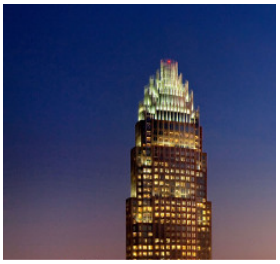
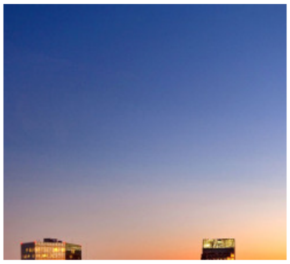
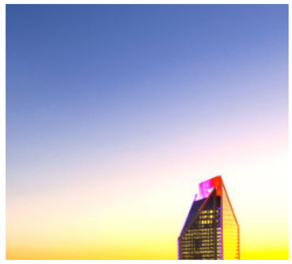


NONRESIDENTIAL ENERGY EFFICIENCY DEPTH OF RETROFIT AND COST EFFECTIVENESS ANALYSIS REPORT

PHASE II

Final Report

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California Public Utilities Commission

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ES EXECUTIVE SUMMARY

ES.1 INTRODUCTION

This report presents the second part of a two-phase research effort to develop a program effectiveness metric for non-residential resource programs, called the Depth of Retrofit – Cost-effectiveness (DORCE) metric. Based on data from 166 non-residential resource programs from 2010-2015, the DORCE metric directly combines cost-effectiveness indicators of program performance with depth of savings indicators into a single metric. The metric quantitatively indicates how deeply a given program achieves savings with its participants as well as how cost-effectively it achieves those savings.

The study's purpose is to provide a program performance indicator that is more aligned than existing quantitative metrics with the state's energy efficiency goals.[1] The Governor's Executive Order B-30-15 pushes the state to establish a California greenhouse gas reduction target of 40 percent below 1990 levels by 2030.[2] As part of that clear and ambitious target, the Executive Order calls for doubling the efficiency savings from existing buildings.

Existing cost-effectiveness tests such as the Total Resource Cost test (TRC) provide important feedback about the balance between program benefits and costs. However, they don't provide quantitative insight into the depth of energy demand and usage reduction for the average program participant. TRC and other commonly used cost-effectiveness metrics are indifferent to program delivery mechanisms. Indeed, higher program cost-effectiveness (as measured through TRC) is often presumed, at least at first pass, to come from a shallower program design approach.

There is currently an absence of tools that quantitatively measure a program's effectiveness in meeting goals for deep energy demand and usage reductions.

A metric such as the DORCE score assists in finding overall non-residential portfolio subsets that do better than others in terms of both depth of savings and cost-effectiveness simultaneously. These findings light the way to specific programs and general program design approaches that deserve to be more carefully scrutinized and potentially emulated.

[1] Commonly used program performance metrics include the Total Resource Cost test (TRC), the Program Administrator Cost test (PAC), and the Participant Cost Test (PCT). See e.g. https://beopt.nrel.gov/sites/beopt.nrel.gov/files/help/Total_Resource_Cost_Test.htm, https://beopt.nrel.gov/sites/beopt.nrel.gov/files/help/Program_Administrator_Cost_Test.htm, https://beopt.nrel.gov/sites/beopt.nrel.gov/files/help/Participant_Cost_Test.htm

[2] See https://www.gov.ca.gov/news.php?id=18938

This report explores and analyzes the significance of including both cost-effectiveness and depth of savings indicators in a single metric. Through this metric's use, programs naturally rise to the top when their achievements surpass their peers in ways consistent with stated policy goals. As such, the metric potentially provides value for reviewing California's large IOU portfolio through a consistent and well-aligned lens.

ES.2 THE TWO RESEARCH EFFORT PHASES

The overall DORCE metric development and application to California's nonresidential resource programs took place in two phases, with an important stakeholder feedback period informing the second phase. Summarized here and described more fully in the corresponding report sections, we describe the main, complementary research activities undertaken. The first phase featured the following three key research activities:

Phase I

- DORCE metric development, derived as a distillation of 10 separate cost-effectiveness and depth of savings indicators using principal components analysis (PCA) on a comprehensive program dataset of 163 nonresidential resource programs, 2010-2014.
- Multivariate regression modeling, serving to draw out patterns in DORCE achievements relative to differences in overall program design, such as degree of targeting on a specific sector, energy end use, customer size, or building type. Separate regression models are developed alongside the DORCE model that focus expressly on cost-effectiveness achievements and on depth of retrofit achievements.
- Ranking of all 163 analyzed non-residential programs (2010-2014) by DORCE score, as well as by component scores specific to depth of retrofit (DOR) and cost-effectiveness (CE).

Phase II

Following the Phase I DORCE metric development and associated regression models and rankings, stakeholder feedback yielded several important DORCE score modifications. The second research phase incorporated these changes to the score's structure, as well as added an additional program year to the overarching dataset, which had not been available when the Phase I DORCE score and models were developed. The second phase included the following research activities:

- Data updates and improvements:
  - Adding 2015 energy savings claims data to produce an expanded overall dataset for 166 programs, 2010-2015

- Adding newly available savings realization rates for 2014 program savings as a function of third party program evaluation
- Estimating and applying proxy realization rates for all unevaluated measures based on realization rates for similar, evaluated measures

- Refining DORCE based on stakeholder feedback
  - Shifting from first year savings to lifecycle savings relative to site consumption to better reflect GHG emissions reductions from energy efficiency measures
  - Shifting to the percentage of sites with more than one technology addressed, rather than average number of technologies addressed per participant, as an indicator of depth of retrofit
  - After applying proxy realization rates for all unevaluated measures, dropping the Phase I approach of keeping both pre-evaluation ("ex ante") and post-evaluation ("ex post") savings values in the metric, in favor of keeping just the post-evaluation ("ex post") values. This step trimmed the total number of input indicators feeding the DORCE score from 10 to 7
- Revising the multivariate regression models and program rankings based on the expanded dataset and refinements to the DORCE score's structure.

This second phase report serves as a standalone document that covers the background and development of DORCE across both phases, with emphasis on the updated score structure, model outcomes, rankings, and residuals that emerged from Phase II. Relatively brief treatment is given to changes in the regression model outcomes and overall program rankings that arise from the expanded dataset and changes to the DORCE score structure.

Findings from these overall research activities inform our recommendations to program and portfolio planners in California. The findings and recommendations may also be useful to program and portfolio planners in other states.

ES.3 DATA DEVELOPMENT

To support this analysis, we created a single large database with data from multiple sources. First we merged the energy savings claims data from 166 non-residential programs across the 2010-2012 and 2013-2015 program cycles. These data included energy savings claim level information, such as measure name, energy end use, building type, sector, incentive amount, first year savings, and lifecycle savings. We then merged customer billing data, ex post savings data, Cost-effectiveness Test (CET) outputs, and program costs from utility monthly reports to this emerging database. We then used variables in this overarching dataset to define a series of seven metrics that each measure some aspect of a program's depth of savings or cost-effectiveness. Section 2 describes the data development process in detail.

ES.4 PROGRAM EFFECTIVENESS SCORING

To develop a single program metric to reflect both depth of energy savings and cost-effectiveness, we combined the seven metrics that each measure some facet of a program's depth of savings or cost-effectiveness into a single composite metric. As described in Section 3, we used principal components analysis (PCA) and analytical decision making based on PCA outputs to achieve this outcome. PCA is a statistical technique that uses underlying correlations among variables in a dataset to assign weights to each input metric in defining a composite metric. The final DORCE metric is comprised of cost-effectiveness (CE) and depth of retrofit (DOR) components that receive equal weight in the overall DORCE score. The DOR component is further subdivided into indicators of the proportion of participants addressing multiple technologies through a program, as well as the lifetime savings relative to annual consumption.

ES.5 MODELING PROGRAM EFFECTIVENESS

Having developed the DORCE metric, the evaluation team could then measure the degree to which various program design elements, such as targeted sector or customer size distribution, for example, correlate with high or low DORCE scores across the IOU portfolio. The team accomplished this using multivariate regression techniques. The final models, described in Section 4, show the specific quantitative DORCE score impacts associated with each significant program design element. These models allow for a detailed review of historical correlations between specific program design elements and effectiveness outcomes.

Notably, in addition to using DORCE score as the dependent variable in regression modeling, the evaluation team built separate, parallel regression models, one featured just DORCE's cost-effectiveness component as the dependent variable and one featured just DORCE's depth of retrofit component as the dependent variable. While the combination of cost-effectiveness and depth of retrofit components is essential to the DORCE score value and structure, separate observation and measurement of correlations between program design elements and cost-effectiveness and the depth of retrofit outcomes is also valuable. By observing these separate model outputs in parallel with the overall DORCE score, the user may track how overall DORCE score may be influenced by the cost-effectiveness and depth of retrofit components in a given context.

