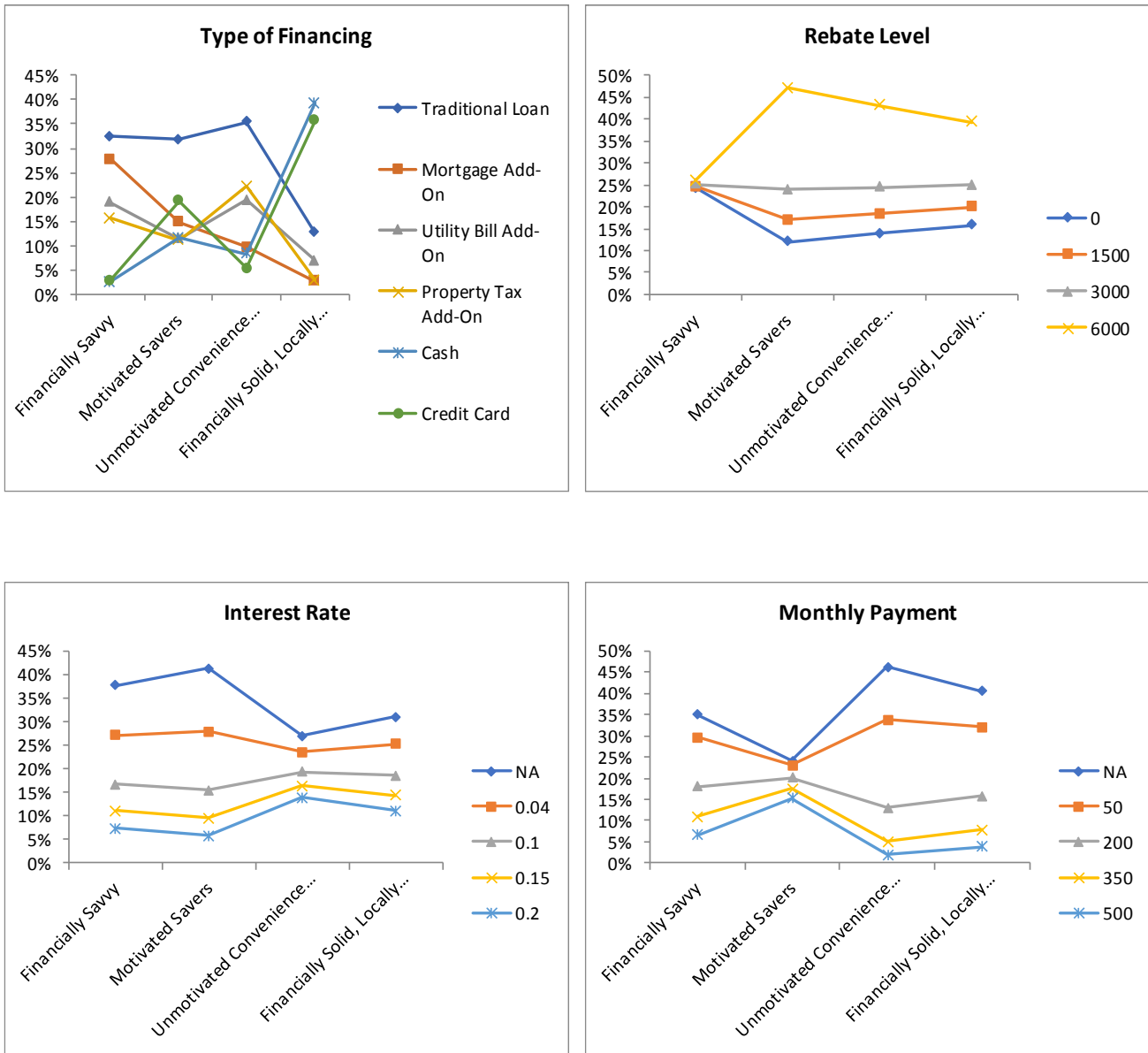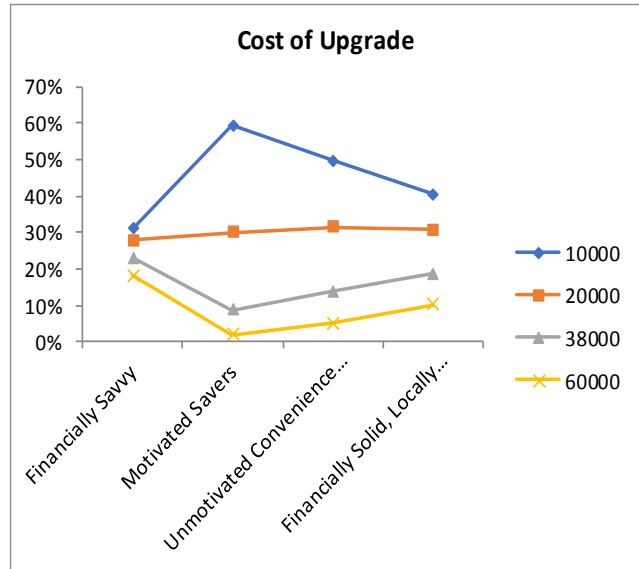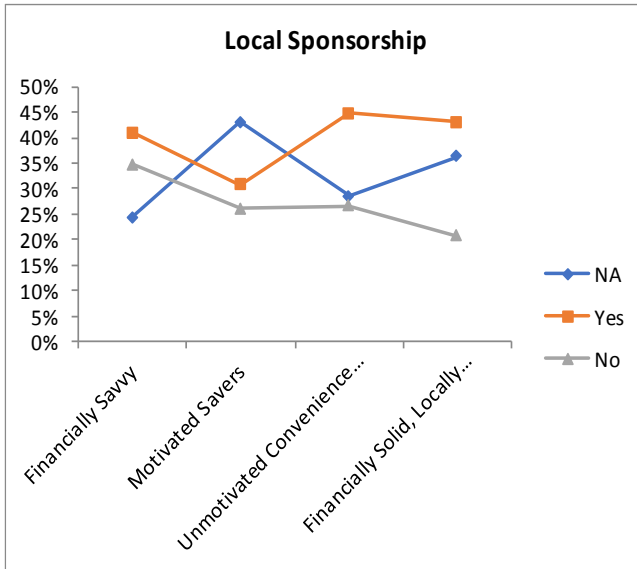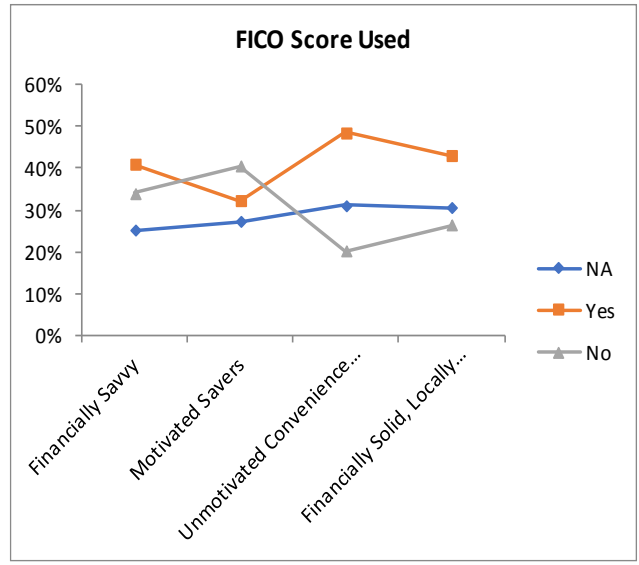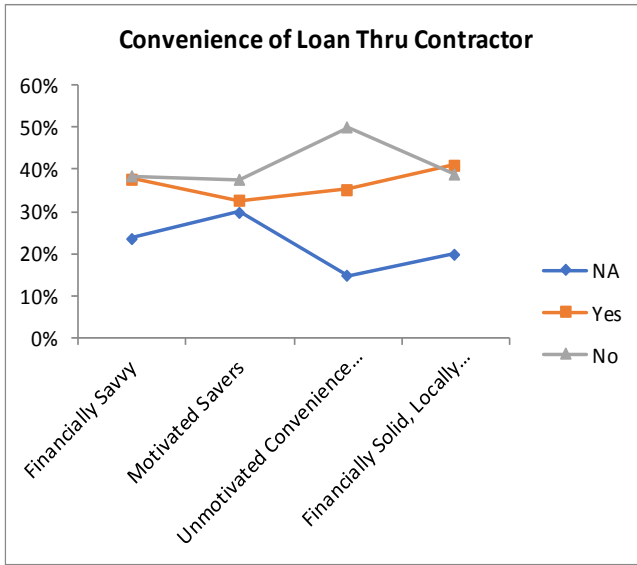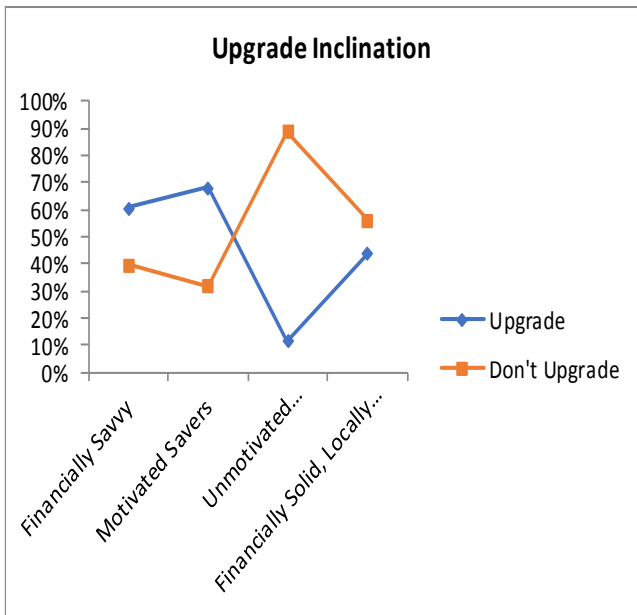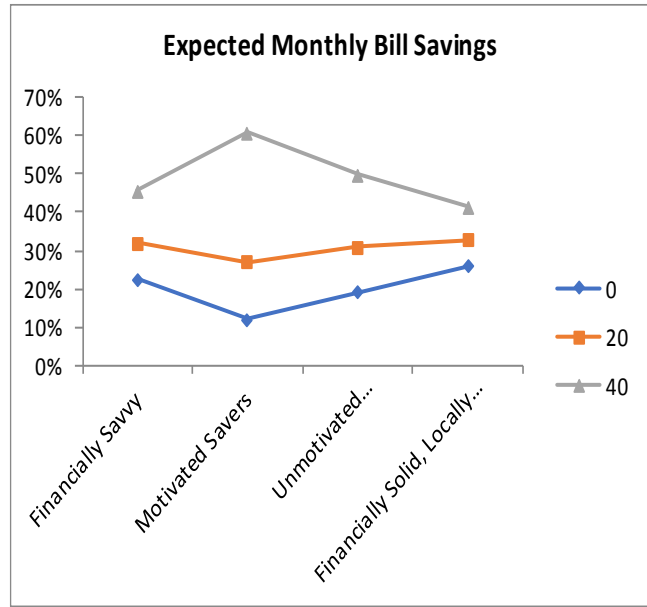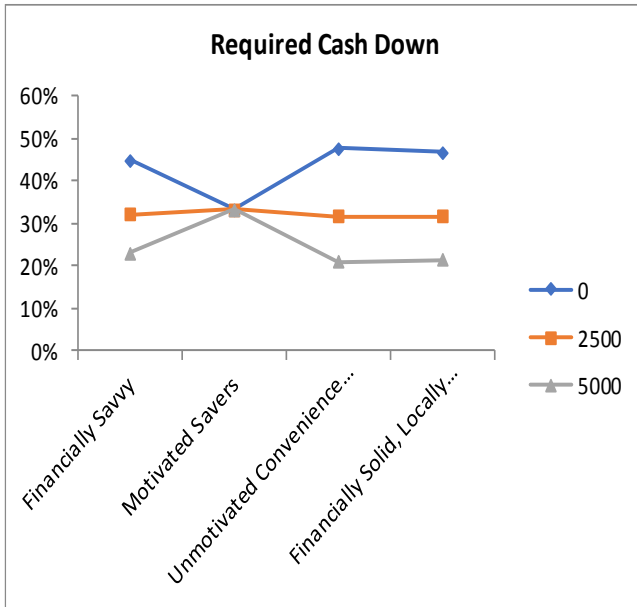


Attribute importance is another basis for characterizing segments. Importance as used here represents the maximum effect for attribute variables within each latent class. It is formally defined as

$$releff_{xp} = \frac{maxeff_{xp}}{\sum_p maxeff_{xp}}$$

For each latent class $x$ and attribute $p$. The *maximum effect* for attribute $p$ is the difference in utility $U_{max} - U_{min}$, where $U_{max}$ is the utility for the level that generates the maximum value for

attribute $A$, and U$_{min}$ is the utility for the level that generates the minimum value for attribute $A$. Figure 15 shows the results of these calculations in the form of a 3-D chart. A simple example illustrates how to read this chart. Notice that segment 1, "Financially Savvy" attaches the most importance (within the segment) on type of financing, interest rate, and monthly payment. This combination contributes to the choice of the segment name.

### Figure 15. Importance by Segment
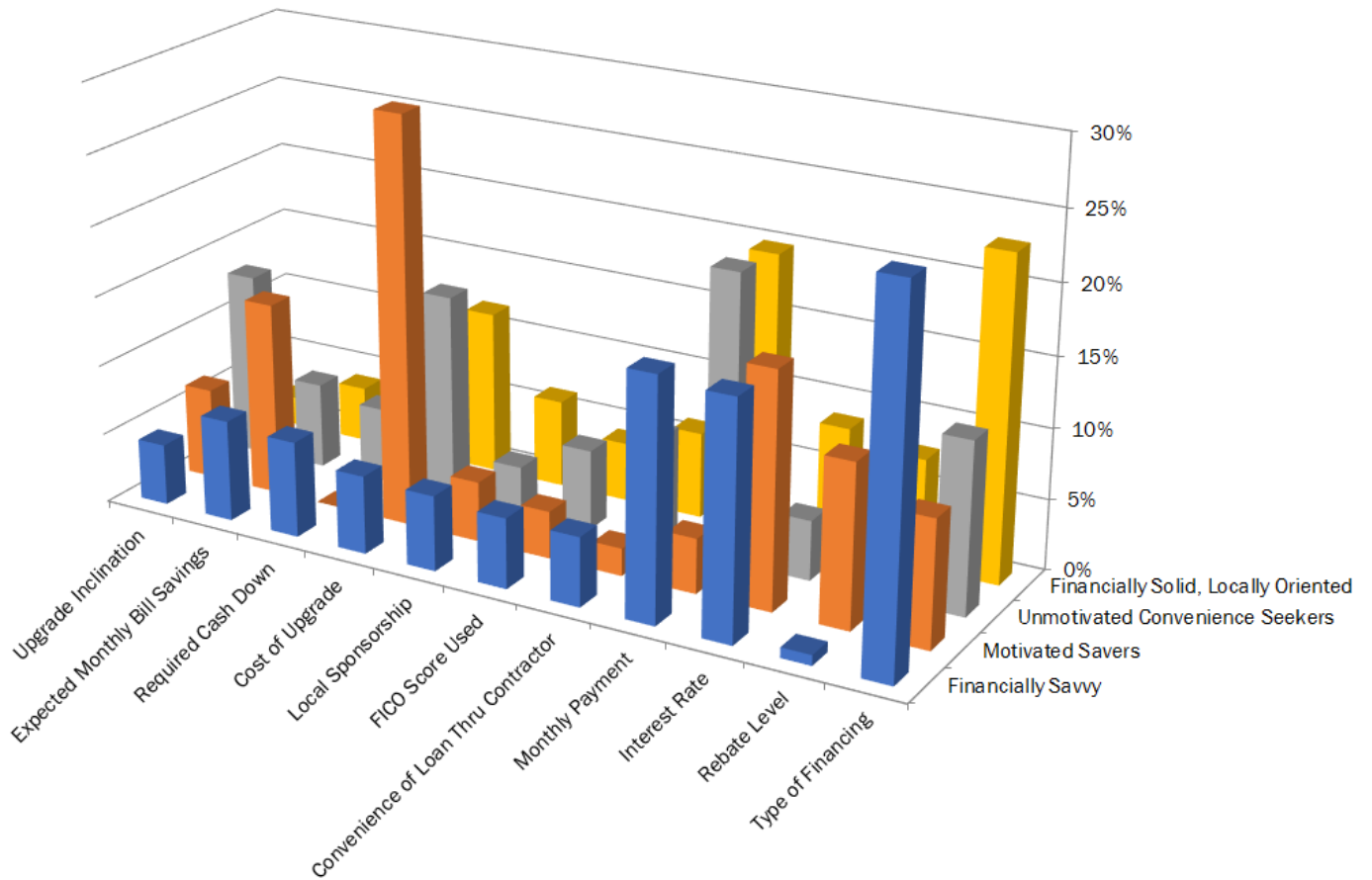
Finally, the proportion of the sample of market-ready customers that fall into each class are shown in Table 51.

## Table 51. Market Shares of Classes

| Class # | Segment Characterization | Percentage of Market-Ready Customers |
|---|---|---|
| Class 1 | Financially Savvy | 37% |
| Class 2 | Motivated Savers | 25% |
| Class 3 | Unmotivated Convenience Seekers | 25% |
| Class 4 | Financially Solid, Locally Oriented | 13% |

## References

Magidson, J. and J. Vermunt (2003). Latent GOLD Choice User's Guide. Statistical Innovations Inc. https://pure.uvt.nl/portal/en/publications/latent-gold-choice-users-guide(e024e155-98b4-4128-8c02-5d8c30c7af57).html.

# Appendix C.    Detailed Cost-Effectiveness Analysis Methods

Cost-effectiveness was conducted in two different ways: first, Dunsky followed the method outlined in the California Standard Practice Manual (SPM) . Secondly, Dunsky used a unique method that included a modified version of the California SPM to address the nuances associated with financing programs.

## California Standard Practice Manual

The cost-effectiveness analysis was performed for RFP participants that participated in the EUC program, using the TRC and PAC tests, as well as the SCT – a variant of the TRC.

## Dunsky Method of Evaluating Financing Program's Cost-Effectiveness

While the Standards Practice Manual provides a standard framework for evaluating cost-effectiveness, it was designed specifically to evaluate rebate programs, and does not consider the unique distinctions of financing programs.  The FPM has adapted the SPM model for the TRC and PAC by reconsidering existing inputs and including new inputs.

Below, we provide the high-level algorithms for each model and details of the adapted benefits and costs by component for the FPM.

### Table 52. TRC High-Level Algorithm

| SPM | FPM |
|---|---|
| $$B_{TRC} = \sum_{t=1}^{N} \frac{UAC_t + TC_t}{(1+d)^{t-1}} + \sum_{t=1}^{N} \frac{UAC_{at} + PAC_{at}}{(1+d)^{t-1}}$$ $$C_{TRC} = \sum_{t=1}^{N} \frac{PRC_t + PCN_t + UIC_t}{(1+d)^{t-1}}$$ | $$B_{TRC} = EB_{EEEM} + NEB_{EEEM} + CCS + MTB$$ $$C_{TRC} = PRC + LLRC + PCN + UIC$$ |
| Where:<br><br>B$_{TRC}$ = Benefits of the program<br><br>C$_{TRC}$ = Costs of the program<br><br>UAC$_t$ = Utility avoided supply costs in year t<br><br>TC$_t$ = Tax Credits in year t<br><br>UAC$_{at}$ = Utility avoided supply costs for the alternate fuel in year t<br><br>PAC$_{at}$ = Program Administrator program costs for alternate fuel in year t<br><br>PRC$_t$ = Program Administrator program costs in year t | Where:<br><br>B$_{TRC}$ = Benefits of the program<br><br>EB$_{EEEM}$ = Energy benefits from eligible energy efficiency measures<br><br>NE$_{BEEEM}$ = Non-energy benefits from eligible energy efficiency measures<br><br>CCS = Capital Cost Savings<br><br>MTB = Benefits from Market Transformation<br><br>C$_{PAC}$ = Program Administrator program costs<br><br>LLRC = Loan Loss Reserve Costs |

| SPM | FPM |
|---|---|
| PCN$_t$ = Net Participant Costs in year t | PCN = Net Participant Costs |
| UIC$_t$ = Utility increased supply costs in year t | UIC = Utility increased supply costs |
| d = discount rate | |

## Adapted TRC Benefits (by component)

### EBEEEM: Energy Benefits from Eligible Energy Efficiency Measures

$$EB_{EEEM} = \sum_{t=1}^{N} \frac{CAES_t \times AC_t}{(1+d)^{t-1}}$$

Where:

CAES$_t$       Cumulative Annual Attributable Energy savings in year t

AC$_t$       Avoided costs in year t

D       Discount rate

### NEBEEEM: Non-Energy Benefits from Eligible Energy Efficiency Measures

$$NEB_{EEEM} = VNEB_{EEEM} \times EB_{EEEM}$$

Where:

VNEB$_{EEEM}$       Value of NEBs for EEEMs as a percent of avoided costs

### CCS: Capital Cost Savings

$$CCS = APR_{BENEFIT} \times \left[ \frac{r}{1-(1+r)^{-n}} - \frac{r'}{1-(1+r')^{-n}} \right] \times \sum_{t=1}^{N} \sum_{i=1}^{LD} \frac{I_t}{(1+d)^{t+i-2}}$$

Where:

$$r = APR_{BASELINE}$$

$$r' = APR_{BASLINE} - APR_{TRICKLE}$$

APR$_{\text{BASELINE}}$     APR Baseline: Assumed weighted average APR for benefitting participants

APR$_{\text{TRICKE}}$     APR Trickle Down is the reduction in participant APR attributable to LLR security

n     Number of periods

I$_t$     Investment in year t

APR$_{\text{BENEFIT}}$     Percent of participants who benefit from reduced APR

## MTB: Market Transformation Benefits

$$MTB = ME \times IAES_{LY} \times \sum_{t=1}^{N} \frac{MTBC_t \times AC_t}{(1+d)^{t-1}}$$

Where:

IAES$_{\text{LY}}$     Incremental Annual Energy Savings form the last year of the program

ME     Market Effects is the continued activity beyond programs/pilots as a percent of IAES$_{\text{LY}}$

MTBC$_t$     Market Transformation Benefits Curve value in year t

## Adapted TRC/SCT Costs (By Component)

## LLRC: Loan Loss Reserve Costs

$$LLRC = LLRL + LOCC + LLRMC$$

Where:

LLRL     Loan Loss Reserve Losses

LOCC     Lost Opportunity Cost of Capital

LLRMC        Lost Opportunity Reserve Management Costs

## Loan Loss Reserve Losses

$$LLRL = \sum_{t=1}^{PD} \sum_{i=1}^{LD} CL_i \times \frac{LLR_t}{(1+d)^{t+i-2}}$$

Where:

$LLR_t$        Loan Loss Reserve fund in year t

$CL_i$        Covered Losses expressed as a percentage of LLR in year i of the loan

LD        Loan duration

## Lost Opportunity Cost of Capital

$$LOCC = (d - r_{LLR}) \times \sum_{t=1}^{PD} \sum_{i=1}^{LD} \frac{LLR_t}{(1+d)^{t+i-2}}$$

Where:

$r_{LLR}$        Annual interest rate on LLR funds

LD        Average duration of loans

## Loan Loss Reserve Management Costs

$$LLRMC = \sum_{t=1}^{N} \frac{LLRF_t + LLRO_t}{(1+d)^{t-1}}$$

Where:

$LLRF_t$        Loan Loss Reserve Fund Fees in year t

LLRO$_t$          Loan Loss Reserve Fund Other Costs in year t

## PCN: Net Participant Costs

$$PCN = \sum_{t=1}^{N} \frac{(LLR_t \times L_{ALL}) + PC_{NB,t}}{(1 + d)^{t-1}} \times SA \times PC_{EEEM}$$

Where:

PC$_{NB,t}$          Amount of non-borrowed participant contributions in year t

PC$_{EEEM}$          Incremental cost as a percent of total EEEM cost

## PAC High-Level Algorithm*

| SPM | FPM |
|---|---|
| $$B_{PAC} = \sum_{t=1}^{N} \frac{UAC_t}{(1 + d)^{t-1}} + \sum_{t=1}^{N} \frac{UAC_{at}}{(1 + d)^{t-1}}$$ $$C_{PAC} = \sum_{t=1}^{N} \frac{PRC_t + INC_t + UIC_t}{(1 + d)^{t-1}}$$ | $$B_{PAC} = EB_{EEEM} + MTB$$ $$C_{PAC} = PRC + LLRC + UIC$$ |
| Where:<br><br>B$_{PAC}$ = Benefits of the program<br><br>C$_{PAC}$ = Costs of the program<br><br>UAC$_t$ = Utility avoided supply costs in year t<br><br>UAC$_{at}$ = Utility avoided supply costs for the alternate fuel in year t<br><br>PRC$_t$ = Program Administrator program costs in year t<br><br>INC$_t$ = Incentives paid to the participant by the sponsoring utility in year t<br><br>UIC$_t$ = Utility increased supply costs in year t | Where:<br><br>B$_{PAC}$ = Benefits of the program<br><br>C$_{PAC}$ = Costs of the program |

* All individual cost and benefit components described previously under TRC algorithm.

## Discount Rates

The following table details the discount rates used in the model for each test and scenario with a brief description of the reasoning behind the input.

| | Low | Medium | High |
|---|---|---|---|
| PAC / TRC | 7.5% - Weighted Average Cost of Capital After Taxes for Utilities[37] | 5.3% - Average of Low and High Scenarios. | 3.0% - Suggested rate at recent CPUC hearing[38] |
| SCT | 5.0% - 2017 California Bond Issuance Upper Interest Rate Limit[39] | 4.0% - 2017 California Bond Issuance Lower Interest Rate Limit | 1.4% - Stern Review on the Economics of Climate Change[40] |

---

[37] "The Basics of Cost-Effectiveness Analysis" Presentation.  http://www.cpuc.ca.gov/WorkArea/DownloadAsset.aspx?id=5189

[38] http://docs.cpuc.ca.gov/PublishedDocs/Efile/G000/M184/K627/184627134.PDF

[39]https://neighborly-issuance-documents.s3.amazonaws.com/production/4d0c3ff3-a570-4ee3-a3b1-f22e313a249c_os_1507132635.pdf

[40] http://mudancasclimaticas.cptec.inpe.br/~rmclima/pdfs/destaques/sternreview_report_complete.pdf

# Appendix D.    Early Evaluation Planning Tasks

This evaluation plan is the result of a number of background research efforts over the last few years. These steps were critical for understanding the RFPs in California, determining our study population, and developing our evaluation approach.

We undertook the following tasks:

- In 2014, as a part of Work Order ED_O_FIN_2, we interviewed program staff from 11 residential and non-residential RFPs. Topics included program design, progress-to-date, and data availability. Using this information, we prioritized five programs for potential impact evaluations. Please refer to the Local Finance Programs Prioritization Memo below. Please note that, at the time of this memo, GSFA was known as the California Homebuyers Fund (CHF).

- We conducted follow-up interviews in late 2015 with each of the five prioritized programs to collect any updates on program design, participation, and data tracking. We ultimately recommended three programs for inclusion in this study. Please refer to the Summary of Findings Memo below.

- We conducted a final round of interviews in mid-2016 with emPower, GSFA, and SoCalREN to collect final performance numbers for 2013-2015 and confirm any remaining details on the programs. The results of these interviews are included in the Regional Finance Program Attribution and Cost-effectiveness Study Evaluation Plan below.

**Local Finance Programs Prioritization Memo**

Opinion **Dynamics**

# MEMORANDUM

TO:      Jean Lamming; CPUC Energy Division, Nikhil Gandhi, CPUC Advisor; Ralph Prahl, CPUC Advisor

FROM:      Opinion Dynamics Evaluation Team – Jennifer Mitchell-Jackson, Nina Merchant, and Jeevika Galhotra

DATE:      10/20/2014

RE:      Local Finance Programs: Summary of Program Manager Interviews

## 1. Summary of Local Finance Programs

As part of Baseline Work Order (ED_O_FIN_2), the Opinion Dynamics Evaluation Team (we) conducted in-depth interviews with management staff from each of the residential and non-residential "local" finance programs. These programs are run by local governments or public agencies. The primary objects of these interviews were to:

1. Understand how the programs were rolled-out;
2. Understand the underlying program logic for the programs[1];
3. Understand what data is/will be available for the programs;
4. Understand the evaluability of the programs; and
5. Prioritize the evaluation of the programs.

We conducted interviews with management staff from 15 local finance programs administered by the Investor-Owned Utilities (IOUs) and the Regional Energy Networks (RENs--see Table 1 below) in the 2013-2014 program cycle. Eleven programs are currently active. Three SoCalREN programs and one Marin Energy Authority (MEA) program have not been approved by the Commission yet (see Appendix 1 for more detail). Therefore, we focus on the 11 programs that are currently active in 2014.[2] Among these programs, we identified three basic types of local financing programs:

1) **Credit Enhancement Programs**: Programs that provide credit enhancements, such as loan loss reserves (LLRs), interest rate buy-downs or on-bill repayment (OBR) to private financial institutions to incentivize them to offer energy efficiency-specific loan products to residential and/or non-residential customers. The overarching logic for such programs is that the credit enhancements lower the risk profile for financial institutions to offer credit for energy efficiency measures. Thus, financial institutions are able to offer financing at better interest rates and terms to customers leading to more and deeper energy efficiency projects.

---

[1] Note that the logic for each program is explained in Appendix 1.
[2] The programs will continue into 2015, although with differing budgets and scopes, with the exception of SDG&E's contractor marketing program.

*Page 1*

2) **Promotional/Administrative Programs**: Programs that provide promotional/marketing or administrative support to already existing credit-enhancement or PACE finance programs. They do not directly offer any type of financial assistance.

3) **ESCO-Like Programs**: Programs that offer full-service energy savings solutions or innovative/new types of financial products.

A summary of each program is provided in Table 1 below. A more detailed description of each program and the achievements to date can be found in Appendix 1 and data for each program can be found here:

Local Finance
Program_Summary_1

Table 1: Local Finance Programs Covered

| Program Administrator | Finance Program Name | Type of Program |
| --- | --- | --- |
| **2013-2014 Finance Programs (N=11)** | | |
| BayREN | Multifamily Capital Advance | Credit Enhancement |
| IOU (PG&E) | California Homebuyers Fund | Credit Enhancement |
| IOU (PG&E, SCE and SoCalGas) | emPower Central Coast | Credit Enhancement |
| Marin Energy Authority | On-Bill Repayment for Single Family | Credit Enhancement |
| Marin Energy Authority | On-Bill Repayment for Multifamily and Small Business | Credit Enhancement |
| SoCalREN | EUC Residential Loan Loss Reserve | Credit Enhancement |
| BayREN | Commercial PACE | Promotional/Administrative Program |
| IOU (SDG&E) | Contractor Marketing | Promotional/Administrative Program |
| SoCalREN | Non-Residential PACE | Promotional/Administrative Program |
| BayREN | Pay as You Save | ESCO-like Program |
| SoCalREN | Public Agency Financing Assistance | ESCO-like Program |
| **Not Approved by the Commission (N=4)** | | |
| SoCalREN | Energy Upgrade California Multifamily Loan Loss Reserve | Credit Enhancement |
| SoCalREN | Public Building Loan Loss Reserve | Credit Enhancement |
| SoCalREN | Public Agency Revolving Loan Fund | Credit Enhancement |
| Marin Energy Authority | Standard Offer | ESCO-like Program |

Four Local Finance Programs have been offered in California since May 2010, though more than half (7 of eleven) are relatively recent programs, operating for less than two years (see **Error! Reference source not found.** below).

*Page 2*

Figure 1: Timeline of Local Finance Program Implementation
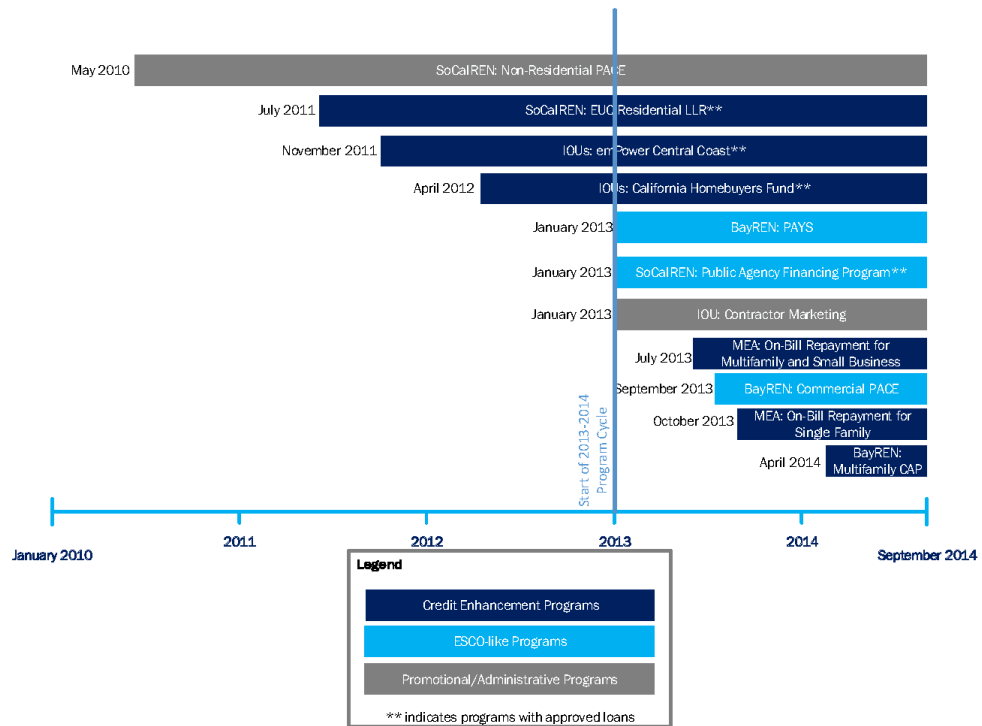
## 1.1 Local Finance Programs Budgets

The local finance programs have 2013-2014 budgets totaling over $30 million (see

Table *2* below). The vast majority of this budget (79%) is used for financing capital (such as maintaining LLRs), while the remaining 21% is used to fund administrative and marketing activities. The new Statewide Finance pilots have a budget of approximately $62.8 million. Thus, the local programs represent a significant investment in energy efficiency financing at the local level, representing approximately 53% of the total investment in financing at the Statewide level.

Table 2: 2013-2014 Budgets for Local Finance Programs

| Program Administrator | Finance Program Name | 2013-2014 Budget | | |
|---|---|---|---|---|
| | | Finance Capital | Admin and Marketing | Total |
| BayREN | Multifamily Capital Advance | $1,500,000 | $500,000 | $2,000,000 |
| BayREN | Pay as You Save | $0 | $719,800 | $719,800 |
| BayREN | Commercial PACE | $0 | $450,000 | $450,000 |
| IOU (PG&E) | California Homebuyers Fund | $20,000,000 | $80,000 | $20,080,000 |
| IOU (PG&E, SCE and SoCalGas) | emPower Central Coast | $1,000,000 | $2,700,000 | $3,700,000 |
| IOU (SDG&E) | Contractor Marketing | $0 | $292,686 | $292,686 |
| Marin Energy Authority | On-Bill Repayment for Multifamily and Small Business | $547,000 | $69,500 | $616,500 |
| Marin Energy Authority | On-Bill Repayment for Single Family | $500,000 | $41,750 | $541,750 |
| SoCalREN | EUC Residential Loan Loss Reserve | $2,553,952 | $385,722 | $2,939,674 |
| SoCalREN | Non-Residential PACE | $0 | $1,411,500 | $1,411,500 |
| SoCalREN | Public Agency Financing Assistance | $0 | $494,573 | $494,573 |
| Total | | $26,100,952 | $7,145,531 | $33,246,483 |

## 1.2 Local Finance Programs Scope and Achievements

As of September 2014, three of the six ongoing credit enhancement programs—SoCalREN's Energy Upgrade California (EUC) Residential Loan Loss Reserve, The California Homebuyer's Fund (CHF) and emPower Central Coast— have approved 622 loans as of September 2014 (see **Error! Reference source not found.** below). It is important to note, however, that these three programs began with ARRA-funding in previous cycles; therefore, some of these loans were originated in previous cycles. As next steps in the evaluation, we plan to follow-up with these programs and ask them to parse out how many loans were originated in each cycle with each funding source.[3] The other three credit-enhancement programs have not received approved any loans nor have they received any applications. The table shows that the programs are falling short of their original participation goals. However, MEA's On-Bill Repayment for Multifamily and Small Business, MEA's On-Bill Repayment for Single Family, and the BayREN's multi-family capital advance just started in 2013 or 2014 and have not had as much implementation time as the others.

[3] We also attempted to cross-reference the loan numbers with monthly and quarterly reports on the EE Stats website. However, the programs are not required to report loan numbers as they are considered non-resource programs in this cycle. EE Stats reporting is limited to budget numbers.

Table 3: Loans Approved through Credit Enhancement Programs

| Program Administrator | Finance Program Name | Loans Approved as of September 2014 | Participation Goal |
|---|---|---|---|
| SoCalREN | EUC Residential Loan Loss Reserve | 352 | 2,307 loans worth $2.8 million |
| IOU (PG&E) | California Homebuyers Fund | 207 | Not provided |
| IOU (PG&E, SCE and SoCalGas) | emPower Central Coast | 63 | 800 to 1,000 loans |
| BayREN | Multifamily Capital Advance | 0 | Loans targeting 1,200 multifamily units (worth $1.5 million) |
| Marin Energy Authority | On-Bill Repayment for Single Family | 0 | 500 homes |
| Marin Energy Authority | On-Bill Repayment for Multifamily and Small Business | 0 | Loans targeting 33 multifamily and 50 small building (worth $3.65 million) |
| **Total Loans Approved** | | **622** | |

*Source: Program management staff interviews, data as of August 2014.

Additionally, several of the ESCO-like and promotional/administrative programs supported loans through their activities (see **Error! Reference source not found.**). Notably, the two programs that have loan support goals, SoCalREN's Non-Residential PACE program and BayRENs PAYS programs have achieved 60% to 65% of their participation goals.

Table 4: Loans Supported by ESCO-like and Promotional/Administrative Programs

| Program Administrator | Finance Program Name | Number of Loans/Customers Supported | Participation Goal |
|---|---|---|---|
| SoCalREN | Non-Residential PACE | 3 loans approved, 44 active applications | 10 customers completing the initial loan application, 5 customers receiving loans and completing projects |
| BayREN | Pay as You Save | 1,300 multifamily units pre-qualified | 2,000 multifamily units, 15 commercial sites |
| SoCalREN | Public Agency Financing Assistance | 8 applications submitted | No participation goals |
| BayREN | Commercial PACE | Not provided | Not provided |
| IOU (SDG&E) | Contractor Marketing | No loans/customers supported | No participation goals |

## 2. Data availability of Local Programs

Data availability across the local programs varies considerably (see Table 5). Most of the credit enhancement programs collect (or are planning to collect) a considerable amount of finance data including the loan amount, loan term, interest rate and FICO scores. This data would be instrumental in determining important process questions related to the programs such as loan performance and terms. Additionally, all of the credit enhancement programs collect some data that would link the programs to either incentive programs—such as utility account numbers—or collect measure and

predicted savings numbers directly. This is important in considering a potential impact evaluation of these programs.

Note that the program implementers provided the information shown in Table 5. Much of this data is the same data that the impact team is recommending that CAEATFA collect from the Statewide pilots in order to calculate gross impacts. We have not yet requested data to verify the quality or usability of the data, but are planning to do so in the future.

Table 5: Types of Data Collected for Credit Enhancement Programs

| Program Name | IOU<br>California Homebuyers Fund | IOU<br>emPower Central Coast | MEA<br>On-Bill Repayment for Single Family | SoCalREN<br>EUC Residential Loan Loss Reserve | BayREN<br>Multifamily Capital Advance |
|---|---|---|---|---|---|
| Utility account number | | x | x | x | |
| Participant housing information (such as housing type, ownership etc.) | | x | | | x |
| Participant demographic information (such as age, income, education etc.) | x | x | | | |
| Participant financial information (such as credit history) | | x | | X | |
| Loan account | | x | x | X | |
| Loan amount | x | x | x | X | x |
| Loan term | x | x | x | X | x |
| Loan interest rate | x | x | x | X | x |
| FICO score | x | x | x | X | |
| Delinquency/default | | x | x | X | x |
| Measure type | x | x | x | | x |
| Predicted savings | x | x | x | x | x |
| Incentive or rebate | x | x | x | | x |
| Monthly consumption data | | | | | |
| Other | | marketing/ contractor metrics | | | Repayment records |

Data availability for the ESCO-like and promotional/administrative programs varies more considerably. No impact-related data is currently available for the SDG&E Contractor Marketing program or the BayREN Commercial PACE program. These programs do not track this data because it is not relevant to the program logic or structure (See Appendix 1). However, the BayREN PAYS program, SoCalREN

Non-Residential PACE Program and the SoCalREN Public Agency Financing program collect a significant amount of financial and measure data.

Table 6: Types of Data Collected for ESCO-like and Promotional/Administrative Programs

| Program Name | IOU (SDG&E) Contractor Marketing | BayREN Pay as You Save | BayREN Commercial PACE | SoCalREN Non-Residential PACE | SoCalREN Public Agency Financing Assistance |
|---|---|---|---|---|---|
| Participant housing information (such as housing type, ownership etc.) | | x | | x | |
| Participant demographic information (such as age, income, education etc.) | | | | | |
| Participant financial information (such as credit history) | | | | | x |
| Loan account | | x | | | |
| Loan amount | | x | | x | x |
| Loan term | | x | | x | x |
| Loan interest rate | | x | | x | x |
| FICO score | | | | | |
| Delinquency/default | | x | | | |
| Utility account number | | x (water utility) | | | x |
| Measure type | | x | | x | x |
| Predicted savings | | x | | x | x |
| Incentive or rebate | | x | | x | x |
| Monthly consumption data | | | | | |
| Other | | | | | |

## 3. Local Program Evaluation Prioritization

Given the number and variety of programs, we must prioritize the programs for potential future evaluation efforts. Based on information collected to date, we sought to prioritize programs for evaluation based on the following criteria:

a) **Program logic, design and features** – We considered the features of the programs (e.g., LLR, OBR) and the barriers they intend to overcome. Given the limited resources for evaluation, we chose to focus more on credit enhancement programs because of they directly provide loans to customers for energy efficiency measures. We did however, seek to include other program categories if they sufficiently met the other three criteria below.

b) **Size of the effort** – We considered the programmatic reach of the program. Programs that had little to no participation in the context of individual participation goals were given lesser priority.

c) **Data availability** – We considered whether the programs had enough data available to answer important process and impact questions.

d) **Amount of Ratepayer dollars –** We considered how much of the overall program funding comes from ratepayer dollars. We also considered the network within which the program operates and whether we will be able to tease out the effect of the ratepayer funding from other potential funding sources.

Based on the criteria above, we prioritized the programs for impact evaluation in Table. According to our current criteria the first five programs listed—SoCalREN's EUC Residential LLR, emPower Central Coast, CHF, BayREN's PAYS and SoCalREN's Non-Residential PACE program—should be prioritized. The first three of these programs are the active credit enhancement programs. While we considered all of the credit enhancement programs, the other three do not currently have participants. The PAYS program is an innovative ESCO-like program with a far reach and good data availability, while the SoCalREN's Non-Residential PACE program is a promotional program which has been successful in bringing large commercial customers into the LA County PACE program. In addition to satisfying the criteria listed above, these five programs represent all three program implementers and touch on both residential and commercial customers.