ES.6 PROGRAM RANKINGS

The DORCE metric's structure allows each of the 166 analyzed programs to be scored, and the whole IOU portfolio to be ranked by DORCE score. This process enables a clear, rank ordered list from 1 to 166 that highlights the highest and lowest overall DORCE scoring programs in the portfolio. Note that in this context, programs can also be assigned rank order 1 to 166 with regard expressly to their score on the metric's cost-effectiveness portion and with regard expressly to their score on the metric's depth of retrofit portion. Further, within the metric's depth of retrofit portion, rankings from 1 to 166 can be provided that separately characterize the proportion of participants addressing multiple technologies and the average proportion of total consumption saved. When the portfolio is sorted by overall DORCE score, the associated rankings specifically for cost-effectiveness and for depth of retrofit achievements provide a concise and clear picture of how much cost-effectiveness and depth of retrofit drive a given program's overall DORCE score.

Subgrouping

Another useful outcome from the rankings exercise is the ability to organize programs into any desired subgroupings, based on one or more shared characteristics, and compare their rankings. For example, one may be interested in comparing the subset of programs targeting medium-sized grocery stores, or programs targeting process efficiency at large industrial sites. Simply by focusing on programs with the desired set of characteristics, a user can take note of the relative rankings for these programs on overall DORCE score, as well as the relative role of the key cost-effectiveness and depth of retrofit components in driving that overall score.

ES.7 PROGRAMS OUTPERFORMING PREDICTED SCORE

The regression models developed in this study yield the ability to predict a program's DORCE score based on aspects of its program design. A program's actual DORCE score may fall above, below, or exactly in line with the model's prediction, and the difference between actual and modeled DORCE score is called the residual. As discussed in Section 5, the residual may highlight factors associated with program achievement not captured in the regression models, but it also may serve as a useful flag for spotting exceptional programs that complement the overall DORCE score. For example, as with the overall DORCE rankings, programs can be ranked 1 to 166 in terms of their residual, and the top ranked programs would be those outperforming their modeled DORCE scores by the greatest amount. These programs score notably higher than similarly designed programs in the IOU portfolio, and this may serve as a guide for further inquiry into how this success can be characterized and emulated. In particular, high residuals for programs in portfolio areas with relatively low DORCE scores may help flag those programs outperforming others in cases where high cost-effectiveness and depth of retrofit outcomes are inherently difficult to achieve. Additionally, programs at the bottom of the residuals ranking would be those achieving outcomes well below what would be expected for programs with their design elements and may be in need of review and revision. When viewed alongside overall DORCE score rankings, residuals rankings can help provide an especially clear picture of program performance.

ES.8 KEY FINDINGS

Key findings from this study are listed below. Most key findings were robust across the addition of data and modifications to the DORCE score between Phase I and Phase II. Where a finding changed across the phases it is noted below and discussed at greater length in Section 3.

- Generally, an increase in technologies addressed does not necessarily mean either an increase, or a decrease, in savings achieved.
- Tradeoffs are not always necessary between depth of retrofit and cost-effectiveness, since depth of retrofit success minimally corresponds with poor cost-effectiveness.
- On balance, focus on very small customers coincides with higher DORCE returns versus focus on large customers. The DORCE score's depth of retrofit portion drives this difference. In the Phase I models, higher DORCE scores were typically associated with very small customers, followed by medium, then small, and large customers had the lowest DORCE scores. In the Phase II models, this order remained except there was no statistically significant difference between small and medium customers in the middle of this spread.
- A focus on food service, a focus on water heating, and a focus on indoor lighting are each associated with above-average DORCE scores. For food service and water heating, this is especially driven by their high cost-effectiveness. In the Phase I models, process efficiency was also associated with above average DORCE scores, but this was not a statistically significant finding in the Phase II models.
- Highly cost-effective gas programs represent several of the top DORCE-scoring programs in the entire portfolio.
- A relatively high proportion of total program cost toward incentives and, conversely, a low proportion of total program costs toward DI activity correspond with better DORCE scores and cost-effectiveness outcomes, without a notable overall impact on depth of retrofit outcomes.
- No single building type corresponds with significantly higher or lower DORCE scores than other building types overall. However, office buildings generally achieve higher cost effectiveness than average, and TCU (buildings associated with transportation, communication, or utilities) achieves above-average depth of retrofit outcomes. In the Phase I models, offices displayed a higher DORCE score than other building types, but this was not a significant finding in the Phase II models.
- Programs achieve high effectiveness scores (top 20%) via three pathways:

- Notably high scores on both depth of retrofit and cost-effectiveness
- Exceptionally strong cost-effectiveness with reasonable depth of retrofit
- Exceptionally strong depth of retrofit with reasonable cost-effectiveness

- Programs targeting the commercial sector achieve lower DORCE scores than those targeting the agricultural or industrial sectors, driven mainly by lower cost effectiveness.
- Programs featuring custom measures fare better on DORCE than those featuring deemed measures, driven by lower cost effectiveness for deemed measures. In the Phase I models, deemed measures fared worse than custom measures for both cost effectiveness and depth of retrofit, but only the cost effectiveness piece remained significant in the Phase II models.
- Some particular programs significantly outperform similarly designed peer programs as evidenced by their high positive residuals.

ES.9 CONCLUSIONS AND RECOMMENDATIONS

The evaluation team has distilled a series of recommendations flowing from the research conducted in this report, aimed at program administrators and other stakeholders. These recommendations, discussed in Section 7, range from the general to the specific. They center on using the DORCE metric and other findings from this work to evaluate program performance and to refine program and portfolio planning in service of meeting the state's energy savings goals. All of these recommendations remained robust across the Phase I and Phase II models and program rankings. The only exception is that several recommendations make reference to high-scoring programs or low-scoring programs. Because some program rankings shifted between the Phase I and Phase II models, it means there is a corresponding adjustment in the particular program sets where these recommendations apply. Section 5.2.5 addresses changes in program performance moving from Phase I to Phase II. Below we describe how program administrators and other stakeholders might use the DORCE score as it is currently structured, opportunities to expand the score, and opportunities to set forward-looking goals in terms of DORCE performance.

ES.9.1 Using DORCE

- Stakeholders should consider using DORCE as a metric for evaluating program performance.
- Programs can be viewed as having achieved high, medium, or low outcomes in terms of DORCE and its constituent score elements when applying and interpreting DORCE rankings.
- Reinforcing and building on programs with high positive residuals may help programs with lower scores achieve success.

- DORCE can be used as an approach to characterizing source energy savings. Consider assessing and prioritizing gas savings on equal footing with electricity savings using DORCE outcomes as a guide.
- Consider putting special focus on the DORCE score's cost effectiveness and savings achieved portions (while minimizing focus on technologies addressed) when evaluating the effectiveness of programs that are intentionally, strategically narrowly focused on a single technology.
- Low DORCE scores may represent an inefficient use of program administrator resources or a particularly challenging set of circumstances for generating cost-effective savings, or both. Consider using DORCE residuals alongside DORCE scores to help chart a course for program improvement, revamping, or elimination.

ES.9.2 Setting Program Performance Goals with DORCE

- By freezing the DORCE development structure, DORCE can be a forward looking benchmarking tool calculated and expressed independently of the set of considered programs. Consider establishing DORCE as a benchmarking tool based on the 2010-2015 score structure and gauging future program performance using the score.
- Consider using DORCE as a standard tool to set goals and expected outcomes in the business planning process.
- As a consistent and detailed lens, consider maintaining its use through the implementation planning and program evaluation processes so as to structure and evaluate programs on the same terms with which they were designed.

ES.9.3 Expanding DORCE

- DORCE score provides details on program effectiveness but does not explicitly identify the drivers of program effectiveness. Consider conducting process evaluation to help identify specific program design elements and implementation strategies possibly driving program outcomes.
- Consider expanding DORCE to the residential sector, since DORCE is based on program performance characteristics that can be assessed and applied consistently across sectors.

1 INTRODUCTION

Energy efficiency programs in California address a wide range of customers using a wide variety of program structures. Focusing on non-residential customers alone, over 160 energy efficiency programs made savings claims in the 2010-2015 timeframe. Programs differ in terms of a wide range of factors in their design, such as the targeted customer segments, program implementer, program measure offerings, and the proportion of total program spending that goes to marketing and other functions, just to name a few sorts of difference.