**Table 7: Local Programs Prioritization**

| Program Prioritization | Criteria for Selection | | | |
|---|---|---|---|---|
| | Program Logic* | Size** | Data | Funding† |
| SoCalREN Residential LLR | Satisfies | Satisfies | Partially | Satisfies |
| emPower Central Coast | Satisfies | Satisfies | Satisfies | Satisfies |
| California Homebuyers Fund (CHF) | Satisfies | Satisfies | Partially | Satisfies |
| BayREN PAYS | Partially | Satisfies | Satisfies | Partially |
| SoCalREN Non-Residential PACE | Partially | Satisfies | Partially | Partially |
| SoCalREN Public Agency Financing Assistance | Partially | Partially | Satisfies | Does Not Satisfy |
| MEA On-Bill Repayment for Single Family | Satisfies | Does Not Satisfy | Satisfies | Partially |
| MEA On-Bill for Multifamily and Small Business | Satisfies | Does Not Satisfy | Satisfies | Partially |
| BayREN Multifamily Capital Advance | Partially | Does Not Satisfy | Partially | Satisfies |
| BayREN Commercial Pace | Partially | Does Not Satisfy | Does Not Satisfy | Does Not Satisfy |
| SDG&E Contractor Marketing | Partially | Does Not Satisfy | Does Not Satisfy | Does Not Satisfy |

*More weight is given to credit enhancement programs.
**A "Does Not Satisfy Criteria Mark" was given to those programs that either had no participants or are not involved in directly or indirectly supporting loans at all.
†"Satisfies criteria" was given to programs with over $2million in total funding. "Partially satisfies criteria" was given to programs with $500K to $2 million in total funding. "Does not satisfy criteria" was given to programs with $500K or less.

| Key | |
|---|---|
| Satisfies Criteria | ● (green) |
| Partially Satisfies Criteria | ● (orange) |
| Does Not Satisfy Criteria | ● (red) |

## 4. Key Interview Findings

Looking across the programs, the following key themes emerged from the interviews:

- **Restrictive Energy Efficiency Program Requirements for Credit Enhancement Programs:** Credit enhancement program managers mentioned that customers generally think the EUC Home Upgrade Program requirements are too restrictive, and as such, few customers took out loans. As the finance programs transitioned from ARRA funding to IOU/PUC funding, some programs were no longer able to offer loans for single measures to customers. For example, SoCalREN through the EUC Residential Loan Loss Reserve was no longer able to offer Flex Path (single measure) loans to customers. SoCalREN experienced a reduction in loan uptake when customers where solely restricted to EUC basic and advanced home upgrade packages. In response to this, some credit enhancement programs are now looking to expand their programs to include single measures. For example, emPower Central Coast recently started a program called "Simple Start", which allows loans for single measures.

- **Competition from HELOC and PACE:** Several credit enhancement program staff mentioned that the programs' main competition comes from traditional home equity loans (HELOCs) and PACE. HELOCs offer competitive rates to customers and do not put restrictions on the types measures that qualify. PACE programs also have fewer restrictions and some customers like that the loan is tied to the property, not the homeowner. However, some program staff, such as those who manage the emPower Central Coast program, mentioned that customers liked energy efficiency-specific loan products because they free up HELOC funds for other types of home upgrades. Therefore, HELOC funds can complement the energy efficiency-specific loan products.

- **Coordination with IOUs:** There is significant coordination with the IOUs across many of these programs, particularly because so many of them require EUC Home Upgrade packages. This has several advantages as EUC contractors are able to verify the energy efficiency measures for the financial institutions, prepare and submit rebate paperwork and coordinate marketing efforts. Most programs have regular meetings and/or coordination sessions with the IOUs. The Statewide Pilots should discuss with the IOUs whether there would be similar coordination with the Master Servicer.

- **Data Collection and Availability:** Most of the programs collect or have access to a significant amount of data. Since most programs operate under EUC requirements, they are able to collect data from EUC contractors on measures and deemed savings. In addition, they are able to collect financial data from participating financial institutions. This should be compared to the availability of data through the Statewide Pilots once those efforts are up and running.

- **Marketing Strategies:** Most programs use a mix of direct marketing (mailers, e-blasts, financial institution partners) and indirect marketing through contractors. To date, we do not know of any evaluation of these programs that has shown which methods are the most influential. However, since many of the programs have EUC requirements, this indirect strategy has been an important marketing avenue as contractors are able to offer the programs at the time customers are making decisions. A few of the programs use a "concierge" model such as emPower Central Coast's Home Performance Energy Coaches which help customers through every step of the process from working with contractors to working with financial institutions.

There may be opportunities to better understand the value of the different marketing strategies based on the evaluation of the five programs that we are proposing to evaluate. As such, the Statewide pilots may benefit from learning what has worked well within the local programs as part of their marketing efforts.

# Appendix 1: Detailed Description of the Local Programs

## IOU Funded Local Finance Programs

There are currently three local programs that received IOU funding in the 2013-2014 program period (the others are funded by MEA and RENS). These three programs are summarized below.

### CRHMFA Homebuyers Fund (CHF) Energy Retrofit Program (LLR for Single Family) – PG&E

The California Homebuyers Fund (CHF) is a Joint Powers Authority (JPA) with member counties. The CHF provides affordable housing finance options for low-to moderate income households in California. With the Energy Retrofit Program, CHF aims to provide credit enhancement using private financing for energy upgrades. Currently this program is available to residential PG&E customers within a member county, with the possibility of adding multifamily and commercial buildings in the future. The program is built off of the Moderate Income Sustainable Technology (MIST) program that was an ARRA funded effort.

The goal of the program is to help residential homeowners with the upfront cost of making energy efficiency improvements in their homes, which helps reduce energy costs, improve home comfort, reduce the impact on the environment and ultimately leads to job creation in California. Funding for this program is primarily from rate payers, however, the program still using some remaining ARRA funding (this funding is only used if rate-payer funding cannot be used – if a customer is within a member county but not a PG&E customer). In addition, CHF has created a partnership with Five Star Bank where the bank provides customers with an unsecured loan for making energy efficient upgrades in their homes and CHF provides the bank with an LLR with a cap of 10% of the actual committed loans.

The program does not target customers on income, rather the financing is available to any qualified customer who requires financing for their upgrades. The program runs in conjunction with the Energy Upgrade California Home Upgrade (or Home Upgrade) program, where customers receive financing for measures eligible for Home Upgrade program rebates. To qualify for the loan, the customer must be either a PG&E customer, own the property at which the energy efficiency improvements are being performed, have the property in a member county, have a minimum FICO score of 640, have a debt-to-income ratio of 45% or lower, not have any outstanding mortgage or property taxes, not have any liens on the property, have a source of verifiable income, and agree to setup automatic withdrawal of the loan payment. Eligible customers are able to borrow up to $50,000 at a 6.5% fixed interest rate. The loan is a 15 year fully amortized loan and up to $20 million in loan financing is available.

### emPower Central Coast (LLR for Single Family) – PG&E, SCE, SoCalGas

**emPower** was initially developed by Santa Barbara County to help homeowners overcome obstacles to making energy saving improvements to their homes. The program now includes the San Luis Obispo and Ventura counties. The goal of the program is to make residential home upgrade projects more affordable through financing. The program also helps customers take advantage of existing IOU incentives and connects them with qualified EUC contractors and energy efficiency experts.

Funding for the program originally came in 2011 through ARRA via the Department of Energy's (DOE) Better Building's Program (BBP). In 2012, emPower also received funds from the CPUC, which allowed it to expand service to San Luis Obispo and Ventura counties. The program currently operates as an LLR with $1 million in credit enhancements and a $2.7 million operating and marketing budget. The LLR offers up to 90% of a loan's value to partner financial institutions up to 5% of the total loan portfolio. The program also offers an interest rate buy-down of 200 basis points using DOE funding.

The program partners with Coast Hills Federal Credit Union and Ventura County Credit Union to offer unsecured loans with low rates and flexible terms of repayment up to 15 years. emPower customers must have a minimum FICO score of 590 and a debt-to-income ratio of no more than 60%. The minimum loan amount is $1,000 and the maximum loan amount is $25,000. There have been 63 loan applications approved for $1.2 million to date with half of those closing for approximately $600,000 in capital. Given the current loans, the average loan amount is for $18,150 at 7.22% over 6 years. To date, there have been no loan defaults and no draw down from the LLR.

Up until recently, these loans could only be used for EUC basic or advanced home upgrade packages. As such, all loans were vetted through the IOU EUC "infrastructure", meaning that EUC contractors were required to verify projects for the financial institutions and help customers through the rebate process. In addition, the program offered Home Performance Energy Coaches to help customers through the EUC process. As of July 2014, emPower started offering loans for single measures through its new Simple Start program. This program allows customers to have more flexibility in choosing measures. Program managers believe that this higher level of flexibility will attract more customers who would like to take advantage of the program, but who do not want to be restricted to the EUC packages.

The program is marketed primarily through the EUC Home Upgrade program participating contractors, as well as through direct means such as the emPower website, outreach events, direct mailers, newsletters and Home Performance Energy Coaches. The participating credit unions are not heavily involved in marketing, but do send out e-blasts and occasionally participate in marketing events.

### Contractor and Local Government Finance Education – SDG&E

The Center for Sustainable Energy (CSE) received ARRA-continuation funding from SDG&E for the 2013-14 cycle to conduct webinars and provide education to local governments and contractors on finance programs and products in San Diego County. These events are held every other month and feature a variety of products and programs including PACE, solar and energy efficiency-specific products offered by private financial intuitions, companies, and public agencies. The webinars are marketed through CSE's website and through word-of-mouth. While the program focuses on education to contractors and local governments, it also highlights products, such as PACE that are available directly to end-use consumers.

## Marin Energy Authority Local Finance Programs

There are currently three programs run by MEA, however one of the programs is yet to submit an advice letter. These programs are summarized below.

### Marin Energy Authority: On-Bill Repayment for Single Family (LLR)

The On-Bill Repayment for Single Family program, also known as "Green Home Loans", is a finance program that is targeted towards residential single family homeowners. Qualified customers can take an unsecured loan, at a 6.5% interest rate, from First Community Bank (a locally-owned community bank) to help pay for energy efficient improvements in their home. The loan is repayable on their monthly utility bill over the life of the loan. The overall logic for the program is to remove the upfront cost associated with making energy efficiency improvements to encourage more and deeper improvements. In addition, by connecting the utility bill with the repayment of the loan, customers are able to see energy savings more prominently. Furthermore, the program could help reduce the percentage of defaults on the loans reduce the cost of financing for customers.

MEA is the implementer for the Green Home Loans program and has created a partnership with First Community Bank where the bank provides the customers with the loan and MEA provides the bank with an LLR with a cap of 10% of the actual committed loans (not to exceed $500,000). MEA also

---

*Page 13*

helps facilitate the payments from the customers to the bank through the monthly utility bills, where the customer pays the utility and the utility pays the bank.

To qualify for the loan, the customer must be either a Marin Clean Energy (MCE) or PG&E customer, own the property at which the energy efficiency improvements are being performed, have a minimum FICO score of 640, not have any defaults on their property taxes, and not have any liens on their property.

This program is complimentary to the EUC Home Upgrade program. The measures eligible for the loan must comply with the EUC Home Upgrade program requirements where customers are eligible to receive incentives up to $4,500. Customers apply directly with the First Community Bank for their loan. Some important features of the finance program are:

1) Loans can be between $2,500 to $30,000;
2) Loan payment is done on a monthly basis, which includes the principle and interest and is fully amortized;
3) The interest rate is fixed at 6.5%;
4) Minimum customer FICO score = 640;
5) Requires a $50 application fee and a $150 documentation fee;
6) There are no late fees;
7) Term of the loan is 5 years for a loan of $7,500 or less and a choice between 5 or 10 years for a loan greater than $7,500;
8) The loan is connected to the customers and must be paid when the property is sold.

The program has an overall budget of $5 million with a goal of getting 500 homes to obtain financing. While this program is currently active, MEA is still resolving some issues with on-bill repayment through PG&E.. Additionally, the program has not processed any applications yet; therefore the data collection effort has not begun. However, the program intends to collect all data as specified in the statewide guidelines which include, but are not limited to, measures installed, project cost, rebate amount, loan terms and loan performance rate.

### Marin Energy Authority: On-Bill Repayment for Multifamily and Small Business (LLR)

The On-Bill Repayment for Multifamily and Small Business program, also known as "Green Property Loans" is targeted towards multi-family property owners (four or more units) and small business owners. The qualified customers are able to take a secured loan, at a 5% interest rate, from River City Bank to help pay for energy efficient improvements on the property. The loan is repayable on the monthly utility bill over the life of the loan. The overall logic for the program is to remove the split incentive issue for multifamily properties, as well as remove the upfront cost associated with making energy efficiency improvements. In addition, by connecting the utility bill with the repayment of the loan, customers are able to see energy savings more prominently. Furthermore, the program could help reduce the percentage of defaults on the loans and hence reduce the cost of financing for customers.

MEA is the implementer for the Green Property Loans program and has created a partnership with River City Bank where the bank provides the customers with the loan and MEA provides the bank with an LLR with a cap of 15% of the actual committed loans. MEA also helps facilitate the payments from the customers to the bank through the monthly utility bills, where the customer pays the utility and the utility pays the bank.

To qualify for the loan, the customer must be a PG&E customer, own the property at which the energy efficiency improvements are being performed, not have any defaults on their property taxes, and not

have any liens on their property. In addition, the property must be located either in Marin County or the City of Richmond.

This program is complementary to the EUC Multifamily Energy Efficiency program. The projects are customizable to the property, but typically include lighting, hot water or heating system replacement, and building envelope improvements. The customers apply directly with the First Community Bank for their loans. Some important features of the finance program are:

1) Loans can be between $10,000 to $265,000;
2) Loan payment is done on a monthly basis, which includes the principle and interest and is fully amortized;
3) The interest rate is fixed at 5%;
4) Secured loan with UCC-1 fixture filing;
5) Requires a $250 bank fee;
6) Term of the loan is 5-10 years;
7) The loan is connected to the customers and must be paid in full if the property is sold.

The program has an overall budget of $3.5 million with a goal of getting 33 multifamily buildings and 50 small commercial buildings to obtain financing. While this program is currently active, they have not received any applications, therefore the data collection effort has not begun. However, the program intends to collect all data as specified in the statewide guidelines which include, but are not limited to, measures installed, project cost, rebate amount, loan terms and loan performance rate.

### Standard Offer

Marin Energy Authority has one additional program, the Standard Offer program targeting non-residential property owners. This program will be tailored to third-party vendors who bid energy savings to MEA as a way to reduce MEA resource adequacy procurement. MEA has yet to submit an advice letter for this program and, as such, this program has not launched.

## SoCalREN Local Finance Programs

The original plan for SoCalREN called for five programs. Two public agency programs have been combined into one new program and the Multifamily LLR has not been funded. Therefore, SoCalREN currently has three financing programs. These programs are summarized below.

### SoCalREN: Energy Upgrade California Residential LLR

The Residential LLR program targets the single family residential market and supports two loan products:

1) Home Energy Loans that support residential energy efficiency and solar upgrades through EUC Home Upgrade; and

2) Cool Comfort Loans that support the installation of HVAC measures above code.

The LLR covers 90% of the loans, resulting in lower interest rates that make these Home Upgrade or Cool Comfort Loans more affordable and attractive to customers. In theory, this results in increased participation in EUC and high efficiency HVAC installations. Home Energy Loans are offered between 4.99% and 6.99% APR with terms from 5 to 15 years.

---

The LLR for Home Energy Loans is funded by a mix of ratepayer and ARRA funding[4], while Cool Comfort LLR is only funded through ARRA. SoCalREN receives approximately $2.94 million in CPUC funding for this program (only Home Energy Loans). The majority of that funding (87%) directly supports the LLR. The remaining 13% supports related administration and marketing activities.

This mixture of funding sources allows SoCalREN to offer a LLR credit enhancements to single family customers in SCE, SoCalGas, SDG&E, and other municipal utility territories in Southern California. The table below provides detail on how funding for the LLR is used to reach these various markets.

Table 8: Residential LLR Funding Sources and Territories Served

| Loan Product Supported by the LLR | Funding Source | Utility Territories Served |
|---|---|---|
| Home Energy Loans | Ratepayer Funds | SCE and SCG IOU territories |
| | ARRA Funds | Municipal territories |
| Cool Comfort Loans | ARRA Funds | SCE, SCG and SDG&E IOU territories; Municipal territories |

Bevilacqua-Knight, Inc. (BKi) implements the program under contract with SoCalREN. Matadors Community Credit Union is the partner lender. One of the key selling points of the program is that customers can be pre-approved in one day or less. This allows contractors to sell EUC or Cool Comfort upgrades to customers as a package along with the loan. Other important features of the loans are:

1) The amount of loan offered through Home Energy Loans is from $2,500 to $50,000 and Cool Comfort Loan is from $2,500 to $15,000;
2) Terms are from 5-15 years;
3) Solar projects must be enrolled in the California Solar Initiative (CSI);
4) LLR buys down interest rates up to 2%;
5) Minimum customer FICO score = 640;
6) The property must be owner-occupied;
7) Customers must have a debt-to-equity ratio of 50% or lower;
8) Customers cannot have declared bankruptcy in the last seven years or mortgage delinquency of more than 30 days in the last two years ;
9) The program does not charge any closing fees or late fees.

The program has a goal of providing 2,307 loans totaling $2.768 million. As of June 2014, 291 Home Energy Loans have been closed, 64 have been paid off, and three have defaulted (<1%).

## SoCalREN: Non-Residential PACE

SoCalREN provides marketing and administration support for commercial PACE loans in SCE and SoCalGas service territories. BKi implements the program under contract with SoCalREN.

PACE loans are offered to commercial, agricultural, and industrial customers. PACE is also offered to multifamily properties with five or more units. PACE loans appear on the customer's property tax bill and cover measures such as weatherization, windows, doors, HVAC systems, efficient appliances,

---

[4] SoCalREN currently uses funding originally granted during the ARRA period, including funding from the California Energy Commission (CEC), DOE Energy Efficiency and Conservation Block Grant (EECBG), and the Better Buildings Program (BBP).

thermostats, solar PV, and other demand response measures. Other important features of the loans are:

1) Loans begin at $250,000 (including closing and other transaction costs) and there is no maximum loan;

2) Loan terms from 5-20 years;

3) No set interest rate; the average interest rate of the three approved loans is 7%;

4) Owner must be current on any existing mortgages and must not have defaulted on any deeds of trust;

5) Owner must not have been delinquent on property taxes for five years;

6) Applicant must be the legal owner of the property (if more than one, all legal owners must agree to participate);

7) Property must  not have any involuntary liens or judgments;

8) Owner must not be in bankruptcy or have declared bankruptcy in the last 10 years.

SoCalREN has an overall budget of $1.41 million for this program. SoCalREN uses the implementation funds for general project management, project development support, consumer outreach, marketing, application support, pre-approval support and website management.

The program has a goal of supporting 10 loans through the initial PACE application process and five loans through the final application process. Program goals also include five completed PACE-funded projects and five loans in the pipeline for 2015. As of June 2014, three loans have been approved totaling approximately $14 million. Eight more projects are currently in the pipeline, potentially worth $10 to $12 million.

## SoCalREN: Public Agency Financing Assistance Program

The CPUC did not approve funding for a Public Building LLR or Public Agency Revolving Loan Fund. Instead, SoCalREN uses these funds to support the Public Agency Financing Assistance program. Through this program, SoCalREN provides "turnkey" technical assistance support to public agencies (such as cities, counties, and schools) by assisting them with evaluating financing options for energy upgrades and completing financing and incentive applications.

The program is offered to any public agency within SCE or SoCalGas service territory. The program is implemented by The Energy Coalition under contract with SoCalREN. The program also partners with Public Financial Management (PFM), which provides additional financial advising services to participating agencies, and Princeton Credit provides brokerage services.

This program has an overall budget of $494,543. Funds are used entirely for marketing, administration and technical assistance activities. Specifically, SoCalREN uses the implementation funds for general project management, contract management, financial analysis, marketing, consumer outreach, application support, pre-approval support, and website management.

One of the program's key services is the development of a calculator that helps participating agencies evaluate the options for financing energy projects. The financing options supported by program include:

1) Energy Project Lease Financing (ELF), formerly known as "Master Lease"[5];

---

[5] This is implemented by The Energy Coalition under SoCalREN's Regional Energy Center (SoCalREC)

2) SCE/SoCalGas On-Bill Financing (OBF);

3) California Energy Commission (CEC) Low Interest Loan program;

4) CEC Prop 39 Funding;

5) Other financing options such as RLFs, infrastructure banking, and bonds.

Because this program is not included in the Program Implementation Plan, there are no stated participation or energy savings goals. To-date, the program has supported public agencies in securing eight loans or financing options (including ELF and OBF).

## BayREN Local Finance Programs

There are currently three programs run by Bay REN, these programs are summarized below.

### BayREN: Pay as You Go (PAYS)

The Pay As You Go (PAYS) program installs energy improvement measures in residential and commercial buildings with no up-front costs to the customer. The program attaches a monthly change on the customer's bill as a method of repayment. The bill savings achieved through program participation are enough to cover the charge on the utility bill – as such, the program is able to promote a financial argument for customers to participate in the program.

The PAYS program is not a traditional finance program as there is no transfer of money between the utilities/city and the customer. Instead, the utility either chooses to self-finance or gets a loan from a financial institution. The funds are then used to purchase and install energy efficiency and energy improvement measures (based on the needs of the areas being served) with no up-front cost to the customer. The funds are "paid-back" through a surcharge on the customer's water utility bill.

Currently, the program is implemented by BKi and is being developed in two areas:

1) Hayward (residential multifamily program): The goal of the program is to serve 2,000 units. The pilot has already pre-qualified 1,300 units.

2) Windsor (commercial irrigation pilot): The goal of the pilot is to have 15 project sites. All projects are expected to be rolled out by the end of 2014.

Some unique features of the program include no requirement of any up-front costs from the customers and no requirement of a credit check (the customer only needs to be in good standing with the utility). In addition, the measures and bill charge are attached to the building rather than the customers – i.e. if a customer moves out of a multifamily building, then either the new tenant started paying the surcharge, or the building management must make the payments. The program also offers extended warranty protections on equipment to provide repair or replacement at no cost to the customer or the utility (which is part of the implementation budget).

This program is complimentary to PACE and customers are able to get additional rebates through EUC (in which case they then pay the "after rebate costs" on their bill). However, unlike some of the other PACE programs, the approved measures are contingent on the program area and the population being served and are decided based on the cost-effectiveness of the measures. For example, Hayward has a lower water rate structure and as such the measures included in the Hayward program include hot water measures, pool pumps and lighting.

### BayREN: Multifamily Capital Advancement Program

BayREN'sMulti Family Capital Advance Program began in 2014 and is administered by the Alameda County Waste Management Authority (Stop Waste). It is a revolving loan fund, with pass through

servicing by a lender. It co-finances with private lenders to provide half the loan amount at half the interest rate for any energy efficiency portion of an unsecured loan to make multifamily upgrades. The loan pool is $1.5 million and the marketing and administrative budget is $500,000. Customers will be part of BayREN's comprehensive multifamily program and requires customers to participate in the IOUs' Multifamily or EUC Whole Building program. Since the program is so new, it has yet to partner with a financial institution or to make a loan.

## BayREN Commercial PACE

Under the original BayREN program implementation plan (PIP) from 2012, the Commercial PACE program was intended to provide customers with an "open market" model to allow commercial property owners to arrange their own financing but would require that they reach an agreement with the primary mortgage holder on the superior position of the PACE lien. It was also originally intended to independently recruit participating lenders and equity funds, and maintain a current database on Commercial PACE options as part of BayREN's one-stop Energy Efficiency Programs website.