At the conclusion of the 2013-2014 program cycle, reports from the different research roadmaps (HVAC, Lighting, Residential, and Non-residential) articulated comparative questions about how programs were performing both within and across roadmaps. Several of these questions were framed in terms of how effectively programs were achieving deep savings relative to other programs and how cost effectively they were doing so. The confluence of these questions served to highlight a shared interest across roadmaps and became the genesis of the research effort described in this report.

1.1 WHY IS DEPTH OF SAVINGS AN IMPORTANT MEASURE OF PROGRAM OUTCOMES?

The Governor's Executive Order B-30-15 pushes the state to establish a California greenhouse gas reduction target of 40 percent below 1990 levels by 2030. As part of that clear and ambitious target, the Executive Order calls for doubling the efficiency savings from existing buildings. In addition, the California Energy Efficiency Strategic Plan (2011) and the CA Existing Buildings Energy Efficiency Action Plan (2015), two of the state's central guiding documents for energy efficiency priorities and strategy, both make extensive reference to the need for deep energy savings in both new and existing buildings to achieve ambitious statewide emissions reduction goals. In discussing the goal of getting 50% of existing commercial buildings to zero net energy (ZNE) by 2030, the Strategic Plan notes that deep levels of energy efficiency will be required alongside clean distributed generation to meet this goal. These documents note the overarching need for programs to look holistically at building energy consumption and move away from traditional mass market approaches to individual products.

The Existing Buildings Energy Efficiency Action Plan further notes the importance of building owners pursuing deeper upgrades over time. That document emphasizes the essential importance of deep energy retrofits in achieving the state's goal of roughly 85% emissions reduction from today's levels by 2050.

1.2 WHY IS IT VALUABLE TO HAVE A METRIC THAT REFLECTS BOTH COST EFFECTIVENESS AND DEPTH OF RETROFIT?

The broad-based emphasis on the importance of deep retrofits across the state's key guidance documents, along with the perennial drive for cost-effective savings, serve as dual key drivers for this research effort. The historical absence of a metric to quantify and compare program performance with regard to both cost effectiveness and depth of retrofit means there has been little systematic discussion and guidance as to which specific programs, which general areas of the non-residential portfolio, and which particular elements of program design move most effectively in the desired direction of these paired objectives.

Measuring something is often a critical ingredient to improving it. This captures the idea that a metric, when appropriately conceived, may point in a direction of value and improvement, focus attention on identifying and overcoming barriers to improvement, and serve as a feedback mechanism on efforts made to date. In the energy efficiency environment, a form of measurement of program achievements that reflects both cost effectiveness and depth of retrofit provides a mechanism for identifying standout programs and may serve as a useful tool for moving toward state goals at a program and portfolio level. Even in areas of the portfolio where deep energy savings are notoriously challenging, such a metric may help identify programs and approaches that have yielded the best outcomes among all that have been tried.

1.3 THE DEPTH OF RETROFIT – COST EFFECTIVENESS METRIC

This report describes the development of the Depth of Retrofit – Cost Effectiveness (DORCE) metric as an initial foray into developing such as tool. The development of the DORCE metric has been a fundamentally exploratory process and is based directly on data from the 166 non-residential resource programs included in the analysis. Itron, with oversight and support from the CPUC, started with the identified interest at the intersection of depth of retrofit and cost effectiveness noted across multiple research roadmaps. We then sought to derive a metric that could meaningfully capture the interaction between cost effectiveness and depth of retrofit at the program level. The evaluation team identified several different views on a program's cost effectiveness that might inform an overall program effectiveness metric:

- Total Resource Cost Test (TRC)
- Program Administrator Cost Test (PAC)
- Savings (kWh, kW, therms) per incentive dollar
- Savings (kWh, kW, therms) per program dollar

We also identified measurable elements of a program that could serve as indicators of depth of retrofit:

- Number of end uses addressed
- Number of measure classes addressed[1]
- Proportion of overall consumption saved (kWh, therms)

Each of the measurable elements in the above lists represents a positive program outcome. That is, each of these elements has a quantitative value that describes the achievements of a program in some way, and all other things being equal, a higher value for each of these elements can be considered a favorable program outcome. As such, each item in this series of elements can appropriately be regarded as a facet, or component, of a program's effectiveness at achieving deep savings cost effectively. Taken together, these facets can provide a balanced picture of a program's overall effectiveness in this regard.

A key challenge was to distill these facets into a single composite metric that would meaningfully capture the interaction between cost effectiveness and depth of retrofit at the program level. The central tool we used for this purpose was principal components analysis (PCA), supplemented with analytical decision-making based on the PCA outcomes. The details of that process are discussed in Section 3. At a high level, PCA uses patterns of covariation in the underlying dataset to put weights on each of the constituent individual metrics of program effectiveness to derive a single, weighted average metric. Hence the essential structure of the scoring tool is based on variations in the data of the programs that are being scored.

1.4 COMPONENTS OF THE DORCE METRIC

The DORCE metric consists of a cost effectiveness component and a depth of retrofit component. Part of the potential value of the DORCE metric is that, while the overall DORCE score serves as the central indicator of program effectiveness in this study, a program's performance on the distinct cost effectiveness (CE) and depth of retrofit (DOR) components of the score is also preserved and displayed. This allows the user to note cases where, for example, a particularly high DORCE score is driven primarily by high cost effectiveness, high depth of retrofit, or equally by both.

The depth of retrofit (DOR) component is derived from indicators of program design, such as the proportion of participants addressing multiple technologies, as well as indicators that are more reflective of program outcomes, such as lifetime program savings expressed as proportion of overall consumption. The number of end uses and measure classes addressed are indicators of specific elements over which

[1] See Section 2.4.1 for the development of Measure Class.

program planners have a large degree of control. That is, a program can be designed to target anywhere from one to many end uses and associated measure classes with its participants.

The proportion of overall consumption saved, on the other hand, is more of an outcome of program involvement. Hence, the number of end uses and measure classes addressed and the proportion of overall consumption saved can be seen as two sides of a depth of retrofit coin. One is more representative of the "inputs" and the other is more representative of the "outputs" from a depth of retrofit standpoint. Throughout this report the evaluation team uses the term "technologies addressed" to refer to depth of retrofit from the standpoint of the proportion of participants addressing multiple technologies. The team uses the term "savings achieved" to refer to depth of retrofit from the outcomes standpoint of program savings relative to total energy consumption. When the portfolio is sorted and ranked by DORCE score, the rankings for each of these constituent components can be displayed as well. This yields a clear signal of the degree to which a notable DORCE outcome is driven by one or more distinct portions of the score.

The remainder of this report goes into the details of creating the overarching dataset for this work, deriving the DORCE metric, and evaluating the performance of non-residential programs from 2010-2015 and general program elements with respect to this metric. The evaluation team has put a focus on deriving actionable recommendations that follow from derivation of the DORCE metric. These focus on using DORCE to identify and extend the success of individual programs and general approaches that are outperforming others as well as to identify underperforming programs and approaches that may deserve re-consideration or re-vamping.

1.5 PHASE I AND PHASE II OF THE RESEARCH EFFORT

The overall task of developing the DORCE metric and applying it to California's nonresidential resource programs took place in two phases, with an important round of stakeholder feedback informing the second phase.

Phase I consisted of deriving the DORCE metric based on a dataset of 163 nonresidential resource programs 2010-2014. It was an exploratory process that included merging the 2010-2012 and 2013-2014 program tracking data for nonresidential resource programs, and then adding additional datasets such as Customer Information Systems (CIS) billing data, monthly reports data on program expenditures, program- and claim level cost effectiveness outputs from the CET, and census data from the American Communities Survey. Through exploratory data analysis, the evaluation team identified and structured ten quantitative indicators of program effectiveness that each measured some aspect of program cost effectiveness or depth of retrofit achievements. The team identified principal components analysis (PCA) as an appropriate statistical means of distilling these ten indicators down to one overarching cost effectiveness metric and one overarching depth of retrofit metric, and these were then combined with equal weighting into the overall DORCE score. The team then pursued a regression modeling approach to characterize trends in DORCE outcomes relative to variations in program structure and participant characteristics across the portfolio.

Phase II focused on gathering stakeholder input on the Phase I DORCE score structure and models, and then refining the score structure to better suit stakeholders' needs. Based on stakeholder feedback, the structure of the DORCE score was modified in several ways. The first of these was to change the energy savings indicators in the DORCE score from first year savings to lifetime savings. Part of the purpose of DORCE is to better align program performance metrics with overarching statewide goals that focus on decreasing greenhouse gas emissions. It made sense to shift to lifetime savings, since these provide a better measure of greenhouse gas emissions reductions than first year savings. This change affects the savings achieved metric. The second change to the DORCE score was to modify the structure of two of the depth of retrofit indicators. Whereas in Phase I the element of depth of retrofit regarding number of technologies addressed was based on the average number of end uses and measure classes addressed by participants, these metrics were shifted to more of a threshold-based structure in Phase II. Thus the updated metrics are based on the proportion of program participants who address more than one end use or measure class in a given program.

Several additional changes were made in moving from Phase I to Phase II. The team added 2015 ex ante program data which had not been available as of the Phase I work, which yielded an overall 2010-2015 dataset as the basis for deriving the Phase II DORCE scores This also led to the addition of 3 programs that were new to the nonresidential portfolio in 2015 and resulted in a total of 166 programs in the analysis dataset. The team also added 2014 ex post data, which also had not been available at the time of the Phase I work.

The team also refined the criteria used for excluding outlier claims from the metrics as a screen to identify sites with potential data issues (that could in turn drive inaccurate program effectiveness scores). In Phase I sites were excluded from the calculation of savings achieved metrics if total ex post program savings were greater than 30% of total energy consumption for the facility. This was based on the assumption that energy efficiency savings greater than 30% of total site consumption were not practically realistic and most likely represented an error in the savings data or in the aggregation of utility billing accounts to represent a given customer site. In Phase II, this approach was refined. We reviewed first year ex post savings at the site level in proportion to annual consumption. Claims were grouped by building type, sector, and end use segments. Then, for each segment the distribution of savings relative to consumption values was calculated and outliers were identified. The maximum allowable value per segment was calculated as the 75th percentile plus 1.5 times the inter-quartile range[2]. Any value above that maximum

[2] This value represents the Tukey outlier, commonly used in box-and-whisker plots

was flagged and excluded from analysis. In addition, any value where savings relative to consumption exceeded 100% was excluded from analysis. Finally, the mean and standard deviation for each segment was calculated, and any value exceeding the 90^{th} confidence interval (mean + 1.645 * standard deviation, assuming normality) was also excluded from analysis.

Lastly, the team added proxy realization rates for unevaluated measures. In DORCE Phase I, measures throughout the portfolio that had not received evaluation did not have any ex post realization rate applied to them. Therefore they were passed through with no adjustments to ex ante savings. This effectively gave a boost to unevaluated measures and represented a distortion in the score rather than a true indication of program achievement. To mitigate this effect, the evaluation team developed proxy realization rates for unevaluated measures based on the calculated realization rates for similar measures throughout the portfolio. Specifically, the team developed default realization rates for six categorizations of measures as follows:

- Custom non-lighting Gas
- Custom non-lighting Electric
- Custom lighting
- Deemed Lighting
- Deemed non-lighting Gas
- Deemed non-lighting electric

These were then applied to all relevant unevaluated measures. In the absence of these default realization rates for unevaluated measures in Phase I, the team had elected to include separate program effectiveness indicators for both ex ante savings and ex post savings for energy savings per overall program dollar, energy savings per incentive dollar, and energy savings as a proportion of total consumption from the customer billing data. The inclusion of both ex ante and ex post acted as a kind of hedge on the issue of unevaluated measures in the Phase I models. The development of the default realization rates for unevaluated measures in Phase II eliminated the need for this hedge, so the team dropped the ex ante savings versions of these 3 indicators in favor of keeping just the ex post versions. This resulted in a reduction of the total number of indicators informing the DORCE metric from ten in Phase I to seven in Phase II, as well as an overall reduction in the distortion associated with unevaluated measures.

2 DATA DEVELOPMENT

This section describes the steps taken to develop the master dataset of 2010-2015 non-residential programs and the effectiveness metrics and program characteristics developed for the analysis. The section begins with a discussion of the methods used to select programs for this study. We follow this section with a description of each data source and the methods used to incorporate each data source into a master database. Next, we define the seven metrics developed to measure program effectiveness (four cost-effectiveness and three depth of retrofit). Then, we discuss the development of additional program characteristics used to identify common traits and core attributes of each program. These program characteristics were used in the regression models to understand what program attributes are correlated with program effectiveness. While this section is intended to serve as a standalone description of the data development process, it includes material that is somewhat condensed from the Phase I report. Interested readers should consult the Phase I report, whose major sections are laid out in parallel with the sections in this Phase I report.[1]

2.1 KEY CHANGES FROM PHASE I

The majority of the data development methods in this second research phase have been carried over from Phase I. However, a few key pieces were added or adjusted in this phase, as follows. The master dataset was expanded to include 2015 ex ante claims and 2014 ex post claim level data. In cases where ex post savings were not evaluated (including all 2015 claims, since ex post data was not available as of the model development and report writing phases of this work), a set of proxy realization rates were developed and applied to those ex ante claims, so that every claim in the analysis dataset receives either an evaluated or proxy ex post savings value (section 2.3.2). These proxy realization rates were also used with the CPUC's Cost Effectiveness Tool to produce proxy evaluated TRC and PAC scores (section 2.4.3). The threshold used to flag and exclude potentially inflated claims or under-aggregated sites was adjusted, taking into account the spread of savings values for each program (section 2.3.5). In addition, a couple changes were made to effectiveness metrics. The savings achieved metric was adjusted from first-year to lifetime MMBtu savings per annual consumption (section 2.4.2). And finally, the technologies addressed metrics were adjusted from the average number of distinct technologies installed through the program to the percentage of sites within a program that installed more than one distinct technology (section 2.4.1).

[1] See http://calmac.org/publications/Comprehensiveness%5FAnalysis%5FReport%5F%2D%5FPhase%5FI%2Epdf. Equivalently, see http://www.energydataweb.com/cpucFiles/pdaDocs/1624/CA%20Comprehensiveness%20Analysis%20Draft%20Report%20-%20Phase%20I.pdf

2.2 PROGRAM SELECTION

This study includes non-residential programs from PG&E, SDG&E, SCE, and SCG from the 2010-2015 program years. The evaluation team identified 166 programs for inclusion in this study, including 79 PG&E programs, 64 SCE programs, 11 SCG programs, and 12 SDG&E programs. Since some program IDs changed from the 2010-2012 program cycle (1012) to the 2013-2015 (1315) program cycle, we needed to identify which programs were continuations across cycles. In some cases, programs were split, merged, or discontinued. We contacted each IOU to get a mapping of the 1012 program IDs to the 1315 program IDs and created our own program ID for each unique program (accounting for merges and splits) in the study. The full list of programs, including the mapping of Itron program ID to the 1012 and 1315 program IDs is found in Table A-1 of the appendix. Of the 166 programs included in this study 15 are new in 1315 (8 PG&E, 5 SCE, and 2 SCG) and 20 were discontinued after 1012 (10 PG&E, 9 SCE, and 1 SDG&E).

The main criterion for selecting programs to include in the study was the presence of non-residential claims in the program tracking data. In most cases, a program's claims were entirely in the non-residential sector. However, there were 26 programs where some claims were non-residential and some claims were residential (7 programs had less than 50% non-residential claims[2]). In these cases, we only included the non-residential claims in the study. Program costs were allocated to these programs on an avoided cost basis (with weights developed from the reported gas benefits and reported electric benefits from the CPUC's Cost Effectiveness Tool (CET)) to assign an appropriate proportion of costs to the non-residential claims. This approach is consistent with how costs are allocated for the TRC and PAC tests per the CET.

From the set of non-residential programs, we also excluded primary upstream lighting programs, codes and standards programs, and energy advisor programs. Upstream lighting programs are primarily residential programs from which a small proportion of installations are allocated to the non-residential sector. Since there is no participant information and they're not designed as non-residential programs they were excluded from analysis. Codes and standards (C&S) programs claim savings due to legislative changes so there is no participant information involved. Similarly, Energy Advisor programs claim savings based on recommendations made to the participant, however no physical measures were incentivized or installed. Since this evaluation is focused on the effectiveness of downstream participant-based resource programs these types of programs were excluded.

[2] The seven programs with less than 50% non-residential claims included in the study are (from most to least non-residential claims): PGE211013 Marin County, PGE211011 Kern, PGE211007 Association of Monterey Bay Area Governments (AMBAG), SCE-13-L-002J Desert Cities Energy Leadership Partnership, PGE211016 Redwood Coast, PGE21037 Light Exchange Program, and SCE-13-SW-005B Lighting Innovation Program.