The original program was also intended to refine and streamline program administration, sustain project momentum, track results, and improve operational efficiency and scale through web-based processes. Lastly, the program was to create a dedicated Commercial PACE Loan Loss Reserve/Debt Service Reserve Fund, as an assurance fund to reduce risk to lenders and translate into lower interest rates for customers.

However, in January of 2013, the CPUC only subsequently funded the Commercial PACE program as a modest ME&O campaign for existing California First Commercial PACE Program for the 13-4 cycle. Thus, the focus of the program shifted to the development and production of a county-by-county commercial inventory and profiling tool and market segmentation for ME&O activities. The program has achieved the following milestones:

1) Development and completion of 9 county-specific Commercial Building Inventory and Profiling Tool(s);
2) Market segmentation exercises to identify and target building owners and operators as retrofit-ready or retrofit-persuadable;
3) Development and completion of BayREN Commercial PACE Website;
4) Cost analysis of full implementation program;
5) Initial research on other commercial sectors, e.g., medical;
6) Early development of Commercial PACE R&D pilot to produce "Commercial PACE toolkit, BMPs, and to develop solutions to persistent market barriers, e.g., bonding process); and
7) Early end-user outreach.

While this pared down version of the program does not include data collection to calculate energy savings, the original version included investment grade audits which would have allowed for the opportunity to calculate energy savings.

## Summary of Findings Memo

Opinion **Dynamics**

# Memorandum

To:     CPUC-Energy Division
From:   Opinion Dynamics and Dunsky Evaluation Team
Date:   01/21/2016
Re:     Local Program Impacts: High Level Findings

### Introduction

Starting in 2014, the Opinion Dynamics Evaluation Team conducted research into 11 active residential and non-residential local/regional programs to prioritize the programs for potential future evaluation efforts. Based on this effort, the Evaluation Team recommended five programs for potential impact evaluations (see Table 1).

Table 1. Local Finance Programs Covered

| Program Administrator | Finance Program Name | Sector |
|---|---|---|
| BayREN | Pay As You Save | Residential |
| SoCalREN | Non-Residential Property Assessed Clean Energy (PACE) | Non- Residential |
| SoCalREN | Residential Loan Loss Reserve (LLR) | Residential |
| IOU (PG&E) | Golden State Financing Authority (GSFA)* Residential Energy Retrofit Program | Residential |
| IOU (PG&E, SCE and SCG) | emPower Central Coast | Residential |
| *Formerly known as the California Rural Home Mortgage Finance Authority Homebuyers Fund (CHF) | | |

Building on this history, the Evaluation Team interviewed staff from these programs in November/December 2015 to better understand any updates or changes in program design participation and/or data tracking. This effort was designed to help determine whether these five programs are still viable options for conducting an impact evaluation with ratepayer funds in 2016 with 2013-2015 participants.

### Summary of Findings

Through this effort, it was learned that ratepayer funds for the BayREN Pay As You Save program contributed minimally to program activity and were only used for program design support. As such, the Evaluation Team does not recommend this program for an impact assessment at this time.

The other four programs had loan activities that were achieved through ratepayer funds (see Table 2).

Table 2. Program Activity to Date (Till October 2015)

| Finance Program Name | Ratepayer Program Budget (2013-2015) | Number of Loans to Date | Total Loan Value |
|---|---|---|---|
| SoCalREN Non-Residential PACE | $2,279,190 | 5 | $14,435,000 |

opiniondynamics.com                                                    Page 1

| Finance Program Name | Ratepayer Program Budget (2013-2015) | Number of Loans to Date | Total Loan Value |
|---|---|---|---|
| SoCalREN Residential Loan Loss Reserve | $4,048,021 | 94 | $2,557,300 |
| GSFA Residential Energy Retrofit Program | Unknown | 190 | $4,800,000 |
| emPower Central Coast | $3,700,000* | 20 | $417,591 |

Note: Transactions listed here are supported through ratepayer funds. These programs have additional activities that are not listed here, because they are funded through other sources including ARRA and EECBG (Energy Efficiency and Conservation Block Grants).
* This represents only 2013-2014 budget as 2015 budget is unknown

The SoCalREN Non-Residential PACE program is purely an administrative program providing marketing and referral support to the PACE program. In addition, it has low activity in terms of the number of customers it serves (5 customers funneled to the PACE program to date). As such, this program may not be ready for a full impact assessment at this time. However, there may be value in exploring these five customers in-depth to better understand the nature of the projects, loan details, and motivations for these customers to participate as well as better understand the efforts that helped enroll these customers (especially since these five customer account for a high volume of loans of about $14 million).

The three residential programs (SoCalREN Residential LLR, GSFA Residential Energy Retrofit, and emPower Central Coast) are all run in conjunction with the Home Upgrade and Advanced Home Upgrade (collectively "Home Upgrade") programs. They are all considered non-resource programs whereby energy savings are currently being claimed by the Home Upgrade programs. Given their design and activities (see Table 2 and program summaries below), these programs are viable candidates for impact evaluation. However, the Evaluation Team would first need to determine if and how to coordinate the finance evaluation with any past or planned impact evaluation efforts for the Home Upgrade programs to ensure the finance evaluation adds value to what is currently evaluated. Next, the Evaluation Team would have to submit a data request and review the actual data available. While each of the programs will need nuanced approaches, some of the impact evaluation topics to consider at this time include:

- Gross impacts (and gross savings per participant)
- Attribution analysis, net impacts accounting for influence of finance alone or finance coupled with rebates (note that there are likely only a handful of customers in one regional program that did not use rebates AND financing)
- Cost-effectiveness
- Comparative analysis (comparing project size/depth amongst participants with finance & rebates versus participants with just rebates)
- Participation rate analysis (analysis of participation within the resource programs before and after the introduction of finance)

## Program Summaries

### SoCalREN Non-Residential PACE

SoCalREN provides marketing and administration support for commercial PACE loans in joint SCE and SCG service territories. Bevilacqua-Knight, Inc. (BKi) implements the program under contract with SoCalREN. Under this contract, BKi conducts general project management, project development support, consumer outreach, marketing, application support, pre-approval support, website management outreach, marketing efforts to

promote the program, and ensures that the all customers and measures meet the program requirements. They then present this information to the Treasury Tax Collector, who then approve or deny the loan. According to BKi the program has helped funnel a total of five loans as of October 31, 2015 (all in 2013-2014, which total of $14,435,000) using ratepayer funds (these count do not include customers who were served by BKi but not enrolled into PACE).

In addition to a program description and information on performance, we were able to gather the types of data that BKi currently collects for the program (see table below).

Table 3. Types of Data Collected for the SoCalREN Non-Residential PACE Program

| Types of Data Collected | SoCalREN Non-Residential PACE |
|---|---|
| **Energy Efficiency Installations** | |
| Type of Installed Energy Efficiency Improvements | √ |
| Measure Type | √ |
| Building square footage | √ |
| Contractors Used for Energy Efficiency Installations | √ |
| Predicted savings | √ |
| Information on Projects Determined to be ineligible | √ |
| **Loan Information** | |
| Loan amount | √ |
| Loan term | √ |
| Loan interest rate | √ |
| FICO score | NA |
| Delinquency/default | √ |
| **Customer Information** | |
| Participant demographic information (age, income, education etc.) | NA |
| Utility account number | x |
| Incentive or rebate | √ |
| Monthly consumption data | x |
| Information on Loan Application Process | x |

## SoCalREN Residential Loan Loss Reserve

The goal of the SoCalREN Residential LLR program is to help single family residential customers obtain home energy loans that support residential energy efficiency and solar upgrades[1] through the Home Upgrade programs (customers must participate in these programs to qualify for financing). The LLR covers 90% of the loans, resulting in lower interest rates that make these loans more affordable and attractive to customers. SoCalREN's program only operates in joint SCE and SCG service territories. Funding for this program is primarily from ratepayers, however, the program still uses some remaining ARRA[2] funding. BKi implements the program under contract with SoCalREN. Matadors Community Credit Union is the partner lender.

One of the key selling points of the program is that customers can be pre-approved in one day or less. To qualify for the loan, the customer must own the property at which they will complete energy efficiency improvements, have a minimum FICO score of 660, have a debt-to-income ratio of 50% or lower, among other criteria. Eligible customers are able to borrow up to $50,000 at interest rates between 4.99% and 6.99% Annual Percentage Rate (APR) with terms from 5 to 15 years.

---

[1] Solar projects must be enrolled in the California Solar Initiative.
[2] American Recovery and Reinvestment Act

According to BKi there have been a total of 94 loans as of October 31, 2015 (57 in 2013-2014 and 37 in 2015) using ratepayer funds, for a total LLR guarantee of $255,730, with $0 claimed against the LLR. The average loan details include a loan of about $18,554 for 101 months at 5.86% interest (these are estimated using closed, paid-off or defaulted loans). In addition to a program description and information on performance, we were able to gather the types of data that BKi currently collects for the program (see table below).

Table 4. Types of Data Collected for the SoCalREN Residential Program

| Types of Data Collected | SoCalREN Residential LLR |
|---|---|
| **Energy Efficiency Installations** | |
| Type of Installed Energy Efficiency Improvements | √ |
| Measure Type | √ |
| Housing Type (SF/MF) | √ |
| Contractors Used for Energy Efficiency Installations | √ |
| Predicted savings | √ - Advance Home Upgrade<br>x - Home Upgrade |
| Information on Projects Determined to be ineligible | x |
| **Loan Information** | |
| Loan amount | √ |
| Loan term | √ |
| Loan interest rate | √ |
| FICO score | √ |
| **Customer Information** | |
| Participant demographic information (age, income, education etc.) | x |
| Utility account number | x |
| Incentive or rebate | √ |
| Monthly consumption data | x |
| Information on Loan Application Process | x |

## Golden State Financing Authority Residential Energy Retrofit Program[3]

The goals of the Golden State Financing Authority (GSFA) Residential Energy Retrofit Program is to help PG&E residential homeowners with the upfront cost of making energy efficiency improvements and solar upgrades[4] in their homes, which helps reduce energy costs, improve home comfort, reduce the impact on the environment and ultimately leads to job creation. Funding for this program is primarily from ratepayers, however, the program is still using some remaining ARRA funding. GSFA has created a partnership with Five Star Bank. The bank provides customers with an unsecured loan for making energy efficient upgrades in their homes and GSFA provides the bank with an LLR with a cap of 10% of the actual committed loans.

The program takes a whole house approach to projects and all projects require a Home Energy Rating System (HERS) inspection to show they it will achieve at least 10% energy savings. The program runs in conjunction with the Home Upgrade programs, where customers receive financing for measures eligible for Home Upgrade rebates. However, there is no requirement for customers to qualify for or plan to take rebates before they can use financing. In other words, customers can use financing with or without applying for the rebates but they

---

[3] GSFA was formerly known as the CRHMFA Homebuyers Fund, or CHF. Please note that in the Evaluation Team's October 2014 memo to the CPUC prioritizing local programs for evaluation ("Local Finance Programs: Summary of Program Manager Interviews". 10/20/2014. Opinion Dynamics.), the Team referred to this program as CHF. Henceforth, the Team will refer to this program as the GSFA Residential Energy Retrofit Program.

[4] Solar projects must be enrolled in the California Solar Initiative.

must install the eligible measures under the Home Upgrade programs. According to the program this does not happen often, but there have been a couple of instances where customers did not want to apply for the rebate and chose to only use financing.

The GSFA program offers two paths for home upgrades[5]:

- GSFA Basic Home Upgrade Path – potentially includes air sealing, insulation, duct sealing, and heating and cooling equipment

- GSFA Advanced Home Upgrade Path – uses computer modeling and technical equipment to customize energy efficiency projects to specific home needs

The program does not do any marketing. Rather, all marketing is done through contractors. PG&E provides GSFA with an eligible Home Upgrade contractor and GSFA provides training to these contractors on how to sell the program to their customers. The program does not target customers on income, rather they qualify based on location (must be in a member county and PG&E customer), home ownership, FICO score (minimum of 640), and debt to income ratio (45% or lower), among others. In addition, customers must agree to setup automatic withdrawal of the loan payment. Eligible customers are able to borrow up to $50,000 at a 6.5% fixed interest rate. The loan is a 15 year fully-amortized loan and up to $20 million in loan financing is available. To date, using ratepayer funds, there have been a total of 190 loans of $4.8 million and there have been two loan defaults.

The program collects overall project-level data through the Energy Pro software package, which gives them overall savings achieved through the program. However, they do not record measure-level data. All data collected is handed over to PG&E and thus, all data request should be directed towards PG&E. According to GSFA, they are purely an administrative program and do not claim savings for the projects. Thus, GSFA is a non-resource program where all savings are claimed by the Home Upgrade programs. The savings claimed are determined via the measures that have claimed rebates. So a customer could have made multiple upgrades in their home, but PG&E can only claim savings for those measures for which they received a rebate.

Table 5. Types of Data Collected for the GSFA Program

| Types of Data Collected | GSFA Residential Energy Retrofit program |
|---|---|
| **Energy Efficiency Installations** | |
| Type of Installed Energy Efficiency Improvements | √ |
| Measure Type | x |
| Housing Type (SF/MF) | x |
| Contractors Used for Energy Efficiency Installations | √ |
| Predicted savings | √ |
| Information on Projects Determined to be ineligible | x |
| **Loan Information** | |
| Loan amount | √ |
| Loan term | √ |
| Loan interest rate | √ |
| FICO score | √ |
| **Customer Information** | |
| Participant demographic information (age, income, education etc.) | x |
| Utility account number | x |
| Incentive or rebate | √ |

---

[5] http://www.gsfahome.org/programs/energy/measures.shtml

| Types of Data Collected | GSFA Residential Energy Retrofit program |
|---|---|
| Monthly consumption data | x |
| Information on Loan Application Process | x |

### emPower Central Coast

The goal of the emPower Central Coast (emPower) program is to make residential energy efficiency improvements and solar upgrades[6] more affordable through financing. Funding for this program is primarily from ratepayers. emPower has created a partnership with Coast Hills Federal Credit Union and Ventura County Credit Union to offer unsecured loans with low rates and flexible terms of repayment up to 15 years. The LLR offers up to 90% of a loan's value to partner financial institutions up to 5% of the total loan portfolio.

The program is tied to the Home Upgrade programs, where customers receive financing for measures eligible for Home Upgrade rebates (customers must participate in these programs to qualify for financing). emPower is a non-resource program where all savings are claimed by the Home Upgrade programs. The program is marketed primarily through the Home Upgrade programs' participating contractors, as well as through direct means such as emPower's website, outreach events, direct mailers, newsletters and Home Performance Energy Coaches. Participating credit unions are not heavily involved in marketing, but do send out e-mail blasts and occasionally participate in marketing events. Given that the program is tied to the Home Upgrade programs, and thus can only finance measures on the eligible measure list, the program focuses a lot of resources on contractor training and engagement to help them sell the program. All program contractors are required to verify projects for the financial institutions and help customers through the rebate process.

In addition to the loans, the program offers Home Performance Energy Coaches to help customers understand and get interested in energy efficiency, which is essential given the whole house approach of the Home Upgrade programs. For example, the program offers a free home assessment "walk thru site visits" to outline potential home upgrades.[7] According to the program staff, they offer about 12 services, with financing being only one of them, all of which contribute towards increased customer/contractor engagement and thus ultimately savings. Examples of other services are energy coaching, marketing, contractor engagement, and web analytics.

To qualify for the loan, the customer must go through the Home Upgrade programs, have a minimum FICO score of 590 and a debt-to-income ratio of no more than 60%. Eligible customers are able to borrow up to $30,000 at a 5.9% fixed interest rate. The loan is a 15 year fully-amortized loan and up to $20 million in loan financing is available. To date, using ratepayer funds, there have been a total of 20 loans of $417,591 and there have been no loan defaults.

In addition to a program description and information on performance, we were able to gather the types of data that is currently collected for the program (see table below).

Table 6. Types of Data Collected for the emPower Central Coast Program

| Types of Data Collected | emPower Central Coast* |
|---|---|
| **Energy Efficiency Installations** | |
| Type of Installed Energy Efficiency Improvements | √ |
| Measure Type | √ |
| Housing Type (SF/MF) | √ |

---

[6] Solar projects must be enrolled in the California Solar Initiative.
[7] https://www.empowersbc.org/about-program/faq/homeowners

| Types of Data Collected | emPower Central Coast* |
|---|:---:|
| Contractors Used for Energy Efficiency Installations | √ |
| Predicted savings | √ |
| Information on Projects Determined to be ineligible | x |
| **Loan Information** | |
| Loan amount | √ |
| Loan term | √ |
| Loan interest rate | √ |
| FICO score | √ |
| **Customer Information** | |
| Participant demographic information (age, income, education etc.) | √ |
| Utility account number | √ |
| Incentive or rebate | √ |
| Monthly consumption data | x |
| Information on Loan Application Process | x |

\* Notably, the Evaluation Team is still waiting for updated information on data collected. Data shown in the data was collected during the first round of interviews in October, 2014.

**Regional Finance Program Attribution and Cost-effectiveness Study Evaluation Plan**

# Regional Finance Program Attribution and Cost-effectiveness Study: Evaluation Plan

Prepared under the direction of the **Energy Division** for the

## California Public Utilities Commission

Kevin Feizi, CPUC Project Manager
kevin.feizi@cpuc.ca.gov

Submitted by:

**Opinion Dynamics**
1999 Harrison Street, Suite 1420
Oakland, CA 94612
aelliott@opiniondynamics.com
510-214-0180

The study effort is covered under California Public Utilities Commission (CPUC) Contract 12PS5093 between Opinion Dynamics Corporation and the CPUC. The evaluation effort is covered under work order ED_O_FIN8, referred to as "Impact Evaluation #3: Regional Financing Study" in the Finance Roadmap (V.8, September 2016)

# Table of Contents

# 1. Study Overview

On behalf of the California Public Utilities Commission (CPUC), Opinion Dynamics and Dunsky Energy Consulting (the Evaluation Team) will perform attribution and cost-effectiveness studies of three 2013-2015 regional finance programs: the emPower Central Coast Program, the Golden State Finance Authority (GSFA) Residential Energy Retrofit Program, and the Southern California Regional Energy Network (SoCalREN) Home Energy Loans Program[1]. Henceforth, we refer to these as the "Regional Finance Programs" or "Finance Programs".

All three of the Finance Programs are Loan Loss Reserves (LLRs) that offer credit-enhanced financing to support energy efficiency whole-home retrofits through the Energy Upgrade California® Home Upgrade and Advanced Home Upgrade Programs (henceforth referred to as the "EUC Programs"). Each Finance Program partners with one or more financial institutions that issue and administer the loans while the LLR guarantees the loan amount in cases of default.

The overarching purpose of this study is to gain a foundational understanding of the value of financing programs in achieving or increasing energy savings from whole home retrofits. We expect that the results of this study will provide important insights to the State and the CPUC as they roll out the Statewide Financing Pilots. Further, this study aims to test out an experimental approach to estimating the influence of financing relative to other influential factors (i.e., rebates), namely the Latent Class Discrete Choice (LCDC) analysis approach. Importantly, the attribution estimates we will develop through this study will not provide inputs into or alter any deemed savings calculations for EUC projects.

## 1.1 Study Population

Our primary study population includes residential customers that participated in one of the EUC Programs and used loans from one of the three Finance Programs to pay for their project.[2] As shown in Table 1, below, our population includes 343 customers who participated in EUC programs offered by three Investor Owned Utilities (IOUs)[3] and SoCalREN.

Table 1: Regional Finance Program Participants

| Regional Finance Program | Number of Program Participants | Number of EUC Participants | EUC Programs |
|---|---|---|---|
| emPower Central Coast | 52 | 42 | • PG&E/SCG Home Upgrade<br>• PG&E/SCG Advanced Home Upgrade<br>• SCE/SCG Home Upgrade<br>• SCE/SCG Advanced Home Upgrade |

---

[1] Also known as the SoCalREN Residential Loan Loss Reserve

[2] We also explored the possibility of including an additional program, the SoCalREN Non-Residential Property Assessed Clean Energy (PACE) program. However, this program does not provide actual financing, but rather provides marketing and administrative support for PACE loans. In addition, it has low activity in terms of the number of customers it serves (seven customers funneled to PACE programs to date). As such, this program may not be ready for a full impact assessment at this time.

[3] Pacific Gas and Electric (PG&E), Southern California Edison (SCE), and Southern California Gas Company (SCG)

*Study Overview*

| Regional Finance Program | Number of Program Participants | Number of EUC Participants | EUC Programs |
|---|---|---|---|
| GSFA Residential Energy Retrofit Program | 201 | 201 | • PG&E Home Upgrade<br>• PG&E Advanced Home Upgrade |
| SoCalREN Home Energy Loans | 100 | 100 | • SCE/SCG Advanced Home Upgrade<br>• SCE/SCG Home Upgrade<br>• SoCalREN Home Upgrade |
| Total | 353* | 343 | N/A |

*10 emPower participants did not participate in the EUC programs. See Section 2.1 for more detail.

For more information on how we selected these three Finance Programs, please see Appendix A.

## 1.2    Objectives

This research will address the following four objectives and research questions.

- Objective 1: Assess data availability of the Regional Finance Programs

  - What data is available for each of the Regional Finance Programs? How much information is available on customers, contractors, programs, measures installed, measure incentives, and costs?

- Objective 2: Determine how much of EUC project energy savings is attributable to the Regional Finance Programs

  - What energy efficient measures do the Regional Finance Programs fund? What are the ex-ante savings associated with these projects?

  - What is the relative impact of the Regional Finance Programs versus rebates on EUC project energy savings and customer participation?

  - Which customer segments do the Regional Finance Programs impact?

- Objective 3: Explore trends in EUC participation with and without the Regional Finance Programs

  - What is the difference in project size and scope between those who participated in the Regional Finance Programs and received EUC rebates versus participants with just EUC rebates?

  - Has EUC participation changed in size or scope since the introduction of the Regional Finance Programs?

- Objective 4: Assess the cost-effectiveness of the Regional Finance Programs

  - Are the Regional Finance Programs cost-effective?

*Regional Finance Programs Description*

# 2. Regional Finance Programs Description

In the following section, we describe each of the Regional Finance Programs, including key program design elements, program performance metrics for 2013-2015, and data availability. We developed these descriptions based on interviews with the Finance Program managers and a review of their tracking data. Following detailed descriptions of each Finance Program, we provide summary tables in Section 2.4 and a review of data availability in Section 3.1.