2.3 DATA SOURCES

We created the master dataset of 166 programs with data combined from five separate sources:

- Program tracking data
- Program cost tables
- Program evaluation tables
- Cost effectiveness data
- Customer information system (CIS) and billing data

We first compiled information from the five sources into a claim level dataset, then we created a program level dataset with effectiveness metrics (cost effectiveness and depth of retrofit) and program characteristics. The program level dataset was used as the basis for the principal component analysis (PCA), regression, and rankings discussed in later sections.

2.3.1 Program Tracking data

For this study, we used the 2010-12, 2013-14, and 2015 CPUC standardized program tracking databases managed and maintained by the Data Management and Reporting team at Itron. These databases include program claim level information such as: measure name, measure group, end use, building type, sector, gross incentive amount, incentive structure (i.e., Custom or Deemed), gross ex ante first year savings (kWh and therms), and gross ex ante lifecycle savings (kWh and therms). Since the 1012 and 1315 databases were developed and maintained separately, there were some differences in the set of variables present in each database. In order to cleanly merge the two datasets, the variables of interest were updated and standardly defined across databases.

We added or changed the following variables in the 1012 database in order to match the logic of the 1315 database: end use, measure group, sector, and building type. End use is defined as one of ten classifications: appliance, food service, HVAC, indoor lighting, outdoor lighting, plug loads, process, refrigeration, water heating, or other. The full list of 219 measure groups can be found in Table A-2 in the appendix. Sector can be Agricultural, Commercial, or Industrial. The full list of 51 building types can be found in Table A-3 in the appendix.

After the 1012 and 1315 datasets were merged, we created five new classification variables for the purposes of this study. In later sections we will discuss the development of those variables; Measure class will be discussed in Section 2.4.1, building group, gross program group (GPG), program cycle in Section 2.5, and target fuel below.

MMBtu Conversion

Savings were reported in the program tracking database separately for electricity (kWh) and gas (therms). Some programs only save electricity, some only save gas, and some save a combination. For this reason, a uniform unit of energy savings was necessary to compare savings across all programs. Instead of analyzing electricity savings in kWh and gas savings in therms, we converted all energy savings and consumption in both fuel types to millions of British Thermal Units (MMBtu).

KWh, therms, and MMBtu are all units of energy measurement. The equation below illustrates the unit conversion of 1 gigajoule (joule is the SI unit for energy) to kWh, therms, and MMBtu. From these conversions we can estimate that one therm is equivalent to approximately 29.3 kWh.

$$1\ GJ \approx 277.8\ kWh\ \approx 9.48\ therms\ \approx 0.947817\ MMBtu$$ [3]

Using the 1:29.3 unit conversion ratio would successfully quantify the reported amount of energy saved at the meter. These savings, often called site savings, quantify a decrease in the amount of energy delivered to and used by the customer. However, some fuel types require more energy at generation to deliver 1 unit of useful energy to the customer. Thus savings by the customer end up delivering more overall grid energy savings from the standpoint of avoided power generation inputs. We refer to these increased savings at generation as source energy savings.

For this analysis, we converted all reported electricity and gas savings and consumption to source energy expressed in MMBtus. We used the approach described in ENERGY STAR's Portfolio Manager Technical Reference document to calculate appropriate site to source energy savings conversion ratios for electricity and gas.[4] Data from the EIA's annual energy flow diagrams were used to calculate the site to source ratio for each year from 2010 through 2014.[5] We took the average across the five years as the site to source ratio used in our analysis. Table 2-1 shows the site energy unit conversion to MMBtu and the site to source ratio for electricity and gas.

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3 Energy unit conversions from www.wolframalpha.com

4 ENERGY STAR Portfolio Manager Technical Reference: https://portfoliomanager.energystar.gov/pdf/reference/Source%20Energy.pdf

5 EIA energy flow diagrams: http://www.eia.gov/totalenergy/data/annual/archive/energyflow.cfm

TABLE 2-1: SAVINGS CONVERSION TO MMBTU

Fuel	Site Energy Unit Conversion to MMBtu	Site to Source Ratio
kWh	0.003412	3.0235
Therms	0.1	1.05

The site energy unit conversion ratio is multiplied by the site to source ratio to determine the ultimate conversion ratio of site electricity or gas savings to source energy savings in MMBtus. The final conversion ratios are presented in the below equation. Note that the kWh to therms ratio is now roughly 1:10.

$$MMBtu = 0.0103 * kWh + 0.105 * therms$$

Target Fuel

Sometimes, a program claimed savings in a fuel source that was not necessarily the targeted fuel source. When evaluating a program's depth of savings, or savings expressed as a proportion of annual consumption, we wanted to be sure programs were not penalized by large consumption among program participants in a non-targeted fuel source. In effect, the task was to exclude a non-targeted fuel source from the denominator of total energy consumption when expressing program savings as a proportion of annual consumption. For this reason, we developed the target fuel source program classification. This field denotes whether a program targeted electricity savings, gas savings, or both. A program targets savings from a fuel source if at least 20% of its ex ante gross first year MMBtu savings came from that fuel source. Out of 166 programs, 20 targeted gas savings, 113 targeted electricity savings, and 33 targeted savings from both fuel sources. When we created the savings achieved metric, only the savings and consumption from the targeted fuel(s) were considered for each program.

2.3.2 Ex Post Data

Claim level evaluation results, managed and maintained by the Data Management and Reporting team, from 2010-2014 were merged to the master claim level data set. This data allowed us to incorporate ex post savings into our analysis. At the time of this analysis, evaluation results were not finalized for the 2015 program year.

For measures that were not evaluated we created proxy realization rates. These rates were developed separately for 1012 and 1315 kWh and therms savings in four groups, deemed lighting, deemed non-lighting, custom lighting, and custom non-lighting measures. We determined the realization rates (defined as ex post divided by ex ante) based on the evaluated claims in each of these categories. Then those realization rates were applied to the unevaluated claims by category. The proxy realization rates are found in Table 2-2 below (starred values indicate those carried over from 1315 to 1012). Note that the 2015 claims are completely estimated through these proxy realization rates, since ex post results were not available at the time of this report.

TABLE 2-2: PROXY REALIZATION RATES

	1012		1315	
Proxy RR Groupings	**kWh Proxy RR**	**Therms Proxy RR**	**kWh Proxy RR**	**Therms Proxy RR**
Custom Non-Lighting	0.66*	0.66*	0.66	0.66
Deemed Non-Lighting	0.63	0.70*	0.66	0.70
Custom Lighting	0.40	0.41	0.86	0.65
Deemed Lighting	0.79	0.41	0.98	0.79

The proxy realization rates were developed from the results of the nonresidential evaluation studies. There are two ESPI studies that evaluate nonresidential custom measures, the Custom Lighting (CL) evaluation and the Industrial, Agricultural, and Large Commercial (IALC) evaluation. The CL evaluation covers all of the custom lighting measures and the IALC study covers the large majority of all custom non-lighting measures, with separate gas and electric realization rates. Therefore, it was logical to estimate a separate proxy realization rate for custom lighting and custom non-lighting measures. In the deemed evaluation space, various ESPI studies have evaluated a significant portion of the overall lighting portfolio level savings. However, there has not been a significant number of deemed non-lighting measures studied. We did not apply the Custom IALC results to the deemed non-lighting measures because of the inherent differences in custom versus deemed spaces. Typically, custom measures are installed in larger and more specialized businesses, so these results are not considered to be transferrable to the deemed measures. For this reason, though limited, the results from the evaluated deemed non-lighting measures were used to create the proxy realization rates for all deemed non-lighting measures.

2.3.3 Cost Effectiveness

Claim level cost effectiveness data from 1012 and 1315, developed and maintained by the Data Management and Reporting team using the Cost Effectiveness Tool (CET), were merged to the master claim level dataset. The cost effectiveness data includes the electric benefits, the gas benefits, the Total Resource Cost (TRC) test costs, and the Program Administrator Cost (PAC) test costs associated with each claim. These fields were used to calculate the TRC and PAC on the non-residential claims of each program from 2010-2015, based on the methods found in the California Standard Practice Manual.

Since some programs had both residential and non-residential claims, we used the electric and gas benefits to establish a weighting scheme to apply program level costs at the claim level. Since we only analyzed non-residential claims, we needed a method to select an appropriate portion of the program level costs to associate with the non-residential claims. The weight applied to each claim was developed for each cycle and program separately, per the below equation. In program p and cycle c, W_i is the weight applied to claim i, E_i is the electric benefits for claim i and G_i is the gas benefits for claim i. Note that W_i will sum to one for all the claims in a given program and cycle. If a program has neither gas nor electric benefits in that cycle, then program costs distribute evenly across all claims in that program and cycle.

$$W_i = \frac{E_i + G_i}{\sum_{i \in p,c} E_i + G_i}$$

2.3.4 Expense Data

The program cost data for each cycle, managed and maintained by the Data Management and Reporting team, was merged to the master claim level data, so that each claim was assigned the costs from the associated program and cycle. To allocate the program cost to the claim level, the program level cost was multiplied by the weighted benefits field for each claim. Expenses in the program costs table were divided into the following five categories: administration costs in overhead and G&A, other administration costs, marketing and outreach, direct implementation activity, and rebates and incentives not calculated on a per unit basis (this last category was only used in 1012 programs).

2.3.5 CIS/Billing Data

In order to include information such as participant annual consumption and size in the analysis, customer information system (CIS) and billing data was incorporated into the master claim level data. The group of accounts corresponding to a single site had been determined by the Data Management and Reporting team for PG&E, SCE, and SDG&E. For those three program administrators (PAs), the CIS and billing data had been aggregated and summarized by the Data Management and Reporting team to the site level, and each claim in the program tracking data was mapped to its associated site. The CIS and billing data was summarized by site with key fields such as customer name, address, latitude and longitude, phone number, and annual consumption.

The SCG billing data needed to be summarized in order to acquire the annual gas consumption in each year from 2010 through 2015. Before that could take place, SCG accounts needed to be aggregated into individual sites and joined to existing PG&E, SCE, and SDG&E accounts where necessary. We followed the same site aggregation process as the data team used for the other PA's to aggregate SCG accounts to sites, based on address, phone number, and customer name. In cases where multiple existing PG&E/SCE/SDG&E sites were matched to a single SCG site, then those sites were combined to create a single new site. Similarly, if a single PG&E/SCE/SDG&E site was matched to multiple SCG sites, then those SCG sites were combined to a single site. Once the final site aggregation had taken place, the new site ID was mapped onto the master claim level data. Once SCG sites were created, a new summary table was created of each site's annual consumption. Finally, the site level annual consumption was merged to the master claim level data by site ID.

Sometimes claims from the program tracking data could not be matched to the CIS data. These claims were excluded from analysis.

Flagging Outliers

As a screen to identify sites with potential data issues (that could in turn drive inaccurate program effectiveness scores), we reviewed first year ex post savings at the site level in proportion to annual consumption. Claims were grouped by building type, sector, and end use segments. Then, for each segment the distribution of savings relative to consumption values was calculated and outliers were identified. The maximum allowable value per segment was calculated as the 75th percentile plus 1.5 times the inter-quartile range. Any value above that maximum was flagged and excluded from analysis. In addition, any value where savings relative to consumption exceeded 100% was excluded from analysis. Finally, the mean and standard deviation for each segment was calculated, and any value exceeding the 90th confidence interval (mean + 1.645 * standard deviation, assuming normality) was also excluded from analysis.

2.4 SUCCESS METRICS

Upon creation of the master claim level data, we summarized key statistics for each program. Based on the objectives of the project, we needed sensible indicators of depth of retrofit and cost effectiveness that could be woven into an overall effectiveness score.

2.4.1 Greater than One End Use and Measure Class per Site

Measure class was defined to classify technologies at a level of granularity falling between end use and measure group. We felt that a more detailed classification than end use would help portray a program's depth of retrofit and serve as a complementary indicator to the number of end uses addressed, but that measure group was too granular and too arbitrary for this purpose. To generate the measure class categorization, each measure group was mapped to a single measure class. Where measure group has 219 unique designations and end use has 11, the measure class variable has 35 as shown in Table A-2 in the appendix.

For each site that participated in a program, we calculated the number of distinct end uses and measure classes addressed. Then the proportion of sites within each program with more than one distinct end use and measure class, respectively, was calculated.

2.4.2 Savings Achieved

A key and complementary indicator of depth of retrofit, in addition to the proportion of participants addressing multiple technologies, is the amount of energy savings achieved. This was expressed as the lifetime ex post gross MMBtu savings per annual MMBtu consumed.

The following steps were taken to calculate the savings as a percentage of consumption metrics. At the claim level, a variable was created for the annual MMBtu consumption in the year of the claim, from targeted fuel sources only. Ex post gross lifetime MMBtu savings relative to annual consumption was calculated for each program and site. The average savings relative to annual consumption was taken across sites within each program to calculate the final savings relative to annual consumption metric.

Through the remainder of this report we will refer to ex post gross lifetime MMBtu savings relative to annual consumption as Ex Post Savings Achieved.

2.4.3 TRC and PAC

"The Total Resource Cost Test measures the net costs of a demand-side management program as a resource option based on the total costs of the program, including both the participants' and the utility's costs."[6]

"The Program Administrator Cost (PAC) Test measures the net costs of a demand-side management program as a resource option based on the costs incurred by the program administrator (including incentive costs) and excluding any net costs incurred by the participant. The benefits are similar to the TRC benefits. Costs are defined more narrowly."[7]

Both of these tests are used by the CPUC to evaluate program cost effectiveness.

Program level TRC and PAC were calculated from the master claim level dataset. Claim level ex post savings (including the proxy ex post savings values) were fed into the CET. For each program, we calculated TRC as the sum of the claim level electric and gas benefits divided by the sum of the claim level TRC costs. Similarly, we calculated PAC as the sum of the claim level electric and gas benefits divided by the sum of the claim level PAC costs.

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6 http://www.cpuc.ca.gov/uploadedFiles/CPUC_Public_Website/Content/Utilities_and_Industries/Energy_-_Electricity_and_Natural_Gas/CPUC_STANDARD_PRACTICE_MANUAL.pdf

7 http://www.cpuc.ca.gov/uploadedFiles/CPUC_Public_Website/Content/Utilities_and_Industries/Energy_-_Electricity_and_Natural_Gas/CPUC_STANDARD_PRACTICE_MANUAL.pdf

2.4.4 Savings per Program Cost and Gross Incentive

Along with the TRC and PAC, we developed two other, simpler metrics measuring cost effectiveness. They are lifecycle ex post gross MMBtu savings per total program cost and lifecycle ex post gross MMBtu savings per total program gross incentive. Total program cost is the sum of the five program cost components from the program cost table (Section 2.3.4) and the claim level gross incentives field. Total program gross incentive is comprised only of the claim level gross incentives field.

2.5 DESCRIPTIVE METRICS

In addition to the program success metrics described above, we developed program level characteristics to describe various attributes of the program. These descriptive metrics would subsequently be used to highlight any correlations between program characteristics and program effectiveness, as explored through regression analysis in Section 4.

Program classification metrics include: Program sector, program gross program group (GPG), program administrator, program cycle (defined below), and program direct install (DI) flag.

Gross Program Group

As part of the gross impact evaluations done for the Efficiency Savings and Performance Incentive (ESPI) evaluations, gross program group was developed as a way to identify programs with similar delivery mechanisms. GPG had only been developed by the Data Management and Reporting team for the 1315 programs, so we utilized the program mapping to assign GPG to the 1012 data as well. We also simplified the GPG definition to four general areas: core/statewide, local government partnership (LGP), third/local party implementer (3P), and state institutional partnership (SIP).

Program Cycle

We created a program classification to identify programs that were discontinued after 1012, continued from 1012 through 1315, or new in 1315.

2.5.2 Percent of Sites Attributes

Site Size

The evaluation team characterized the percent of sites in each program that are very small, small, medium, and large. A site's size was defined based on its 2015 annual consumption from the CIS/billing data. If the site had kWh consumption in 2015 then the kWh criteria were used, otherwise the therms criteria were used. Each site was tested against the size criteria in Table 2-3 in sequential order from very small to large until a size bucket was matched. For example, if a site did not meet the threshold for very small it was then tested against the small criteria. If at that point the size was determined to be a small site no further criteria testing took place.

TABLE 2-3: SITE SIZE CRITERIA

Size	kWh Criteria	Therms Criteria
Very Small	≤ 40,000 kWh	≤ 8,478,507 therms
Small	≤ 300,000 kWh	≤ 149,927,361 therms
Medium	≤ 1,750,000 kWh	≤ 245,060,234 therms
Large	> 1,750,000 kWh	> 245,060,234 therms

If a site could not be matched to CIS/billing data, then the size of the site was defined as “unknown”.

End Use

Another proportion metric we developed was the percent of sites in each program that installed a particular end use including: appliances, food service, HVAC, indoor lighting, outdoor lighting, plug loads, process, refrigeration, water heating, and other.

Building Group

The building type classifications in the tracking data were too granular for the purposes of this study, with 51 different building types. For instance, there were separate building types for fast food and sit down restaurants. We consolidated some of these building types and created a new variable, called building group, with just 19 different classifications. Building groups were created so that each group would have a significant amount of savings (at least 1% of portfolio).