## 2.1 emPower Central Coast Program

The goal of the emPower Central Coast Program is to help property owners overcome obstacles to making residential energy efficiency improvements and solar upgrades, through financing and a variety of other programming and services. The Coast Hills Federal Credit Union and Ventura County Credit Union issue and administer the loans. The LLR guarantees 90% the loans' value and maintains an LLR escrow[4] account equal to 5% of the loan portfolio's value. This program has received funding from several sources, including ratepayer (through SCG), American Recover and Reinvestment Act (ARRA), and the California Energy Commission (CEC) funds.

The majority of the loans support EUC projects but some support other programs or projects. In 2013 to 2015, six loans supported California Solar Initiative projects and four supported "Flex Path" home upgrade projects. Flex Path customers installed measures that would qualify for EUC Program rebates, but they did not participate in EUC. We do not include these ten loans in our study population. Loans are available to homeowners in Santa Barbara, San Luis Obispo, and Ventura Counties. Customers must have FICO score of 590 or higher and a debt-to-income (DTI) ratio of 60% or lower to qualify.

During the study period, the program issued 52 loans, 42 of which supported EUC projects. The EUC loans totaled $873,997 and there have been no loan defaults. EUC loan amounts ranged from $10,843 to $30,000, with an average of $20,809. Interest rates varied, averaging 5.85%. A special rate of 3.90% was available only in Santa Barbara County, although not all loans in that county received that rate. Loan terms also varied, averaging about 15 years.

## 2.2 GSFA Residential Energy Retrofit Program

The goal of the GSFA Residential Energy Retrofit Program is to help PG&E residential homeowners cover the upfront cost of making energy efficiency improvements in their homes. Five Star Bank issues and administers the loans. The LLR guarantees 100% the loans' value and maintains an LLR escrow account equal to 10% of the loan portfolio value. Funding for this program is primarily through ratepayer dollars. However, the program is still using some remaining ARRA funding from 2012.

All of the loans support EUC projects. Loans are available to homeowners in PG&E territory who have a FICO score of 640 or higher and a DTI ratio of 45% or lower.

---

[4] "Escrow" refers to funds deposited into the bank's LLR account. LLRs typically do not actually maintain 90% of the entire loan portfolio in the LLR account. Rather, they agree with the partner bank on a smaller percentage to keep in escrow based on risk calculations.

*Regional Finance Programs Description*

During the study period, the program issued 201 loans. The loans totaled $5,148,031 and five loans have defaulted. Loan amounts ranged from $4,620 to $50,000, with an average of $25,612 in project years 2013-2015. All loans had an interest rate of 6.50% and a term of 15 years.

## 2.3 SoCalREN Home Energy Loans

The goal of the SoCalREN Home Energy Loans program is to help single-family residential customers obtain home energy loans that support energy efficiency and solar upgrades[5]. Matadors Community Credit Union issues and administers the loans, and Bevilacqua-Knight, Inc. (BKi) administers the LLR. The LLR guarantees 90% the loans' value and maintains an LLR reserve account equal to 15% of the loan portfolio's value.[6] Funding for this program has been from ratepayer dollars since December, 2013. Prior to this, ARRA funds supported the program.

All of the loans support EUC projects. Loans are available to homeowners in joint SCG/SCE territory, excluding Santa Barbara, San Luis Obispo, and Ventura Counties.[7] Customers must have a FICO score of 660 or higher and a DTI ratio of 50% or lower to qualify.

During the study period, the program issued 100 loans. The loans totaled $1,808,728, and there have been no defaults. Loan amounts ranged from $3,318 to $50,000, with an average of $18,087. Interest rates ranged from 3.00% to 6.99% with an average of 5.87%. Loan terms varied, averaging about 10 years.

---

[5] Solar projects must be enrolled in the California Solar Initiative.

[6] According to SoCalREN, they placed 90% of the first five loans into the escrow account from the reserve account and then 10% of all subsequent loans. They regularly manage the reserve account to maintain a balance equal to 15% of outstanding loan value.

[7] These customers are covered by the emPower Central Coast program.

*Regional Finance Programs Description*

## 2.4 Summary and Achievements by Program

Table 2, below, summarizes each Finance Program's key characteristics, and Table 3 summarizes each program's 2013-2015 budget, LLR allocations, expenditures, and loans issued.

**Table 2: Regional Finance Program Summary**

| Program Design Details | emPower Central Coast Program | GSFA Energy Retrofit Program | SoCalREN Home Energy Loans |
|---|---|---|---|
| Program Administrator | emPower | GSFA | SoCalREN, BKi |
| Financial Institution Partnership(s) | Coast Hills Federal Credit Union and Ventura County Credit Union | Five Star Bank | Matadors Community Credit Union |
| IOU(s) Involved | PG&E, SCE, SCG | PG&E | SCE, SCG |
| Target Geography | Santa Barbara, San Luis Obispo, Ventura Counties | 44 California counties in PG&E territory | SCE/SCG joint territories; property owners in the counties of Santa Barbara, Ventura and San Luis Obispo are not eligible. |
| Programs Supported by Loans | Energy Upgrade California® Home Upgrade/Advanced Home Upgrade, Flex Path, and California Solar Initiative | Energy Upgrade California® Home Upgrade/Advanced Home Upgrade | Energy Upgrade California® Home Upgrade/Advanced Home Upgrade and California Solar Initiative |
| Program Start Date | Nov-11 | Sep-12 | Dec-13 |
| **Loan Details** | | | |
| Interest Rate | 3.90-12.5% (Average: 5.85%) | 6.50% fixed | 4.99-6.99% (Average: 5.87%) |
| Term | 5-15 years (Average: 14.5 years) | 15 years | 5-15 years (Average: 9.5 years/114 months) |
| Average Loan Amount | $20,809 (EUC only) | $25,612 | $18,087 |
| Minimum Loan Amount Allowed | $1,000 | None | $2,500 |
| Maximum Loan Amount Allowed | $30,000 | $50,000 | $50,000 |
| **Qualification Requirements** | | | |
| EUC Program Participation Required | No | Yes | Yes |
| Debt-to-Income Ratio | 60% or lower | 45% or lower | 50% or lower |
| Minimum FICO | 590 | 640 | 660 |

Source: Interviews with program staff in August 2016; data received from program staff in August and September 2016

*Regional Finance Programs Description*

**Table 3: 2013-2015 Achievements by Finance Program**

| Metric | emPower Central Coast Program | GSFA Residential Energy Retrofit Program | SoCalREN Home Energy Loans |
|---|---|---|---|
| **Total Budget (millions)** | **$5.05** | **$1.00** | **$5.21** |
| Funds available to support LLR | $1.00 | $0.92 | $3.83 |
| Non-Financing Program Budget (i.e., Administrative, Marketing) | 4.05 | $0.08 | $1.38 |
| **Total Expenditures/Allocations (millions)** | **$3.20** | **$0.48** | **$1.69** |
| Total Allocated to the LLR Escrow Account | $0.60 | $0.40 | $0.50 |
| Non-Financing Expenditures | $2.60 | $0.08 | $1.19 |
| **Number of Completed Loans** | **52** | **201** | **100** |
| Loan Supporting Advanced Home Upgrade | 42 [a] | 176 | 13 |
| Loans Supporting Home Upgrade | | 25 | 87 |
| Loans Supporting Non-EUC Projects | 10 | N/A | N/A |
| Number of Loans in Default | 0 | 5 | 0 |
| **Total Loans Amount Issued [b]** | **$1,019,083** | **$5,148,031** | **$1,808,728** |
| EUC Loans Amount | $873,997 | $5,148,031 | $1,808,728 |
| Other Program Loans Amount | $145,086 | N/A | N/A |

Source: Data received from emPower, GSFA, and SoCalREN in August and September 2016

[a] The data provided by emPower does not indicate which EUC Program each loan supports.

[b] This does not reflect the value of outstanding loans, which would account for repayment. This reflects the sum of original loan amounts issued.

*Evaluation Plan*

# 3. Evaluation Plan

Considering the background information and research objectives presented above, we propose the following evaluation tasks, timeline and budget.

## 3.1    Evaluation Tasks

### Task 1: Data Inventory

The Evaluation Team has reviewed all data received from the Regional Finance Programs and has assessed the availability of information on loans, projects, participants, and contractors. We face confidentiality barriers when it comes to accessing financial data. As a result, two of the three Programs submitted anonymized loan data accompanied by a second file only containing unique EUC project identifiers (no loan information) or addresses. We will cross-reference these identifiers with the EUC program-tracking databases. Theoretically, this will allow us to identify which EUC projects received Program loans, but will not allow us to link those projects or customers' personal information to individual loans.

Table 4 summarizes the data we have received to date. All essential loan information is available, but we have limited participant and project information. We have received essential contractor information from all three Programs, including the names and contact information of specific contractors for each project.

**Table 4: Received Data**

| Data Type | emPower (n=42) Availability | GSFA (n=201) Availability | SoCalREN (n=100) Availability |
|---|---|---|---|
| **Loan Information** | | | |
| Date loan funds released | Most or all (>90%) | Most or all (>90%) | Most or all (>90%) |
| Loan status | Most or all (>90%) | Most or all (>90%) | Most or all (>90%) |
| Loan amount | Most or all (>90%) | Most or all (>90%) | Most or all (>90%) |
| Interest rate | Most or all (>90%) | Most or all (>90%) | Most or all (>90%) |
| Loan term | Most or all (>90%) | Most or all (>90%) | Most or all (>90%) |
| **Participant Information** | | | |
| Fico score | Most or all (>90%) | Most or all (>90%) | Most or all (>90%) |
| Income | Most or all (>90%) | Most or all (>90%) | Data unavailable |
| Zip code | Most or all (>90%) | Data unavailable | Most or all (>90%) |
| Debt to income ratio | Most or all (>90%) | Data unavailable | Data unavailable |
| Name | Data unavailable | Data unavailable | Most or all (>90%) |
| Address | Data unavailable | Most or all (>90%) | Most or all (>90%) |
| Contact e-mail | Data unavailable | Data unavailable | Data unavailable |
| Contact phone | Data unavailable | Data unavailable | Data unavailable |
| **EUC Project Information** | | | |
| Flag for Advanced vs. Home Upgrade project | Data unavailable | Most or all (>90%) | Most or all (>90%) |
| Predicted energy savings | Most or all (>90%) | Data unavailable | Some (> 50%) |
| Installed measures | Most or all (>90%) | Data unavailable | Data unavailable |
| Rebate amount | Most or all (>90%) | Data unavailable | Data unavailable |
| Housing characteristics | Some (> 50%) | Data unavailable | Data unavailable |
| Project Cost | Data unavailable | Data unavailable | Data unavailable |

*Evaluation Plan*

| Data Type | emPower (n=42) Availability | GSFA (n=201) Availability | SoCalREN (n=100) Availability |
|---|---|---|---|
| **Contractor Information** | | | |
| Company name | Most or all (>90%) | Most or all (>90%) | Most or all (>90%) |
| Contractor name | Most or all (>90%) | Most or all (>90%) | Most or all (>90%) |
| Contact e-mail | Most or all (>90%) | Most or all (>90%) | Most or all (>90%) |
| Contact phone | Most or all (>90%) | Most or all (>90%) | Most or all (>90%) |

To date, we have received loan data from the Programs but are awaiting EUC program-tracking databases from DNV-GL[8]. While we do not anticipate any challenges, once we have received all data, we will develop a Data Inventory Memo that assesses whether any data limitations affect our ability to answer the study research questions.

## Task 2a: Contractor and Participant In-depth Interviews

We will conduct interviews with a limited number of Regional Finance Program participants and contractors who completed projects for participants. These interviews will provide critical inputs into the larger participant survey regarding financing options available to customers in the Finance Programs' territories. They will also provide insight into how, if at all, the Finance Programs have influenced contractors' likelihood to promote the EUC programs, which would represent an important path of influence. Our specific goals are to:

- Understand what financing options are available to customers for completing energy efficiency home upgrades;

- Learn how customers typically shop for financing options (or if they shop at all);

- Discuss if and how contractors support customers in understanding, selecting, or applying for financing options;

- Determine the importance of the Regional Finance Programs in contractors' ability or willingness recommend the EUC program;

- Learn what part financing plays in the upgrade decision, and what proportion of the project the customers finance;

- Collect feedback on the motivations and barriers for customers to get financing in the market (i.e., credit scores, level of effort);

- Measure the relative importance of financing versus rebates in customers' decisions to complete energy efficiency home upgrades;

- Gain contractors' and customers' perspectives on the pros and cons of choosing energy efficiency financing programs versus other financing options; and

---

[8] DNV-GL has lead several EUC impact evaluations and has agreed to share EUC program tracking data with us.

*Evaluation Plan*

■ Understand how the IOUs' association with the Finance Programs influences customers' decisions regarding project initiation and the use of energy-efficiency-specific financing, beyond just offering rebates.

Our goal will be to interview three to four contractors from each Program, for a total of nine to twelve interviews. Contractors had a wide range of Finance Program involvement, working with between one and thirty-two participants. To ensure that our results reflect as many projects as possible, we will prioritize interviewing contractors who worked with more participants. Similarly, we plan to interview three to four participants in each Finance Program (nine to twelve total), and will aim to speak with customers who completed projects in a range of sizes (we will likely use total project cost or rebate amount as proxies for size).

## Task 2b: Participant and Near-Participant Internet Survey

We will field a survey to Finance Program participants, EUC program participants, and customers who indicated some interest in financing and in the EUC Program. The primary purpose of the participant survey will be to provide inputs into a net-to-gross ratio (NTGR) for each Finance Program. The NTGR represents the incremental energy savings that can be attributed solely to the use of Regional Financing Programs when completing EUC projects. The key theoretical components of this influence are:

■ How influential was the availability of **both** Regional Finance Program loans and rebates in participants' decisions to do EUC projects?

■ What is the relative influence of the Regional Finance Program loans compared to the rebates?

■ Did participants complete measures they otherwise would not have if the Regional Finance Program loans had not been available? Would they have done fewer measures? Would they have done less energy efficient measures?

We will estimate the NTGRs for each Regional Finance Program overall and across groups of participants with different levels of project cost and financing amounts, as we would expect these groups to have different levels of program influence. To overcome the confidentiality constraints mentioned in Task 1, we will ask survey respondents to self-report whether they received rebates or financing (for Finance Program participants, we will ask about other sources of financing), their total project cost, and the total amount of financing and rebates they received.[9]

While the primary goal of the survey is to measure the influence of the Regional Finance Programs, we will incorporate relevant non-participants in the sample as well. The most statistically robust models come from not only surveying as many respondents as possible but also capturing responses from a broad range of customer scenarios.[10] Specifically, we want to include customers who have a range of characteristics and who have made a variety of upgrade and financing decisions. However, it is also important that the exercise be relevant to the respondent, i.e., they at least have an interest in doing an energy-relevant upgrade, are

---

[9] As always, it is possible that some survey respondents will report this information inaccurately. To assess self-report bias, we will compare tracking data (where possible) to self-reported information.

[10] For example, it is difficult to get a robust estimate of the correlation between any two variables if the model is estimated on a very narrow range of values on those variables.

*Evaluation Plan*

likely to be qualified for the EUC and Regional Finance programs, and/or have completed an upgrade. Thus, as shown in Table 5 below, our sample will include three distinct groups:

- **Group 1:** Customers who received loans from the Regional Finance Programs to complete a EUC project.

- **Group 2:** Customers who participated in the EUC programs but did not receive Regional Finance Program loans. Importantly, these participants may have received financing from other sources. We will confirm this in the survey.

- **Group 3:** Customers who considered getting an energy efficient home upgrade and/or financing for that project. Currently, we've identified visitors to the Financing Concierge System (FCS) on the statewide EUC website as one part of this sample group. The FCS is an online tool that helps customers who are considering a home upgrade to decide which financing options are the best fit for them.[11] Thus, this group represents customers who are at least considering doing a home upgrade and using financing. Further, we will coordinate with the EUC program and evaluation teams to investigate other opportunities to develop a sample of customers who considered participating in the EUC program, but ultimately did not participate.

Please see Task 3 for more detail on how we will use these groups in our attribution analysis.

Table 5 presents our survey sample frame. Because our survey approach requires a visual format to present shopping exercises (see more below), we must field this survey via the internet. We typically invite customers to take internet surveys via e-mail. However, until we receive the EUC program databases, we cannot confirm how many Finance Program participants in our sample have e-mail addresses. Should there not be enough e-mails to get a sufficient number of completes, another option is a mail-push-to-web design. This would involve sending a physical mailer with a website link, which customers would need to input themselves. This option is not ideal, as it adds more complexity to the survey participation process.

**Table 5: Internet Survey Sample Frame**

| Participant Group | Number of EUC Program Participants | Number of Unique Contact E-mails |
|---|---|---|
| **Group 1: Finance Program Participants** | | |
| emPower Central Coast | 42 | TBD* |
| GSFA Program | 201 | TBD* |
| SoCalREN Home Energy Loans | 100 | TBD* |
| *Group 1 Subtotal* | *343* | *TBD* * |
| **Group 2: EUC-Only Participants** | | |
| EUC Participants | TBD* | TBD* |
| **Group 3: Non-participants** | | |
| Visitors to the Statewide FCS tool** | 142 | 142 |
| **Total Survey Sample** | **TBD*** | **TBD*** |
| **Notes:** | | |

---

[11] For more on the FCS tool, please visit: http://myenergy.energyupgradeca.org/vendor/choose-financing. Additionally, Opinion Dynamics is currently conducting a Finance Marketing Education & Outreach study that includes a survey of FCS tool participants. To avoid over-burdening respondents, we will ensure that customers receive the Regional Finance survey several weeks after they receive the FCS survey.

*Evaluation Plan*

| Participant Group | Number of EUC Program Participants | Number of Unique Contact E-mails |
|---|---|---|
| **Sample and/or unique e-mails counts will be determined when we received the EUC participant databases | | |
| **This reflects visitor counts as of September 2016, which will likely increase by the time we field the survey in Q1 2017. We will cross-reference with the EUC program databases to confirm whether any of these visitors have participated in the EUC program. In this case, we would survey them as a part of Group 2. | | |

**Notes:**
**Sample and/or unique e-mails counts will be determined when we received the EUC participant databases
**This reflects visitor counts as of September 2016, which will likely increase by the time we field the survey in Q1 2017. We will cross-reference with the EUC program databases to confirm whether any of these visitors have participated in the EUC program. In this case, we would survey them as a part of Group 2.

We will use a census approach for this survey, meaning we will attempt to reach everyone in our sample frame. Our outreach efforts will include an initial e-mail invitation and up to three reminders (likely once per week). Finally, we plan to offer an incentive of $50, should the respondent qualify, to ensure that we get as many completes as possible.

## Shopping Exercise Detail

The survey will provide the inputs into our Latent Class Discrete Choice attribution approach, which we describe under Task 3. We will use a stated-preference discrete choice approach, which asks respondents to complete multiple "shopping" exercises. In each exercise, we will ask them to choose among various bundles of home upgrade characteristics, including financing characteristics. During each exercise, we will present four to eight bundles on the screen. Each bundle will list key attributes of the financing, such as all-cash or financing, interest rates, loan terms, and the type of financing (i.e., bank loan or credit card). Each bundle will also describe what size upgrade they would be complete with the associated financing attributes, specifically, project cost, potential energy savings, and available rebates. The survey will assign attributes randomly to each bundle in a way that causes the attributes to appear in a balanced and uncorrelated manner.[12] The range of values will be realistic. On each screen, respondents will also have the option to select none of the bundles. Giving them this choice is an important element in grounding the research in reality. Figure 1 below provides a simple mock-up of a potential shopping exercise.

**Figure 1: Shopping Exercise Mock-up**

## Store 1

Please choose from among the following products, or specify "None of these" if you would not want any of them.

| | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| **Financing Type** | Term Loan | Term Loan | Credit Card | Cash | |
| **% of Project Rebated** | None | None | 10% | 30% | |
| **% of Project Financed** | None | 50% | 75% | None | |
| **Financing Interest Rate:** | 6% | 4% | 10% | None | None of these |
| **Financing Loan Term** | 30 years | 10 years | Unlimited | None | |
| **Upgrade cost before rebate:** | $20,000 | $10,000 | $15,000 | $15,000 | |
| **Annual energy savings:** | $4,000 | $1,000 | $3,000 | $1,000 | |

---

[12] However, in some logical cases, certain attributes will be set to appear or not appear together. For instance, a cash option will never include interest rates or loan terms.

*Evaluation Plan*

## Task 3: Attribution Analysis

We will use the survey data and discrete choice results to develop NTGRs for each of the Regional Finance Programs and for distinct population groups (including demographic segments, attitudinal segments, and different levels of project cost and financing). These NTGRs will reflect the proportion of EUC participants that would not have done the upgrades without the Regional Finance Programs. We will weight these NTGRs by project savings so that each participant contributes an appropriate amount to the overall NTGR. Our focus will be the increment in savings that is attributable to the Finance Programs beyond the influence of rebates. Figure 2 illustrates this concept.

**Figure 2: Regional Finance Program Attribution Concept**

Incremental influence of Regional Finance Program alone

Regional Finance Program

Influence of EUC Rebates and Regional Finance Program together

EUC Rebates

Would have occurred without rebates or financing

EUC Project Energy Savings
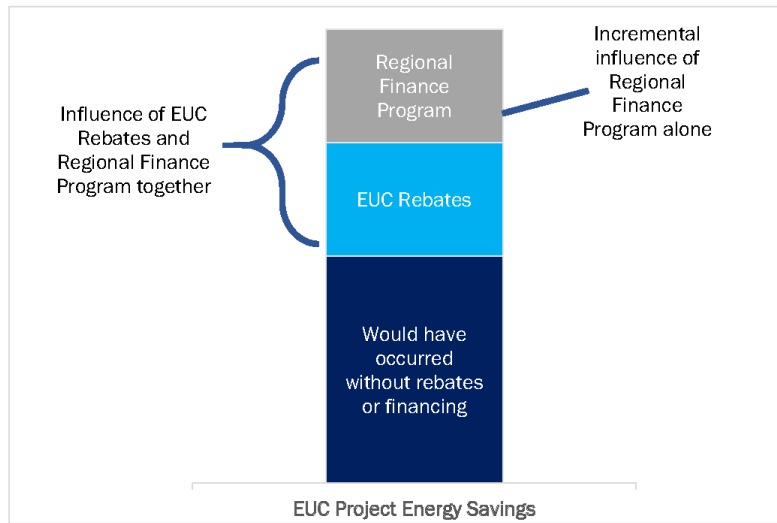
Importantly, there is the possibility of "dual causality" such that, for some participants, only one inducement would be required. In other words, either financing or rebates would have resulted in participation in EUC. Our survey questions will allow us to identify these participants and account for them in that NTGR estimate. We are exploring whether we can do the same in the LCDC analysis.

Our primary attribution approach is a LCDC analysis. However, this approach is somewhat experimental for this application. Therefore, as a backup, we will include questions in the survey that ask participants to self-report the influence of the Regional Finance Programs directly. We will use this data to calculate a second NTGR using a traditional algorithmic approach. Table 6 summarizes which survey questions we will ask each group and how we will analyze that data.

*Evaluation Plan*

Table 6: Attribution Approach Summary

| Survey Group | Survey Battery | | Analysis Approach | |
|---|---|---|---|---|
| | Shopping Exercise | Self-Reported Influence | Approach 1: LCDC NTGR | Approach 2: Self-report NTGR |
| Group 1: Finance Program Participants | ✓ | ✓ | ✓ | ✓ |
| Group 2: EUC-only Participants | ✓ | ✗ | ✗ | ✗ |
| Group 3: Non-participants | ✓ | ✗ | ✗ | ✗ |

Group 2 and Group 3 will serve two functions: 1) they will increase the variation among the respondent characteristics and preferences, and 2) they will increase the sample size. Both will contribute to the robustness of the model coefficients that inform the simulator (described next in Approach 1).

We provide more detail on each attribution approach below. For more information on our rationale for selecting these methods, please see the Attribution Memo in Appendix B.

## Approach 1: Latent Class Discrete Choice NTGR

LCDC uses customers' stated preferences (from the shopping exercises described above) to determine the factors that influence their choices about whether to do a home upgrade, whether to do an energy efficient version, and whether to use financing for it. It also cleanly distinguishes between the influence of rebates and financing on that decision. The results of the shopping exercise produce the inputs for a simulator that allows program administrators to predict customer preference for any range of financing options that they wish to consider (e.g., options with varying loan terms and interest rates). **For this evaluation, our primary interest will be in the probabilities that customers would do an upgrade with versus without the Regional Finance Programs.**

The simulator produces probabilities of customers doing an energy efficiency upgrade both with and without the Finance Program. This is achieved by setting the finance offering attributes to match the actual Finance Programs and the customer attributes to match the average Finance Program participant.[13] The overall probabilities form the basis for calculating Finance Program-level NTGR, using the formula:

Equation 1: LCDC NTGR Formula

$$NTGR = \frac{Prob_w - Prob_{wo}}{Prob_w}$$

Where:

$Prob_w$ = the probability of choosing a given bundle with the Finance Program

$Prob_{wo}$ = the probability of choosing the same bundle without the Finance Program

This process will produce the probabilities that Finance Program participants would elect to do an upgrade under four relevant conditions:

---

[13] We will hold all other project option and participant attributes constant at their averages.

*Evaluation Plan*

- **Condition 1:** Rebates and Finance Program offered;
- **Condition 2:** Rebates only offered;
- **Condition 3:** Finance Program only offered, and;
- **Condition 4:** Neither being offered.

The critical values for this evaluation would be conditions 1 and 2, as they would provide the relevant inputs for the NTGR (Equation 1). However, observing all four will present a fuller picture and could be of value for program planners. We will apply the resulting NTGR for each Finance Program to related EUC project ex ante savings to produce net EUC project savings.

Notably, it will also be possible to use the simulator to discover what customer segments are good targets for program expansion. Multiple program scenarios and participant characteristics can be tested.

Any method of estimating customer decisions that is based on hypothetical scenarios (e.g. traditional self-reported NTGRs as well stated-reference discrete choice methods such as LCDC) can be subject to hypothetical bias. Most often this would take the form of customers over-stating how likely they are to participate in what they view as a socially desirable program, or their likelihood to have done an efficient upgrade regardless of the program inducements. This is a common concern for the traditional self-report approach to estimating NTGRs. It can also affect stated-preference discrete choice experiments. We believe that the discrete choice approach handles this issue better than traditional self-report methods due to the fact that the "socially desirable" choice is much more masked in this approach. Still, LCDC may not be perfectly free of hypothetical bias. There is considerable literature on discrete choice methods of correcting estimates of program-related decisions that might suffer from hypothetical bias.

One method that we plan to use to deal with this issue is to calibrate the LCDC's model results at the simulator stage. We will calibrate the LCDC results to a set of known quantities that can also be called "revealed preferences." For instance, the simulator will provide the overall probabilities that customers with participant characteristics will complete an efficient project both with and without the program. We will also have actual numbers for these situations from program data and from information we collect during the survey (sample groups 2 and 3). We will use these numbers as they compare to the stated preference results to generate adjustment factors. To the extent that stated and revealed probabilities differ, we will use the adjustment factors for all relevant simulator scenarios to further ground results in reality.

### Approach 2: Self-Report NTGR

In addition to the shopping exercise, we will ask Regional Finance Program participant (Group 1) respondents to estimate directly how influential the Regional Finance Programs were in their decisions to do a EUC project at all, and on the size and scope of their project. We typically design these questions to be scalar (i.e., a scale of 0 to 10, with 10 being "very influential"), so that we can easily translate results into probabilities. We will design these questions to identify answers that are not internally consistent or logical so that we have confidence in the internal validity and reliability of the results. We anticipate collecting information on the following aspects of influence:

- **Participation Likelihood:** Without the rebates and/or financing, how likely would respondents be to complete an EUC project at all?
- **Project Timing:** If the rebates and/or financing had not been available, would they have done their project at the same time, or later? How much later?

*Evaluation Plan*

- **Project Efficiency:** If the rebates and/or financing were not available, what is the likelihood they would have installed equipment with the same level of energy efficiency? Would the measures have been somewhat less or significantly less energy efficient?

- **Project Size:** If the rebates and/or financing were not available, what would be the likelihood they would have done a project of the same size? Would they have done a somewhat smaller project, or a much smaller project?

- **Relative Influence of Rebates and Financing (All Aspects):** For all of the aspects above, we will ask the respondent to distinguish between the influence of the Regional Finance Program and the EUC rebates. One potential method is to first ask how likely they would have been to do an EUC project if both the financing and rebates were not available, and then to ask how likely they would be (on the same scale) if only the rebates were available. The difference between these two scores represents the incremental influence of the Regional Financing Program. Additionally, to the extent that the participant has used both program finance and rebates, and divides their relative influence evenly, we can assess the level of dual causality. We can also address this issue with participants who used only rebates by asking them what they would have done if only financing had been available. If there are customers who used the finance program only, we would ask how likely they would be to do the same program if only rebates were available.

Further, during our contractor in-depth interviews, we will explore the influence of the Regional Finance Program on the contractor's ability to sell the EUC program, especially to customers with only moderate credit ratings. If we find that contractors rely heavily on financing to convince customers to undertake EUC projects (i.e., projects would not occur at all or would be much smaller), we will determine if it is appropriate to adjust participant self-reported NTGRs with contractor influence ratings. That decision will also include information from the participant in-depth interviews to determine how influential contractors were in their decisions. While the exact nature of this adjustment depends heavily on the types of influence contractors and participants report, we would only adjust the NTGRs scores of participants who report being highly influenced by their contractor's recommendation to participate in the EUC program.

## Task 4: EUC Database Analysis

We will conduct a comparative analysis using the 2010-2012 and 2013-2015 EUC program databases to understand trends in projects with and without Regional Finance Program loans. First, we will compare 2013-2015 EUC projects completed by those who got Program loans to those who did not. We will focus this comparison on the size and depth of projects (i.e., overall project costs or rebate amounts, the types and number of measures installed). Second, we will compare all projects in 2010-2012 EUC database to all projects in the 2013-2015 database. This analysis may illuminate trends in participation before and after the introduction of ratepayer-funded financing programs. We will not only explore the size and depth of projects in this analysis, but also the total number of participants. Importantly, while this analysis may show trends we cannot attribute them conclusively to the Regional Finance Program. Any number of other factors, including the availability of other financing programs, could potentially explain these trends.

## Task 5: Cost-effectiveness Analysis

Once we have established net savings (see Task 3), the team will conduct a cost-effectiveness analysis to understand whether the Regional Finance Programs' benefits outweigh the program costs. We will conduct this analysis in compliance with the CPUC cost-effectiveness framework. However, the team has developed an experimental approach that adapts the CPUC framework to improve its fit for LLR finance programs. All of our data collection and analysis efforts will provide the necessary inputs for this analysis, such as total loan

*Evaluation Plan*

amount issued, total loan amount defaulted, administrative and marketing costs, EUC project savings (gross and net), and non-energy benefits (i.e., the value of non-energy efficiency measures installed). Table 7 below summarizes the key cost and benefit components potentially included in the cost-effectiveness analysis.[14]

Table 7: Cost-effectiveness Inputs

| Input | Brief Description/Examples |
|---|---|
| **Costs** | |
| Setup Costs | Pre-program launch costs relating to administration, overhead, and marketing and outreach to lenders and others. |
| Administration & Marketing Costs | Budgeted operating and marketing and outreach costs from 2013-2015 |
| LLR Costs | Direct losses to the LLR, and Lost Opportunity Cost of Capital (i.e., cost due to keeping cash reserves, not accruing interest), other contract fees |
| Participant Costs | Incremental cost of finance-driven measures |
| **Benefits** | |
| Energy Benefits | Energy savings/avoided utility costs associated with financed measures |
| Non-Energy Benefits | Estimated as a percentage of energy benefits (multiple scenarios tested) |
| Reduced Borrowing Costs | Lower interest rates |
| Market Transformation Benefits | Estimated as a percentage of program savings that may persist after the program ends (multiple scenarios tested) |

Source: July 2016. Dunsky Energy Consulting. Assessing the Cost-effectiveness of Energy Efficiency Financing Programs: Methodology & Strategy Issues. Draft V.2.

## 3.2    Timeline

Below is the expected timeline:

Table 8: Estimated Evaluation Timeline by Task

| Task | Timing |
|---|---|
| **Evaluation Tasks** | |
| Task 1: Data Inventory | Jan 2017 |
| Task 2a: Contractor/Customer In-depth Interviews | Jan 2016 |
| Task 2b: Participant and Near-Participant Internet Survey | Jan/Feb 2017 |
| Task 3: Attribution Analysis | Feb 2017 |
| Task 4: EUC Database Analysis | Jan 2017 |
| Task 5: Cost-effectiveness Analysis | Mar/Apr 2017 |
| **Reporting** | |
| Interim Data Inventory Memo | Jan 2017 |

---

[14] These inputs were used to calculate the cost-effectiveness of the Residential Energy Efficiency Loan (REEL) pilot and may vary when applying this method to the Regional Finance Pilots.

*Evaluation Plan*

| Task | Timing |
|------|--------|
| Draft Report | June 2017 |
| Final Report | July 2017 |
| Presentation of Results | May/June 2017 |

## 3.3    Budget

We expect to be able to complete this evaluation within project maximum budget of $200,000.

*Appendices*

# Appendix A. Early Research Tasks

This evaluation plan is the result of a number of background research efforts over the last few years. These steps were critical for understanding the regional finance programs in California, determining our study population, and developing our evaluation approach.

We undertook the following tasks:

- In 2014, as a part of Work Order ED_O_FIN_2, we interviewed program staff from 11 residential and non-residential regional finance programs. Topics included program design, progress-to-date, and data availability. Using this information, we prioritized five programs for potential impact evaluations. Please refer to the "Local Programs Prioritization Memo" below. Please note that, at the time of this memo, GSFA was known as the California Homebuyers Fund (CHF).



Local Programs
Prioritization Memo

- We conducted follow-up interviews in late 2015 with each of the five prioritized programs to collect any updates on program design, participation, and data tracking. We ultimately recommended three programs for inclusion in this study. Please refer to the "Summary of Findings Memo" below.



Summary of
Findings Memo

- We conducted a final round of interviews in mid-2016 with emPower, GSFA, and SoCalREN to collect final performance numbers for 2013-2015 and confirm any remaining details on the programs. The results of these interviews are included in this evaluation plan.

*Appendices*

# Appendix B.    Attribution Memo

The memo below provides more detail on a variety of attribution analysis methods we explored for the Statewide Finance Pilots.

Local Programs
Attribution Memo

# Appendix E.    Additional Documents

The Local Programs Attribution Memo below provides more detail on a variety of attribution analysis methods we explored for the Statewide Finance Pilots.

## Local Programs Attribution Memo

# Memorandum

To:    Jen Caron, Ralph Prahl, Nikhil Gandhi
From:  Opinion Dynamics and Dunsky Evaluation Team
Date:  07/28/2015
Re:    Attribution Methodology for Statewide Finance Pilots

In September 2013, the California Public Utilities Commission (CPUC) adopted Decision 13-09-044 to pave the way for the Statewide Finance Pilots ("Statewide Pilot Programs"). The CPUC directed the investor-owned utilities (IOUs) to offer several pilot programs to finance energy efficiency projects across the residential and non-residential sectors. The California Alternative Energy and Advanced Transportation Financing Authority (CAEATFA) will implement the Statewide Pilot Programs, which will offer a combination of credit enhancements and on-bill repayment options to serve two main purposes:

1.  Encouraging customers to undertake larger and more in-depth energy efficiency projects (encourage demand); and
2.  Broadening market eligibility and participation by funding credit enhancements designed to make financing options for energy efficiency improvements more attractive to both customers and financing institutions (increase supply).

Additionally, in March 2014, the Legislative Analyst's Office (LAO) expressed strong interest in understanding the effectiveness of various financing efforts, including the Statewide Pilot Programs, the Statewide On-Bill Financing (OBF) program, and the Property Assessed Clean Energy (PACE) programs. To gauge the effectiveness of these various financing efforts, it is important to compare net impacts for the programs. For the Statewide Pilot Programs, that means understanding the incremental effect of financing on energy efficiency program participation and overall energy savings beyond what the IOUs already claim due to rebate programs that coexist with financing programs.

This memo presents some key issues and the recommended methods for conducting attribution analysis for the Statewide Pilot Programs. Notably, this memo does not provide specifics such as model specifications, or self-report questions as the Statewide Pilot Programs are still in the planning stage and program attributes could change. Note that we are currently anticipating estimating attribution at the program level[1] (see the individual list of finance programs in Table 1 below) since they target different sectors and CAEATFA will roll them out at different times. The final attribution method for each of the individual Statewide Pilot Programs will depend on the final program design and scale of the effort; however, we discuss our core approaches below. These methods should also be considered for the other finance initiatives.

### Key Issues

Below, we discuss five key issues that we considered prior to making program-specific recommendations for methods that should be used to assess attribution for the Statewide Pilot Programs (which should also be

---

[1] Program level attribution encompasses multiple interventions and intervention attributes

---

*1*

considered for other finance initiatives). The attribution method will need to be tailored to each specific effort, but to the degree possible, we will want to look for methods that allow us to compare across programs.

## Multiple Market Alternatives

California has a mix of ongoing and proposed ratepayer/taxpayer-funded finance initiatives: the Statewide Pilot Programs, the American Recovery and Reinvestment Act (ARRA)-originated local government finance programs and the regional finance pilots/programs, and the Statewide OBF program. In addition, customers have the option of using other financing options such as the local and state-funded PACE loans (if a program exists in their geographic location). Customers are also able to use other traditional financing vehicles that are privately funded including home equity lines of credit, unsecured loans, private/retailer financing, and credit cards. Table 1 summarizes the taxpayer-funded finance programs supported by the CPUC during 2013–2015. We also include the PACE programs since these are of particular interest to the LAO. In addition, we include the various traditional forms of financing available to residential and non-residential customers.

Table 1. Market Alternatives for Financing

| Program Administrator | Sector | Finance Program Name |
|---|---|---|
| **Statewide Pilot Programs (ratepayer funded)** | | |
| CAEATFA | Residential | Residential Energy Efficiency Loan Assistance Program |
| CAEATFA | Residential | Energy Finance Line Item Charge - PG&E only |
| CAEATFA | Non-residential | Master-Metered Multifamily Pilot |
| CAEATFA | Non-residential | Small Business Loan Program, OBR |
| CAEATFA | Non-residential | Small Business Lease Program, off- and on-bill |
| CAEATFA | Non-residential | Non-Residential On-Bill Repayment Program, w/o CE |
| **OBF Program (ratepayer funded)** | | |
| IOUs (PG&E, SCE, SCG, SDG&E) | Non-residential | OBF Program |
| **Local and Regional Finance Pilots/Programs (taxpayer and ratepayer funded)** | | |
| IOU (PG&E) | Residential | California Homebuyers Fund |
| IOUs (PG&E, SCE, SoCalGas) | Residential | emPower Central Coast |
| IOU (SDG&E) | Residential | Contractor Marketing |
| Marin Energy Authority | Residential | On-Bill Repayment for Single Family |
| BayREN | Residential | Multifamily Capital Advance |
| BayREN | Residential | Pay as You Save (City of Hayward) |
| SoCalREN | Residential | EUC Residential Loan Loss Reserve |
| IOU (SDG&E) | Non-residential | Contractor Marketing |
| Marin Energy Authority | Non-residential | On-Bill Repayment for Multifamily and Small Business |
| BayREN | Non-residential | Commercial PACE |
| BayREN | Non-residential | Pay as You Save (City of Windsor) |
| SoCalREN | Non-residential | Non-Residential PACE |
| **Other Programs (taxpayer and ratepayer funded)** | | |
| California Energy Commission | Non-residential | Energy Conservation Assistance Act (ECAA) |
| **PACE Program (local and state funded)** | | |
| Local/City Government | Residential | Home Energy Renovation Opportunity (HERO) |
| Local/City Government | Residential | mPower |
| Local/City Government | Residential | Palm Desert PACE program |
| Local/City Government | Residential | Sonoma County Energy Independence Program (SCEIP) |
| Local/City Government | Residential | Clean Energy Sacramento |

*2*

| Program Administrator | Sector | Finance Program Name |
|---|---|---|
| Local/City Government | Non-residential | HERO |
| Local/City Government | Non-residential | mPower |
| Local/City Government | Non-residential | CaliforniaFirst |
| Local/City Government | Non-residential | Clean Energy Sacramento |
| Local/City Government | Non-residential | Figtree |
| Local/City Government | Non-residential | Green Finance San Francisco |
| Local/City Government | Non-residential | Los Angeles County PACE |
| Local/City Government | Non-residential | Sonoma County Energy Independence Program (SCEIP) |
| **Traditional Financing** | | |
| Private Financing | Residential | Options include, but are not limited to, home equity lines of credit, unsecured loans, credit cards, and private/ retailer financing |
| Private Financing | Non-residential | Options include, but are not limited to, business lines of credit, credit cards, Energy Service Companies (ESCOs), and leasing companies |

Note: PG&E = Pacific Gas and Electric; SCE = Southern California Edison; SCG = Southern California Gas Company; SDG&E = San Diego Gas & Electric; SoCalGas = Southern California Gas Company; REN = Regional Energy Network

Understanding the attribution of these market alternatives requires using methods that allow us to separate the effects of one from the other. Additionally, given the vast differences in program designs and strategies between the residential and non-residential sectors, each sector requires separate thinking based on its specific issues when it comes to estimating attribution. As such, to get an accurate description of the savings attributable to a specific program and a specific intervention, we will tailor our attribution method to each specific effort, while maintaining some consistency across methods whenever possible.

### Three Levels of Market Intervention

The attribution method will need to consider whether the impacts of the finance effort occur at the customer level or higher upstream (i.e., affecting the supply of finance). The Statewide Pilot Programs will occur at multiple levels in the marketplace, depending on program design. These include:

- Upstream: A program seeks to recruit and work with financial institutions (FIs) to change offerings made to customers. Or existing programs may be modified to incorporate new offerings. Because such things take place upstream, customers may not be aware of these changes.

- Midstream: A program seeks to work with midstream market actors, such as contractors, to market the program and help change offerings to customers. Because this is midstream, customers may not be aware of this change.

- Downstream with potential customers: A program seeks to increase awareness among customers about the availability of financing to help with their decisions to make energy efficient upgrades in their homes

Similar to market alternatives and sectors discussed above, each level requires a different approach when it comes to estimating attribution. We will consider the level of market intervention in the selection of our program-specific attribution methods.

### Scale of Finance Initiatives

The attribution methods will also have to match the scale of the program effort. The scale of programs takes three different forms: geographic, numeric (i.e., the number of participants), and budget. Geographically, the Statewide Pilot Programs and OBF are available to eligible IOU customers, whereas local and regional programs and PACE programs are limited to a smaller set of zip codes and are not necessarily in an IOU

*3*

territory. Moreover, some programs may end up reaching large numbers of participants, while others may have only a handful of households or businesses that receive loans. Another scale issue that we have to consider is the budget that is allocated, both to the program and to the evaluation. We will tailor our methods to the scale of each initiative and its budget (program and evaluation). While it would be safest to make these decisions at the end of the program cycle, we already have a good idea of the program and budget sizes. While this allows us to make decisions on evaluation design early, we have to be prepared to make a course correction if the anticipated numbers do not materialize.

## Stage of Program Development

It is important to understand when the various interventions are occurring, and to take that into consideration when determining the best timing for attribution research. The Statewide Pilot Programs are pilots and, generally, pilots experience changes in program design before a full rollout. Other programs (specifically some local and regional offerings and OBF) are already in their full rollout phase and are ready for savings attribution work. Determining attribution values before the start of a program or during the program cycle (with a small number of participants) requires methods that rely at least partially on conjecture, small sample sizes, and/or models employing stated preferences. Determining attribution values after the program cycle has the option of employing methods that use revealed (rather than stated) preferences when there are enough customers in each relevant category or post-program self-reports of what the customer would have done without the program. We note that each of these methods has its own drawbacks. Revealed preference studies will come too late for adjusting program attributes, and retrospective self-report methods have well-known weaknesses. Because the timing of the research can influence the findings, our team will consider it when determining the attribution method and presenting any results. One option is to collect some data, such as self-report information over the program cycle so that interim values can be calculated in time for making modifications to the program design before the cycle is over.

## Availability versus Awareness

Finally, to the extent possible, we will want to be able to understand why any change occurred, and whether it was due to increased *availability* of the finance options (i.e., a supply issue; for example with contractors) and/or an increased *awareness* of finance options (i.e., a demand issue, i.e. the customer). Attribution generally tries to capture whether customers made an energy efficiency upgrade or increased the energy efficiency level of an upgrade due to a program. Given the nature of the program, we might capture an increase in energy efficiency projects due to increased awareness of the financing options rather than increased availability of financing options to customers, that is, the effects of marketing rather than the program attributes.[2] In a framework of an impact evaluation, it might not matter, since the Statewide Pilot Programs are also responsible for creating awareness. However, from the point of view of improving the attribution analysis, it is important to know whether uptake (and therefore savings) is due to awareness or an attractive program design, or both. Wherever possible, we will choose methods that allow us to understand why the changes occurred.