The building group metric is defined as the percent of sites in each program that include accounts in one of the following building groups: assembly, colleges, food/liquor, health, lodging, manufacturing, office, retail, restaurant, school, transportation, communication, and utilities (TCU), and warehouse.

Incentive Structure

Another proportion metric we developed was the percent of sites in each program with a deemed incentive structure and the percent of sites with a custom incentive structure.

2.5.3 Percent of Total Program Cost

Total program cost was split into five categories: Administration costs – overhead and G&A, administration costs – other, DI activity, marketing/ outreach, and incentives. For each program, the proportion of total program cost spent in each of these individual categories was calculated.

3 PROGRAM EFFECTIVENESS SCORING

Program comparison and ranking requires a single metric to measure against, driving the search for a method to combine all of the program level effectiveness metrics. Inherent in their creation, the seven effectiveness metrics discussed in the previous section often measured similar ideas. Therefore, high correlation is expected across some of these variables. The evaluation team decided to use a statistical tool called principal components analysis (PCA) to combine the metrics mathematically into a single effectiveness metric. PCA is a variable reduction technique that combines highly correlated variables. The analysis process drove the determination that there were three distinct effectiveness groups, necessitating a separate PCA for each group. Weighting the three metric groups allowed for the creation of a single program effectiveness score.

This section begins with an introduction to PCA and a review of the metrics chosen to measure various aspects of program success. Next is a discussion of the analytical basis for three separate metric groups and the results of the PCA analysis, followed by a description of the weighting scheme used to combine the three metric groups. The Phase I report provides further detail on the concept and analytical approaches involved with principal components analysis.

3.1 METHODS

In analytical cases with many variables that are highly correlated and are likely measuring the same thing, PCA can be used to reduce the number of variables. PCA uses an orthogonal linear transformation to execute a change of basis and obtain a set of the same number of variables as inputted. A subset of the outputted variables, capturing the majority of the variability in the data, can then be selected for continued analysis. Whereas prior to PCA the input variables might have had high correlations, the variables output from PCA are linearly uncorrelated. Closely related to factor analysis, PCA is a purely mathematical, data-driven approach for variable reduction.

3.1.1 Concept

The basic concept of PCA begins with a set of n variables fed into the PCA procedure.[1] PCA produces a set of n principal components (PC) representing the same information as the inputted variables. The n principal components are linearly orthogonal (statistically independent) and ordered from the PC representing the most variability in the data to the least. Each PC represents a different facet or type of activity in the n-dimensional space that is completely different and uncorrelated with the other PCs.

[1] The evaluation team used SAS to carry out the principal component analysis

Essentially, PCA identifies which variables measure the same activity and groups those variables together into a single PC. The following example illustrates this idea. Imagine a single variable, x1. Now imagine defining four other variables as exact copies of the original variable (x1 = x2 = x3 = x4 = x5). If those five variables are input into a PCA the output includes a set of five PCs. The first PC represents all of the variability in the data (eigenvalue[2] = 5) and the remaining four PCs represent zero of the variability. This is because PCA recognized that the five input variables measured the same thing and therefore mapped all into a single PC. For variable reduction one would select only the first PC for analysis. The Phase I report provides further detail on the analytical approaches used in applying PCA to this study.

3.2 FINDINGS

This section presents a brief discussion of the metrics chosen to measure program effectiveness and other metrics also considered but not included in the final set of effectiveness metrics. The section goes on to review the relationships between the seven final effectiveness metrics and explains the motivations behind developing three separate PCA models. The results of each PCA are described and the final algorithm for combining metrics to a single variable is presented.

3.2.1 Effectiveness Metrics Selection

The evaluation team used PCA to develop the dependent variable for the regression model (the program effectiveness metric). As described in Section 2, seven metrics were developed to measure program effectiveness. These metrics are classified into three general groups: savings achieved, technologies addressed, and cost effectiveness. There are two types of technologies addressed metrics: percentage of sites with more than one distinct measure class and percentage of sites with more than one distinct end use addressed. There is one savings achieved metric: ex post savings achieved. There are four types of cost effectiveness metrics: evaluated PAC, evaluated TRC, ex post savings per gross incentive, and ex post savings per total program expenditure. While we recognize that these metrics may not necessarily align perfectly with each program’s designed outcomes, this set of performance metrics best exemplify depth of retrofit and cost effectiveness.

A Note on Program Size Relative to DORCE

It is an intentional feature of DORCE that overall program size is not reflected in the score. While there can be a temptation to reward the larger magnitude savings of large programs within the structure of the score, to do so would cause the large programs to overshadow smaller niche programs in terms of communicating their effectiveness for the purpose they serve. Rather than include program size in the

2 Eigenvalue represents the amount of variance in the data accounted for by a given principal component (see 3.1.2)

score itself, it is best to view DORCE achievements alongside additional contextual information such as program size and program target areas.

3.2.2 Key Changes from Phase I

With the introduction of proxy realization rates for all unevaluated claims in the second phase of this study, every claim in the analyzed dataset now receives either an evaluated or proxy ex post savings value. Therefore, ex ante savings values are no longer included within the set of effectiveness metrics. They were initially included along with ex post savings, since not all claims received ex post values and many were passed through. Ex post savings in phase I were not complete, and therefore ex ante savings were included as well to balance out any bias. Once all claims had at least a proxy ex post value in Phase II, the set of effectiveness metrics was reduced to ex post values only. This reduces the number of effectiveness metrics from ten to seven.

3.2.3 Effectiveness Metrics Analysis

The underlying structure and correlations of the seven effectiveness metrics led to separating into three metric groupings. This is based on natural divisions that can be seen in the full correlation matrix of the seven metrics shown in Table 3-1 below. Correlations above 0.5 are shown in bold text. Shading in each cell illustrates different patterns found in the correlation matrix. The white box, comprised of the first four metrics, is comprised entirely of correlations of 0.5 or higher, illustrating that these four metrics are all highly correlated. To the right of the white box, the medium-grey region highlights the correlation of those same four metrics against the technologies addressed and savings achieved metrics. The correlations between these sets of variables range from -0.3 to -0.1, indicating very weak, to absent, correlations. These two observations regarding the first four metrics, led to grouping the four cost effectiveness metrics together, apart from the others. With regards to the remaining three variables, the savings achieved metric (Ex Post Savings per MMBtu Consumed) is weakly correlated with the technologies addressed metrics (light grey region). And finally, the black shaded region shows that technologies addressed metrics are highly correlated with each other. These last findings led to grouping the technologies addressed and savings achieved metrics separately.

TABLE 3-1: EFFECTIVENESS METRICS CORRELATION MATRIX

Input Variables	TRC	PAC	Ex post Savings per Cost	Ex post Savings per Gross Incentive	Ex post Savings per MMBtu Consumed	% >1 Measure Class	% >1 End Use
TRC	**1**	**0.8**	**0.7**	**0.5**	-0.1	-0.1	-0.2
PAC	**0.8**	**1**	**0.9**	**0.6**	-0.1	-0.1	-0.2
Ex post Savings per Cost	**0.7**	**0.9**	**1**	**0.7**	-0.1	-0.2	-0.2
Ex post Savings per Gross Incentive	**0.5**	**0.6**	**0.7**	**1**	-0.3	-0.3	-0.3
Ex post Savings per MMBtu Consumed	-0.1	-0.1	-0.1	-0.3	**1**	0.2	0.1
% >1 Measure Class	-0.1	-0.1	-0.2	-0.3	0.2	**1**	**0.7**
% >1 End Use	-0.2	-0.2	-0.2	-0.3	0.1	**0.7**	**1**

PCA itself was also used as another method to confirm the three groupings of the effectiveness metrics. The seven effectiveness metrics were input into a single PCA. Table 3-2 shows the eigenvalue PCA table. The first three PCs satisfied the Kaiser criterion (eigenvalue greater than one) with eigenvalues of 3.4, 1.6, and 1.0. Cumulatively, the first three PCs represent 85% of the data's variability, surpassing the minimum 70% threshold that is commonly used in deciding the number of PCs to retain in variable reduction.