## Recommended Approaches

The evaluation team examined various approaches to assessing attribution. Using the above-mentioned key issues, as well as other factors, such as the validity of the results, the availability of data, policy constraints and budget constraints, the team was able to narrow down the various approaches to the recommended ones discussed in this memo. The full list of methods considered can be found in the appendix.[3]

---

[2] Finance could (theoretically) be 100% of the reason why someone takes an action; however, several papers (e.g., *Getting the Biggest Bang for Your Buck*) have discussed the fact that financing alone is not usually responsible for actions.
[3] The evaluation team discussed the various methods for assessing attribution during the September 12, 2014, PCG meeting. We list all the methods considered, but have a detailed discussion for only the recommended methods in this memo.

4

To determine attribution for the Statewide Pilot Programs, the team is recommending multiple research methods (which rely on a range of data sources). These are listed in Table 2 and discussed in more detail below. Details about the selection criteria can be found in the Appendix. These methods could also be applied for the other local and regional finance interventions. However, these recommendations are specific to the Statewide Pilot Programs listed at the top of Table 1.

Table 2. Overview of the Recommended Attribution Methods for the Statewide Pilot Programs

| Methodology | Data Sources |
| --- | --- |
| Latent Class Discrete Choice | Mainly non-participant internet survey, adding some participants later. If needed, supplement with combination mail/phone survey. |
| Self-Report with Supplements | Participant survey, contractor survey, FI interviews |
| Discrete Choice/Nested Logit Modeling | Participant survey, baseline survey, mystery borrower research, secondary research |
| Longitudinal Expert Panel (Delphi Method) | Primary and secondary data |

Note that as of the writing of this memo, none of the Statewide Pilot Programs have launched. While the general design of the programs is known, there are still aspects of the efforts that are under development. The final attribution method for each of the individual Statewide Pilot Programs will depend on the final program design and scale of the effort. However, we discuss the core methods that we anticipate using, by program, below.

### Latent Class Discrete Choice

LCDC is a method based on customers' stated customer preferences (but can be calibrated by revealed preferences or market share data as well) that helps determine the factors or attributes that influence customers' choices about whether to do an upgrade, whether to do an energy-efficient version, whether to use financing for it. It estimates the degree of influence of rebates and financing and cleanly distinguishes between the two. This method allows program planners to assess what the uptake rate would be for programs with any bundle of attributes/values the planner wishes to consider (e.g. loan terms). It also allows for the possibility that different types of customers will have different preferences as it performs a segmentation analysis simultaneously with producing choice patterns. It also provides more flexibility than revealed choice methods in the variety of program characteristics that can be incorporated into the available choices. Notably, this method will produce NTG ratios overall and by segment. However, we do not recommend this (or *any* one method) as a standalone method but as a valuable input to final NTG ratio calculations, for use as a planning tool. Results based on stated preferences can be calibrated with revealed preferences from program participants or using secondary data.

We are incorporating LCDC into our method mix for many reasons. The most important reasons are that:

1. It is the method that will provide the cleanest estimate of how attribution of program effects can be apportioned between finance and rebate programs, and
2. It is a way to get early feedback on the programs.

Table 3 summarizes when to use this method and the various benefits and drawbacks.

5

Table 3. Summary of LCDC

| | | |
|---|---|---|
| **Latent Class Discrete Choice** | **Description** | The **LCDC** method is based on stated preferences through an experimental design of choice alternatives. Presents choice alternatives to respondents who make choices among whole product or program descriptions (bundles of attributes). Provides preferred choices and reveals which choice patterns are present with different customer segments. Provides NTGRs and allocation of attribution to rebates vs finance programs. Best if based on a sample of at least 300 respondents overall (with about 20-40 customers who have taken the action studied included). |
| | **How the Method Helps in Attribution** | • Allows program planners to assess what the uptake rate would be for programs with any bundle of attributes/values the planner wishes to consider (e.g. interest rates, level of rebates offered). |
| | **Benefits** | • Can get attribution answers based on comparison of realistic market representations (i.e. choices are made in context of what is available outside program).<br>• Results can distinguish the effect of financing net of rebate influence<br>• A planning Net-to-Gross (NTG) ratio can be established based on stated preferences<br>• Allows great flexibility in program features to be tested and on outputs produced, including effects of some upstream and midstream interventions<br>• Tells us what configurations or bundles of product attributes are most favored by potential customers<br><br>• Shows how choices are different for different segments of population - the method allows for the possibility that different types of customers will have different preferences<br>• Program design/offerings could be modified based on predicted customer choices and uptake rates<br>• Can predict both choice to do a project and size of project with and without financing.<br>• Provides a wealth of information for program planning purposes, including elasticities, assessment of possible future programs—what it would take to have a program that influences customers' decisions to take action, and whether that design would be cost effective.<br>• The method deals with nested structures and the problem of Independence of Irrelevant Alternatives (IIA) |
| | **Drawbacks** | • Results are typically based on stated not revealed preferences - data can be based entirely on stated preferences of non-participants, although there are multiple ways that stated preference results can be calibrated. One possibility is including participants and customers who have done upgrades recently. Another way is to use secondary data to create adjustment factors. There are a number of other ways as well. |
| | **When to Use** | **Intervention Level**<br>✓ **Downstream**<br>✗ Midstream (although things like contractor influence could be included in choices)<br>✗ Upstream (although effects of buy-downs would be embedded in choices) |
| | **Timing** | ✓ **In Planning Stage**<br>✓ **During program implementation**<br>✗ After program cycle complete |
| | **Program to Use for** | ✓ **Statewide Pilot Programs**    ✗ Local and Regional Programs    ✗ OBF    ✗ PACE |
| | **Table Key** | ✓ Method can/should be used for specified condition    ✗ Not recommended for specified condition |

**When to Use** additional columns:

| Sector | Objective | Scale |
|---|---|---|
| ✓ **Residential**<br>✓ **Non-Residential** | ✓ **Short-Term**<br>✗ Long-Term | ✓ **Small # of participants**<br>✓ **Large # of participants** |

The method presents choices to customers in a way that mimics real-world choices, i.e. choice sets or bundles are presented, not individual attributes or just one generic program design. This is typically accomplished in

6

an online format. For a finance program the respondent would be presented with multiple choice sets (stores) of 4-8 choices with different configurations of finance and rebate options, combined with upgrade projects that include or exclude energy efficiency attributes, and a selection is made in each "store." The respondent indicates which option he would choose, including "none of the above." Giving them a choice of "none of the above" is an important element in grounding the research in reality. The choice bundles are designed to reflect a variety of attributes and a range of values on them that are realistic. The bundle attributes are assigned randomly, and in a way that causes the attributes to appear in a balanced and orthogonal manner. This is a key characteristic that provides the ability to distinguish cleanly the influences of rebate and finance on preferences/decisions.

Based on the model, we will produce a simulator that will allow program planners to assess what the uptake rate would be for programs with any bundle of attributes/values the planner wishes to consider. It shows results overall and for each defined segment. The software also provides information for assessing the cost effectiveness of customers' preferred options.

In the impact evaluation situation, the simulator produces probabilities of customers doing an efficient upgrade both with and without the program(s). These probabilities form the basis for calculating anticipated NTG ratios, using the formula:

$$NTG = \frac{Prob_w - Prob_{wo}}{Prob_w}$$

Where:

$Prob_w$ = the probability of choosing a given option with the finance program (given availability and awareness)
$Prob_{wo}$ = the probability of choosing the same option without the finance program

To conduct the LCDC, data is gathered via a survey, typically via internet, that presents a series of upgrade projects which asks the customer to choose which of them, if any, they would complete. The customers are presented with a series of "stores" of 4-8 such projects, each time asking them to choose which they would complete, if any (giving them a choice of 'none of the above' is an important element in grounding the research in reality). We then subject all of those answers to discrete choice modeling to determine which options customers prefer, and what drives their choices, including rebates and financing programs.

By using this method during the program implementation period, we will use this short-term study to estimate an interim attribution number for the first year (during program implementation) with the end of program cycle study then providing final estimates of attribution for the future. However, the results of the LCDC should not be discarded once revealed choice modeling has been completed. At a minimum, it should be used as a point in triangulation as well as a method to apportion the joint effects of rebates and finance identified by the revealed choice models. At the end of the program cycle, a multi-method approach can be used to provide evidence on which a final decision about attribution can be made.

## Self-Report Method with Supplements

Self-report is the most commonly used method for attribution. This method is based on answers to multiple questions on a questionnaire. The questionnaire design specifies questions to catch answers that are not internally consistent or logical so that we have confidence in the internal validity and reliability of the results. The questionnaire asks respondents to respond to the questions about program influence on a scale so that analysts can easily translate results into probabilities of program influence. The questionnaire also asks the respondents directly to estimate relative program influence and to say what they would have done absent the program. Respondent answers are combined to estimate program attribution.

Often, when we use self-report methods to estimate program influence, we also interview market actors such as contractors/vendors or FIs to supplement customer reports of program influence. Taking the example of contractor surveys - we do this because customers are not always aware of the program as it works through

*7*

the contractor. However, for the Statewide Pilot Programs, the customer should be aware of how influential the financing package was to their decisions. They may have become aware of the particular financing terms through the contractor.

As such, contractor interviews about how much influence the finance program had in selling projects to customers, especially for customers with only moderate credit ratings, will provide context for our customer-based estimates of program attribution. Depending on how integral contractors are to the programs, we would consider integrating contractor reports of the influence of financing with customer reports. One way of choosing contractors to interview is to interview the specific contractors that performed the work for a specific interviewed customer, and tailor the contractor interview to the specific case. Another approach is to interview a sample of contractors known to be involved in the programs. Of course, the latter may be more feasible than the former, but the ways that we could use such results would be more general and in aggregate.[4]

In support of the self-report effort, the evaluation team will collaborate with DNV and Itron to review the NTG battery used in the residential and non-residential IOU-funded rebate projects surveys (we will review all program cycle batteries of questions including the 2006-2008 residential battery, which was heavily tested and reviewed) conducted in the 2013–2015 period. The evaluation team will then make revisions (those specific to financing) and additions to these NTG batteries to both compare attribution estimates across rebate and finance programs and to help establish a method for understanding the incremental effect of financing on participation and overall energy savings beyond what is already attributed to rebate programs that coexist with financing programs.[5]

The self-report method can be applied to both the residential and non-residential Statewide Pilot Programs. We are recommending using primary data collection efforts, namely, a self-report survey with participants, to estimate attribution. To help augment the attribution findings and make adjustments, if warranted, to the NTG ratios, we will use the following data collected through the various studies under the Residential and Non-Residential Finance Baseline Research Plans:

- General availability of energy efficiency financing products in California from secondary research
- Non-participant behaviors prior to the launch of the Statewide Pilot Programs from the residential baseline survey
- Finance institution offerings to residential customers prior to the launch of the Statewide Pilot Programs from the mystery borrower research
- Availability of financing to residential customers using Experian-purchased proxy credit scores
- Awareness of and supply of financing through market actors from the residential and non-residential contractor surveys, FI interviews, and other market actor interviews

Through this method we will be able to observe the differences among the customers who have used both financing and rebates and those who have used only financing or rebates, i.e., we will establish what portion of savings is attributable to rebate programs and what portion is attributable to the Statewide Pilot Programs. Furthermore, this method will provide observations of changes in type of projects and savings in the use of financing among Statewide Pilot Programs participants.

Criteria for Timing and Use of the Method

The timeline for this study is dependent on the implementation timeline for the Statewide Pilot Programs. However, participant surveys can begin any time after implementation of the program. It should be noted that the initial participants are more likely to be free-riders than later participants, since these participants may have already had projects under way or planned before the Statewide Pilot Programs entered the market, so an aggregate NTG should not be determined until there is a significant number of participants. Currently, the

---

[4] Additional details about the methodology will be developed should this method be deemed appropriate.
[5] Notably, for the Statewide Pilot Programs, customers will be able to use financing with or without rebates.

8

residential pilots are expected to roll out in Q3 2015 and the multifamily and non-residential pilots are expected to roll out in Q4 2015, so one full year of data collection would not be complete until Q3/Q4 of 2016.

Table 4 summarizes this method, its benefits and drawbacks, when the method should be used, the timing of the study, and the other finance programs (besides the Statewide Pilot Programs) that can use this method.

The self-report method will be used for every Statewide Program effort unless the program participation data do not allow for survey work to be conducted or the scale of the effort does not support an evaluation effort. The current Finance Roadmap includes funding to cover the self-report method (under impact studies).

Table 4. Summary of the Self-Report Method with Supplements

| | | | |
|---|---|---|---|
| **Self-Report Method** | **Description** | The self-report method asks participants about what they would have done in the absence of the program, as well as how likely they would have been to complete the same project with different loan terms, and how likely they think they could have found the same terms elsewhere. We will also ask them directly about the influence of financing versus rebates in their upgrade decisions. | |
| | **How the Method Helps in Attribution** | • Direct reporting of attribution from the program participants | • Can be adjusted if biases are found in customer responses (based on externally generated estimates of realistic options) |
| | **Benefits** | • Simple<br>• Well understood and has established approaches to handle issues that may arise | • The NTG ratios can be weighted by project size<br>• Realism of customer attribution estimates can be judged against analysis of the loan market and contractor issues |
| | **Drawbacks** | • Respondents may bias their responses in a socially desirable direction or in the opposite direction to influence the continuation of the program<br>• To get results for each program type, samples of participants in each program would have to be large enough to produce an independent estimate for that program | • The results do not help determine what program changes would be required to improve the NTG ratio or program uptake. This is particularly important in this evaluation because of the wide variety of finance programs and their attributes, and the many possible future configurations.<br>• Based on hypothetical alternatives (counterfactual) |
| | **When to Use** | **Intervention Level**<br>✓ Downstream<br>✓ Midstream*<br>✓ Upstream<br>* dependent on whether participants can be identified | **Sector**<br>✓ Residential<br>✓ Non-Residential    **Objective**<br>✓ Short-Term<br>✓ Long-Term    **Scale**<br>✓ Small # of participants<br>✓ Large # of participants |
| | **Timing** | ✕ In Planning Stage<br>✓ During program implementation<br>✓ After program cycle complete | Timing dependent on objective |
| | **Program to Use for** | ✓ Statewide Pilot Programs    ✓ Local and regional programs    ✓ OBF    ✓ PACE | |
| | **Table Key** | ✓ Method can/should be used for specified condition    ✕ Not recommended for specified condition | |

## Discrete Choice/Nested Logit Modeling

While the self-report with supplements method uses a set of algorithms and involves some subjectivity in participant reporting, and in how the evaluation team selects and applies potential adjustments, discrete choice/nested logit modeling uses statistical analysis and, as such, may be less subjective and more rigorous (but not without its own unique sources of error). Therefore, we are also recommending conducting a nested logit model to determine net effects, when the scale of the effort is appropriate; i.e., there are enough participants to conduct statistical modeling.

9

This model would use survey data from participants, survey data from non-participants (collected at the time of the follow-up to the baseline study), and market-level data from market actors and secondary research. The value of this method is that it can integrate both customer-level data and data from midstream and upstream market actors while using statistical modeling to estimate attribution. Moreover, this method would not require additional data collection (note that we are assuming that a self-report method and a follow-up study to the baseline will be conducted in the future and that questions relating to the discrete choice model can be asked).

Overview of Method

Discrete choice/nested logit is based on revealed preferences (benefiting from the advantage of dealing with actual behaviors, not hypothetical ones), with the preferences in this case being defined by the choices customers make to do or not do a home upgrade, and if an upgrade is done whether or not the upgrade includes energy efficiency upgrades. The model predicting these discrete choices will include variables indicating the availability and awareness of different financing options, rebates, and relevant covariates, such as the creditworthiness of the customer. Some variables will come from geocoding available finance programs to customer addresses, others from secondary data sources, and some from customer questionnaire responses.

The estimated model would serve as the basis for a simulator that will allow us to evaluate the model with different relevant predictors turned on or off or set to mean values. The output of the simulator will allow us to calculate a NTG ratio with the following generally accepted formula:

$$NTG = \frac{Prob_w - Prob_{wo}}{Prob_w}$$

Where:

$Prob_w$ = the probability of choosing a given option with the finance program (given availability and awareness)
$Prob_{wo}$ = the probability of choosing the same option without the finance program

The discrete choice/nested logit model can be applied to both the residential and non-residential sectors as long as there is a large number of participants and non-participants in the relevant design cells[6] (i.e., where the program changes are expected to occur downstream and where the quantity of available data allows for this analysis). Given that customers can qualify to receive rebates and/or financing for a variety of measures, we expect to have sufficient participants and non-participants in the residential sector. As such, we currently anticipate using this method for the Residential Energy Efficiency Loan (REEL) Assistance Program. We are not currently anticipating using this method for the non-residential programs, but we will revisit this based on the final program design, the level at which the changes are expected to occur (i.e., upstream or downstream), and the number of participants.

Data Requirements

We will use the following data collection efforts for this method:

- Surveys with REEL Assistance Program participants and non-participants. We will expect to get a minimum of 300 completed surveys to support this maximum likelihood technique, with 20-40 customers in any given design cell, which includes customers doing an upgrade without the finance program, and those doing upgrades that do not include energy efficient products beyond what is required by code.

---

[6] Large enough samples does not imply that these needs are larger for nested logit analyses than other modeling types. The participant needs are greater than in self-report methods, or LCDC, but not greater than other modeling methods. Typically, the most difficult design cells to fill are those requiring customers who took the actions under study outside of the program.

- General availability of energy efficiency financing products in California from secondary research, geocoded and values assigned to each customer
- Non-participant behaviors during and prior to the launch of the Statewide Pilot Programs from the residential baseline survey
- Finance institution offerings to residential customers prior to the launch of the Statewide Pilot Programs from the mystery borrower research

Figure 1 shows a simple decision tree that could represent the choices customers make that might be influenced by programs, awareness of programs, and other variables relevant to program attribution. The first relevant (for our purposes) decision the customer makes would be whether or not to do an upgrade. It should be noted that the relative split between the 'yes' and the 'no' answers and what effectively predicts that decision will depend on doing careful sampling. Certainly, the sample would be restricted to homeowners, and possibly to customers who have considered doing an upgrade. After that decision, the customer must make a decision about whether to include energy-efficient measures or not[7].

Figure 1. Discrete Choice/Nested Logit Model Decision Tree
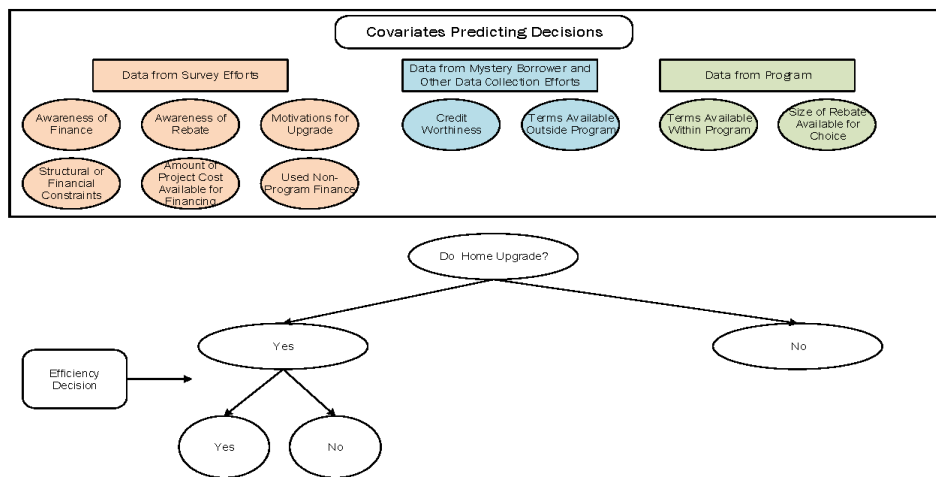


NTG and Method of Apportionment to Rebates and Financing

The output of the model simulator will allow us to calculate NTG ratios for the program overall, and will help us apportion the program effects between rebates and finance. This is done at the simulator stage by setting the values for both program awareness (finance & rebate) and availability to 1 or 0 in different combinations to tease out each effect. With each change in values for these variables a different probability for doing an energy efficiency upgrade will be produced by the simulator. It is from the changes in these probabilities that we will be able to apportion attribution. Note also that turning the awareness to 'on' (or 1) and producing probabilities for different sets of program attributes in succession will allow us to note the influence of program attributes without being confounded with different levels of awareness.

To the extent that we measure and include loan terms as covariates in the model, upstream effects could also be estimated at the simulator stage by changing the average values for those variables in the simulator to match what was possible and not possible from upstream programs. Again, this information would come from

---

[7] These are the decisions best addressed by nested logit designs, though there are others, such as project size, that are better analyzed with modeling that handles continuous outcomes.

*11*

the geocoded data that we gather on loan terms available in what areas and for what customers (e.g. credit worthiness).

Analyzing Continuous Outcomes

Nested logit is the method we recommend as the central approach to analyzing customer decisions about undertaking a home upgrade and whether to do it with energy efficiency products. These are, for the most part, discrete choices, and some will be nested within others (the likely structure is shown in Figure 1). This is what makes nested logit especially appropriate for the part of this project that deals with revealed preferences about choice. It is less well suited to explaining decisions customers make about the size of the projects they undertake, as measured by expense and savings. For these outcomes, we recommend pairing nested logit with multi-level modeling.

Multi-level modeling is an analytic method that addresses continuous outcomes in a nested structure. It is a regression-based method that takes account of nested variables in its error structure. If variables that are nested are treated as if independent, standard errors will be incorrect. It is likely that in the current project, analyzing the effect of the program and efficiency decisions on project size using the usual assumptions of independence of observations would produce standard errors that are artificially small, although it can go in the other direction as well. We consider it important to treat the error structure appropriately in any case.

There is every reason to expect that the nesting structure that applies to discrete choices will also be appropriate for the modeling of continuous outcomes. Even if there is no hierarchical structure for the decisions being modeled, multi-level modeling will likely still be important because it can build on any clustering that is present in the data (hierarchical or not) and develop standard errors accordingly.

The timeline for this study is dependent on the implementation timeline for the Statewide Pilot Programs. Currently, the residential pilots are expected to roll out in Q3 2015 and the multifamily and non-residential pilots are expected to roll out in Q4 2015, so one full year of data collection would not be complete until Q3/Q4 of 2016. However, we recommend conducting this research only after the Statewide Pilot Programs have an adequate number of participants and sufficient time has passed to be able to conduct the follow-up study to the baseline study (i.e., it would only occur if the programs make a significant impact on the market), which would extend data collection into 2017. This timeline incorporates our preference to gather and analyze data that covers both early and later participation—at least a full program year. This will allow us to assess the more long-term viability of the program in terms of its net impacts.

Table 5 summarizes this method, its benefits and drawbacks, when the method should be used, the timing of the study, and the other finance programs (besides the Statewide Pilot Programs) that can use this method.

Most likely, the current Finance Roadmap budgets would not be used for the discrete choice/nested logit method for the REEL Assistance Program because the timing of that study would not occur until after 2017.

Table 5. Summary of the Discrete Choice/Nested Logit /Multi-Level Modeling

| | | | |
|---|---|---|---|
| **Discrete Choice/Nested Logit** | Description | The **Discrete Choice/Nested Logit** model is based on revealed customer preferences, with the preferences in this case being defined by the choice to make an upgrade and make an energy efficiency upgrade, nested within the first choice. | |
| | How the Method Helps in Attribution | • Helps in estimating NTG ratio for finance programs and for rebate programs so that the two can be distinguished | • Helps in predicting discrete choices, including the availability and awareness of different financing options, rebates, and relevant covariates, such as creditworthiness of the customer |
| | Benefits | • Well understood and has established approaches to handle issues that may arise<br>• Provides a more holistic view of the market by using a mix of data sources<br>• The NTG ratios can be weighted by project size<br>• The questionnaire can be relatively short and focused<br>• Accounts for nested or clustered structures in the data (such as variability within the interest rates) | • Does not rely on self-reported estimates of program influence (e.g., how much did the program influence your choice?)<br>• Does not rely on self-report of a response to a hypothetical situation (e.g., what would you have done if the program were not available?)<br>• If choices are not nested as anticipated, a different method (usually multinomial logit) can be easily applied to the same dataset<br>• The data can be used to further analyze and predict continuous variables, such as project size. via multi-level modeling |
| | Drawbacks | • As with any modeling method, a substantial number of participants must be included for stable estimates, and enough customers making the upgrades without the program, with and w/o efficient projects has often been difficult.<br>• As with any quantitative modeling done outside an experimental design, causal direction can be an issue. Most likely to appear in establishing program effect on project size as part of multi-level model. | • There are limits to how fine-grained the analysis can be, as a narrow focus on individual programs (which typically offer one or two measures) could result in too few cases in some of the design cells. However, given that the Statewide Pilot Programs are not pertinent only to single measures, but can apply to any one or combination of measures, this is less likely a problem. However, it does require substantial data collection among non-participants. |

| | When to Use | Intervention Level | Sector | Objective | Scale |
|---|---|---|---|---|---|
| | | ✓ **Downstream**<br>× Midstream<br>× Upstream | ✓ **Residential**<br>✓ **Non-Residential** | × Short-Term<br>✓ **Long-Term** | × Small # of participants<br>✓ **Large # of participants** |

| | Timing | × In Planning Stage<br>× During program implementation<br>✓ **After program cycle complete** | | | |
|---|---|---|---|---|---|
| | Program to Use for | ✓ **Statewide Pilot Programs** | × Local and Regional Programs | ✓ **OBF** | ✓ **PACE** |
| | Table Key | ✓ Method can/should be used for specified condition | | × Not recommended for specified condition | |

## Longitudinal Financial Institution Panel

The Statewide Pilot Programs will work closely with upstream actors. FIs play a critical role in making financing available for targeted sectors. These FIs have intimate knowledge of their customer base and are valuable resources to help understand and characterize the market. The Evaluation Team has already conducted interviews with FIs to help develop a market baseline. We will be conducting a follow-up study after the launch of the Statewide Pilot Programs (follow-up to be conducted 1–2 years after rollout) to understand the change in the market from the baseline. This method can be applied to both the residential and non-residential sectors, as long as we are able to appropriately characterize the market and are able to get correct experts

*13*

into the discussion. As such, we are recommending using the forthcoming Financial Institution Panel (being developed under the Statewide Pilot Program Evaluation) to help ground the evaluation findings and help estimate if the market is changing overall and how much the Statewide Pilot Programs are contributing to that change. In addition, we recommend using the Delphi method for the data collection. The Delphi method is a systematic and interactive data collection method that combines the gathered research and the varied perspectives of subject matter experts into a single answer to a research question; in this case, how much influence does a finance program have in the increase in financing from the FIs.

Data Requirements.

For this effort, we will combine research results into a report to share with the panel. We are proposing to conduct this at two points in time for relevant programs. This initial data will include information from the following sources:

- Participant surveys
- FI pre-program (baseline) interviews
- FI post-program interviews
- Secondary research on general availability of energy efficiency financing products in California
- Contractor surveys, FI interviews, and any other interviews

We will ask for feedback and comment on the aggregated information. Specifically, we will ask the panel to comment on (1) whether the baseline is accurately characterizing the market, (2) whether the post-program characterization of the market is accurate, and (3) whether the program influenced the number of projects, the size of projects, and the savings per project. The output of the panel will be the result of combining the various research outcomes into a single estimation of attribution.

An example of how we will use the panel is shown below using hypothetical data.

| Metrics | Result from Pre-Program Interviews | Result from Post-Program Interviews |
|---|---|---|
| Number of FIs who offer energy efficiency-specific financing products | 100 | 100 |
| Volume of energy efficiency loans/leases: Total value of energy efficiency loans/leases originated | $200 million | $300 million |
| Spread between energy efficiency interest rate offered and 5 year mortgage rate | 2%-3.2% | 1.5%-2.7% |
| Access: Underwriting criteria (Minimum acceptable FICO score) | Minimum FICO of 620 | Minimum FICO of 580 |

Prior to the first round of the expert panel, we will have collected the results from the pre-program FI interviews. After collating this information as shown in the table above, we would present this data to the panel to focus their attention on available data. We will ask them whether the baselines established are representative of the overall market for energy efficient financing. In the second round of the expert panel, we would present them with two sets of findings; first, similar to the baseline, we would present them with the post-program characterization of the market for verification, and second, we would present them with the changes observed between the baseline and post-program market characterizations. For example, in the illustration above, we see a reduction of the minimum FICO score requirement from 620 to 580. We would then ask the panel to theorize on why this change occurred and how much of an influence the program had compared to influence of other market forces.

14

Currently, we are recommending using the FI panel, however we may also identify other key upstream (or midstream) market actors to serve as panelists as CAEATFA finalizes the non-residential program designs, such as leasing companies.

Table 6 summarizes this method, its benefits and drawbacks, when the method should be used, the timing of the study, and the other finance programs (beyond the Statewide Pilot Programs) that can use this method.

Table 6. Summary of the Longitudinal Expert Panel

<table>
<tr><td rowspan="8">Longitudinal Expert Panel</td><td>Description</td><td colspan="2">The **Longitudinal Expert Panel** will be a systematic and interactive data collection method (similar to a Delphi method) that combines the varied perspectives of subject matter experts into a single answer to a research question.</td></tr>
<tr><td>How the Method Helps in Attribution</td><td colspan="2">The main objective of this task is to confirm and triangulate all the findings obtained through the self-report and secondary research to obtain a single attribution estimate.</td></tr>
<tr><td>Benefits</td><td>• Provides another point of comparison and helps confirm the findings from other methods<br>• Participants are asked to be thoughtful about issues when faced with different assessments from other panelists<br>• All stakeholders represented in one analysis</td><td>• Offers systematic ways to combine results to see both agreement and diversity in responses<br>• Participants are less likely to forget to report some things than they would be if surveyed alone</td></tr>
<tr><td>Drawbacks</td><td>• Requires substantial amount of upfront work before the data ever reach the panel<br>• Can be time consuming given the number of experts and preparation time required<br>• Requires more time from participants than a single interview or questionnaire</td><td>• Cannot be used as a stand-alone method and should be used to augment data from other methods<br>• Would probably have fewer participants than would be interviewed, so there is less coverage than the interview method</td></tr>
<tr><td>When to Use</td><td colspan="2"><u>Intervention Level</u>    <u>Sector</u>    <u>Objective</u>    <u>Scale</u><br>× Downstream   ✓ **Residential**   × Short-Term   ✓ **Small # of participants**<br>✓ **Midstream**   ✓ **Non-Residential**   ✓ **Long-Term**   ✓ **Large # of participants**<br>✓ **Upstream**</td></tr>
<tr><td>Timing</td><td>✓ In Planning Stage<br>✓ During program implementation<br>✓ After program cycle complete</td><td>Ideally should be done before and after program implementation</td></tr>
<tr><td>Program to Use for</td><td colspan="2">✓ **Statewide Pilot Programs**    × Local and Regional Programs    × OBF    × PACE</td></tr>
<tr><td>Table Key</td><td colspan="2">✓ Method can/should be used for specified condition      × Not recommended for specified condition</td></tr>
</table>

## Comparison and Integration of Selected Methods

While all methods have some inherent limitations (as discussed in the above sections), some of these issues can be solved by using multiple methods. Table 7 summarizes how each chosen method helps solve some of the weaknesses of the other attribution methods.

Table 7. Comparison of Proposed Methods of Attribution

| Limitations of Attribution Method | How Other Chosen Methods Help |
|---|---|
| Self-Report:<br>1. Potential social desirability bias<br>2. Potential desire to support program bias<br>3. Potential recall error<br>4. Hypothetical bias (hypothetical counterfactual) | LCDC:<br>1. Socially desirable choices are not obvious to customers<br>2. Options that would support programs are not obvious to customers<br>3. No recall involved—all present choices |

---

*15*

| Limitations of Attribution Method | How Other Chosen Methods Help |
|---|---|
| 5. Limit to how many alternatives can be covered in survey<br>6. Limited to causal factors of which they are aware | 4. All choice alternatives on equal footing, and calibration to external data possible, and inclusion of customers who have done or are actively considering upgrades provides grounding<br>5. Alternative attributes and levels embedded in choices—no need to ask about each separately<br>6. Awareness eliminated as an issue<br>**Expert Panel:**<br>7. Uses expert panel to address upstream data issues specifically |
| **Nested Logit:**<br>1. Choice alternatives are confounded due to confounding in real world—programs usually offered together and decisions made simultaneously so may be impossible to separate rebate from finance influence<br>2. Can be hard to fill design cells based on actual decisions (this is less an issue in finance than rebate programs, but still a possible problem in getting non-participants who did efficiency upgrades)<br>3. Some may not be aware of alternatives, thus restricting their choices—cannot study a trade-off that was not possible<br>4. Doesn't estimate impact of finance on project size<br>5. Decisions may not be nested<br>6. Addresses some but not all upstream & midstream interventions | **LCDC:**<br>1. Experimental design used for presenting alternatives so attributes and levels do not co-vary, and each presented the same number of times; provides the best possible chance to separate influences cleanly<br>2. We create the choices and a balanced design that assures enough choices of each kind available for analysis<br>3. All participants are aware of all alternatives in the experiment, allowing us to study all trade-offs; to study effects of non-awareness, simulate that at simulator stage by turning off alternatives<br>4. Multi-level modeling estimates impact on continuous variables like project size, models any nesting structure<br>**Other Models using Nested Logit Data; Multinomial Logit:**<br>5. Estimates program impact on non-nested decisions<br>**Expert Panel:**<br>6. Uses expert panel to address these issues specifically |
| **LCDC:**<br>1. Based on stated preferences—possible hypothetical bias<br>2. Doesn't estimate impact of awareness<br>3. Addresses some but not all upstream & midstream interventions | **Nested Logit:**<br>1. Based on revealed preferences<br>2. Directly estimates impact of awareness<br>**Expert Panel:**<br>3. Uses expert panel to address upstream issues specifically |
| **Expert Panel:**<br>1. Based on expert opinion, not customer preferences<br>2. Not very rigorous | All other chosen methods address both issues, where they can address upstream & midstream interventions |

## Summary

We currently anticipate estimating attribution of the Statewide Pilot Programs at the program level (see the individual list of pilots in Table 1) since they target different sectors and CAEATFA plans to roll them out at different times. The final attribution method for each of the individual Statewide Pilot Programs will depend on the final program design and scale of the effort.

Given the complexity of the program and the market, a thorough evaluation should consider the overall program design, the scale of the effort, the flexibility to capture all aspects of the program with the evaluation methodology, and the availability of data when considering a methodology for estimating attribution. The attribution evaluation should address both 1) the relative impact of finance and rebates, and 2) the incremental impact of finance as compared to non-program finance and other payment alternatives. Keeping these and the various market issues in mind, we recommend using multiple approaches as no one approach is sufficiently flexible and rigorous. Specifically, we recommend that LCDC be used for its flexibility in addressing multiple issues, and especially because it will provide the cleanest distinction between finance and rebate impacts. We recommend nested logit for its flexibility in addressing multiple issues and the fact that it is based on revealed preferences; we would add a multi-level modeling approach to estimate the effect of the program(s) on project size, based on the same nested structure. We recommend using the self-report

method because of its flexibility and direct participant approach, and the Expert Panel method for its ability to address some upstream impacts that may not be estimable from other methods.

We summarize our core approaches for conducting attribution analysis for the Statewide Pilot Programs in Table 8. These methods should also be considered for other finance initiatives. Notably, since these studies will be conducted after the Statewide Pilot Programs have been implemented (likely in 2017 as noted throughout this memo), the final decision to conduct the studies is dependent on timing of the Statewide Pilot Programs, participation levels, and budget available.

Table 8. Recommended Attributions Methods for the Statewide Pilot Programs

| Finance Program Name | Sector | Recommended Methods |
|---|---|---|
| REEL Assistance Program | Residential | We will select the specific method based on the final design and scale of the effort.<br>(1) LCDC<br>   a. to be completed early in the program to provide clean apportionment of attribution between finance and rebate programs<br>   b. to provide early results |
| Energy Finance Line Item Charge - PG&E only | Residential | |
| Master-Metered Multifamily Pilot | Non-residential | (2) Self-Report with Supplements<br>   a. All programs anticipated to include this method unless scale of effort does not support it (i.e., participation levels)<br>(3) Discrete Choice/Nested Logit Modeling<br>   a. Dependent on participation levels<br>   b. Anticipated to be used for REEL Assistance Program<br>   c. Supplemented by multi-level modeling to assess impact on project size<br>(4) Longitudinal Expert Panel (Delphi Method)<br>   a. Dependent on program design<br>   b. We currently anticipate financial institution panels to support all relevant programs, as well as a leasing agencies panel |
| Small Business Loan Program, OBR | Non-residential | |
| Small Business Lease Program, off- and on-bill | Non-residential | |
| Non-Residential On-Bill Repayment Program, wo/CE | Non-residential | |

As noted previously, this memo does not provide specifics such as model specifications, or self-report questions as the Statewide Pilot Programs are still in the planning stage and program attributes could change. In addition, while we recommend more than one method, we have not provided specifics about how the results from various methods will be combined to get one attribution estimation. These specifics will be developed when the Statewide Pilot Programs are in their implementation phase and program attributes have been determined. When the method specifics are developed, the Evaluation Team will once again distribute the research plan and solicit comments.

*17*

## Appendix

Table 9 shows our analysis of the strengths and weaknesses of each study design that we considered. We weighed the following eight criteria while evaluating each method:

- Flexibility: Testing Geographical Availability – whether the method would provide a test of the impact of differences in availability across regions of the state
- Flexibility: Timing or Scale of Programs -- whether the method can adapt to differences and/or changes in the program's timing or scale
- Flexibility: Testing Program Attributes – whether the method is able to test one program attribute against another for determining what customers value
- Flexibility: Estimating Upstream Effects -- whether the method can incorporate and represent the influences of upstream or midstream market actors
- Internal / External Validity -- whether the results from the method are likely to have serious problems in internal and/or external validity
- Policy Constraints -- whether the method would be viable from a policy perspective (the only method that did not pass this screen was the experimental design method where it would be very difficult to navigate the policy sphere to convince one region to offer and one region not to offer a Statewide program)
- Data Availability/Collection -- whether it would be feasible to collect all the necessary data to conduct the proposed method
- Quantitative Separation of Finance and Rebate Effects -- whether the method would be able to separate out the effects of rebates versus financing on their influence on customer decisions to use financing to complete an energy efficient home upgrade or purchase energy-efficient equipment

We stressed flexibility on four dimensions because the varied nature of the program(s) and their geographical distribution creates complexity. Fewer methodology designs and data collection efforts with more flexibility will allow us to modify plans as needs arise; it will also provide more information per dollar spent if one design can fulfill multiple goals. Some designs that are extremely strong on one dimension may be very weak on another. For instance experimental design is generally very strong on internal validity, but may be weak on external validity[8], in addition to having some severe policy constraints.

For example, the self-report method is flexible on all dimensions in that it can be deployed anytime after programs have participants, and can include a variety of questions about the influence of various factors, but is generally considered to have some weakness in terms of internal validity. On the other hand, since it is based only on participants, a random sample can be taken, thus buttressing external validity.

Similarly, the LCDC is extremely flexible and can do very clean tests of different attributes and combinations of attributes; i.e., it can be used at any stage of program development and can incorporate many attribute combinations that cover current and possible future program attributes. This method can be based on participants and non-participants, providing flexibility on multiple dimensions, but some may be bothered by the fact that it is based on stated preferences. Still, this issue can be addressed in multiple ways, such as including participants in the sample, or calibrating the models with revealed preferences from other sources.

Most upstream methods tend to suffer from some validity problems, and are not usually quantitative in their estimates. Nevertheless, they are good for gaining insights that we would not get from downstream actors.

---

[8] Because many times the narrowing of attributes to be tested to fit into an experimental design results in being non-representative of the real-world attributes.

Table 9. Heat Map of Critical Design Characteristics

Table Key:

- ⬤⬤ (two green) - Positive feature of the method
- ⬤ (green) - Not a concern or limitation
- ⬤ (orange) - Some concern or limitation
- ⬤ (red) - Definite concern or limitation

| Attribution Evaluation Design Options for Downstream Interventions | Flexibility: Testing Geographical Availability | Flexibility: Timing or Scale of Programs | Flexibility: Testing Program Attributes | Flexibility: Estimating Upstream Effects | Internal / External Validity | Policy Constraints | Data Availability/ Collection | Quantitative Separation of Finance and Rebate Effects |
|---|---|---|---|---|---|---|---|---|
| Self-report with Supplements | green | green green | green | orange | orange/green | green | green | green |
| Discrete Choice / Nested Logit Modeling (+ Multi-level Modeling) | green | orange | green | orange | green/green | green | green | green |
| Latent Class Discrete Choice (LCDC) | green green | green green | green green | green | green/green | green | green | green green |
| Delphi Method / Expert panel | green | green | orange | green | red/red | green | green | orange |
| Analytical Hierarchy Process (AHP) | green | green green | green | orange | green/green | green | green | orange |
| Structural equation modeling | green green | orange | green | orange | green/green | green | green | green |
| Regression Discontinuity | orange | orange | orange | red | green/green | green | red | orange |
| Quasi-Experimental (baseline and follow-up with comparison and treatment groups) | green | orange | green | orange | green/green | green | green | green |
| Pre/Post design (baseline and follow-up, no comparison group) | orange | orange | green | orange | red/red | green | green | orange |
| Experimental design | green | red | green | orange | green/red | red | orange | green green |
| General Statistics & Expert Reports | orange | green | green | orange | red/red | green | green | orange |
| Case Studies | red | green | green | green | red/red | green | green | orange |
| Focus Groups | orange | green | orange | green | green/red | green | green | orange |
| Mystery Borrowers | green | green | orange | green | green/green | green | green | red |
| In-depth Interviews with Market Actors, Pre and Post | green | green | green* | green* | green/green | green | green | red |

*From market actors' perspectives

19

# Appendix F. Study Recommendations

Table 53. Study Recommendations in IESR Format

| Study ID | Study Type | Study Title | Study Manager |
|---|---|---|---|
| ED_O_FIN_10 | Attribution and Cost Effectiveness | Regional Finance Program Attribution and Cost-Effectiveness Study | CPUC |

| Recommendation | Program or Database | Summary of Findings | Additional Supporting Information | Best Practice/Recommendations | Recommendation Recipient | Affected Workpaper or DEER |
|---|---|---|---|---|---|---|
| 1 | Statewide Financing Pilots | The self-report and LCDC approaches both have pros and cons. LCDC tends to provide better market insights, but is costly to implement and requires more sample. Self-report is simpler and cheaper to implements, and provides a more holistic view of program influence, but lacks the market simulation capabilities of LCDC. | | While a mixed method approach is ideal, it is likely infeasible in terms of cost and timeline to execute an LCDC approach for evaluation of the Statewide Financing Pilots. It may be better to adopt an enhanced self-report approach that incorporates some discrete choice portions. | CPUC | |
| 2 | Statewide Financing Pilots | Using a financing-specific alternative to the standard cost-effectiveness, | | The financing-specific adaptation provides a robust interpretation of the standard framework, and could be appropriate to accurately capture financing program cost-effectiveness in | CPUC | |

*Study Recommendations*

| Study ID | Study Type | Study Title | Study Manager |
|---|---|---|---|
| ED_O_FIN_10 | Attribution and Cost Effectiveness | Regional Finance Program Attribution and Cost-Effectiveness Study | CPUC |

| Recommendation | Program or Database | Summary of Findings | Additional Supporting Information | Best Practice/Recommendations | Recommendation Recipient | Affected Workpaper or DEER |
|---|---|---|---|---|---|---|
| | | the study found that the Financing + Incentives inducements under the TRC and SCT proved to be cost-effective.<br><br>The financing programs offer non-energy benefits that greatly outweigh the energy benefits. The financial benefits accrued by the participants, mostly as a result of an APR reduction, are the primary factor supporting the program cost-effectiveness under the TRC and SCT. | | the future. However, data irregularities should be addressed to improve the accuracy of the cost-effectiveness results. | | |

**For more information, please contact:**

**Alan Elliott**
**Principal Consultant**

510 214 0180 tel
510 444 5222 fax
aelliott@opiniondynamics.com

1 Kaiser Plaza, Ste 445
Oakland, CA 94612

**Opinion Dynamics**

**Boston | Headquarters**

617 492 1400 tel
617 497 7944 fax
800 966 1254 toll free

1000 Winter St
Waltham, MA 02451

**San Francisco Bay**

510 444 5050 tel
510 444 5222 fax

1999 Harrison Street
Suite 1420
Oakland, CA 94612

**Salt Lake City, UT**

385 375 8802 tel
801 335 6544 fax

3006 Highland Drive
Suite 100
Orem, UT 84057