TABLE 3-2: PCA EIGENVALUE TABLE

PC	Eigenvalue	Proportion	Cumulative
PC1	3.4	49%	49%
PC2	1.6	22%	71%
PC3	1.0	14%	85%
PC4	0.5	7%	92%
PC5	0.3	4%	96%
PC6	0.2	3%	99%
PC7	0.1	1%	100%

Inspection of the factor pattern (Table 3-3) leads to the same three groupings as identified from the correlation matrix (cost effectiveness, technologies addressed, and savings achieved). The cost effectiveness metrics load strongly on PC1, suggesting that the cost effectiveness metrics have a clear and distinct pattern from the depth of retrofit metrics. The technologies addressed metrics load strongly onto

PC2 and savings achieved loads strongly onto PC3. Overall technologies addressed and savings achieved also have a clear and distinct pattern from each other as well as different from cost effectiveness. For these reasons, with support from the correlation matrix, we used three separate PCAs for creation of the final effectiveness metric.

TABLE 3-3: FACTOR PATTERN OF PC1, PC2, AND PC3

Input Variables	PC1	PC2	PC3
% >1 Measure Class	-0.5	**0.8**	-0.1
% >1 End Use	-0.4	**0.8**	-0.3
Ex post Savings per MMBtu Consumed	-0.3	0.3	**0.9**
TRC	**0.8**	0.3	0.1
PAC	**0.9**	0.3	0.0
Ex post Savings per Cost	**0.9**	0.3	0.1
Ex post Savings per Gross Incentive	**0.8**	0.0	-0.1

3.2.4 PCA Models

The final variable reduction approach included two separate PCA models, one each for cost effectiveness and technologies addressed. Since there is only a single savings achieved metric, PCA was not needed.

Cost Effectiveness

The cost effectiveness PCA consisted of four metrics: evaluated TRC, evaluated PAC, ex post savings per gross incentive, and ex post savings per total program cost.

Below is the cost effectiveness eigenvalue PCA table (Table 3-4). PC1 was the only PC to satisfy the Kaiser criterion (eigenvalue greater than one) with a 3.1 eigenvalue. Representing 79% of the data's variability it surpassed the minimum 70% threshold. The evaluation team kept only PC1 as the measure of cost effectiveness.

TABLE 3-4: COST EFFECTIVENESS PCA EIGENVALUE TABLE

PC	Eigenvalue	Proportion
PC1	3.1	79%
PC2	0.5	13%
PC3	0.2	6%
PC4	0.1	2%

The factor pattern (Table 3-5) illustrates the relationship between the input variables and PC1. All of the input variables are highly correlated with PC1. All six input variables measure a similar pattern in the program level data, called cost effectiveness.

TABLE 3-5: COST EFFECTIVENESS PCA FACTOR PATTERN

Input Variables	PC1
TRC	0.9
PAC	0.9
Ex post Savings per Cost	1.0
Ex post Savings per Gross Incentive	0.8

Technologies Addressed

The technologies addressed PCA consisted of two metrics: number of measure classes addressed and number of end uses addressed.

Below is the technologies addressed eigenvalue PCA table (Table 3-6). PC1 was the only PC to satisfy the Kaiser criterion (eigenvalue greater than one) with a 1.7 eigenvalue. Representing 86% of the data's variability it surpassed the minimum 70% threshold. The evaluation team kept only PC1 as the measure of technologies addressed.

TABLE 3-6: TECHNOLOGIES ADDRESSED PCA EIGENVALUE TABLE

PC	Eigenvalue	Proportion
PC1	1.7	86%
PC2	0.3	14%

The factor pattern (Table 3-7) illustrates the relationship between the input variables and PC1. Both input variables are highly correlated with PC1. Both input variables measure a similar pattern in the program level data, called technologies addressed.

TABLE 3-7: TECHNOLOGIES ADDRESSED FACTOR PATTERN

Input Variables	PC1
% >1 Measure Class	0.9
% >1 End Use	0.9

3.2.5 Combined Score

The evaluation team combined the two PCs from the cost effectiveness and technologies addressed PCAs with savings achieved by the following steps.

1. Set Depth of Retrofit (DOR) = average (standardized Technologies Addressed PC1, standardized Savings Achieved)
2. Standardize DOR to have a mean of zero and standard deviation of one
3. Set DORCE = average (DOR, cost effectiveness PC1)
4. Standardize DORCE to have a mean of zero and a standard deviation of one

This essentially gave weightings of 1/2 to cost effectiveness, 1/4 to technologies addressed, and 1/4 to savings achieved. Technologies addressed and savings achieved each got 1/4 weightings since each represent a different facet of depth of retrofit. Equal weightings were desired for depth of retrofit and cost effectiveness.

The following equation reflects the DORCE calculation, where: T1 is the percentage of sites within a program with more than one distinct measure class; T2 is the percentage of sites within a program with more than one distinct end use; S is savings achieved; C1 is evaluated TRC; C2 is evaluated PAC; C3 is ex post lifetime gross savings per program dollar spent; C4 is ex post lifetime gross savings per dollar gross incentive.

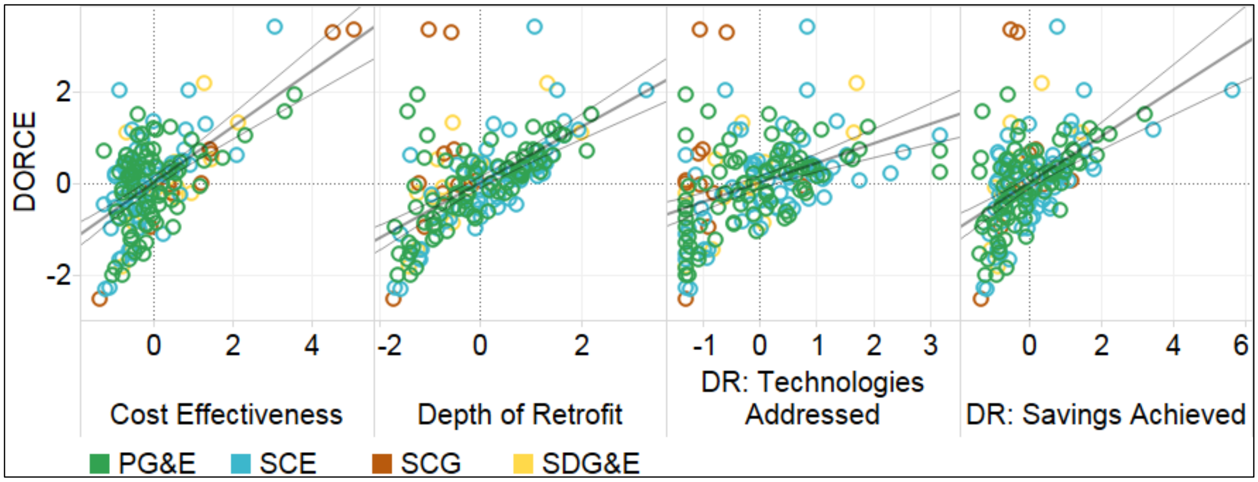
$$DORCE = \frac{0.5}{0.607}\left\langle\frac{0.5}{0.767}\left[\left\{0.54\left(\frac{T1-0.387}{0.273}\right)+0.54\left(\frac{T2-0.213}{0.216}\right)\right\}+\left\{\frac{S-0.682}{0.488}\right\}\right]\right.$$
$$+\left\{0.273\left(\frac{C1-1.40}{1.24}\right)+0.301\left(\frac{C2-1.73}{1.16}\right)+0.302\left(\frac{C3-0.227}{0.184}\right)\right.$$
$$\left.\left.+0.247\left(\frac{C4-0.659}{0.523}\right)\right\}\right\rangle$$

A simplified version of the equation follows.

$$DORCE = 1.06(T1) + 1.34(T2) + 1.10(S) + 0.182(C1) + 0.213(C2) + 1.36(C3) + 0.389(C4) - 2.64$$

The four scatterplots in Figure 3-1 below show the relationships between the final program effectiveness metric (DORCE) and the components of that metric. Each circle represents a program and its color indicates the PA. Programs are plotted by their DORCE score (y-axis) against their cost effectiveness, depth of retrofit, technologies addressed, or savings achieved scores (x-axes). Linear trend lines, along with 95% confidence bands, are also included in each graphic. A few specific observations from the figure stand out. The figure illustrates how each individual component is positively correlated with the final program effectiveness metric, DORCE. It also shows how each of the depth of retrofit metrics (technologies addressed and savings achieved) are positively correlated with DORCE. This illustrates how DORCE rewards programs that achieved high cost effectiveness and high depth of retrofit. Whereas if a program did well in one area and not the other then a program would end up scoring somewhere in the middle on DORCE.

FIGURE 3-1: DORCE RELATIONSHIP TO COST EFFECTIVENESS AND DEPTH OF RETROFIT PCS



4 MODELING PROGRAM EFFECTIVENESS BY PROGRAM FEATURES

The development of the comprehensive analysis dataset, as well as development of the DORCE metric via principal components analysis, provided the structure to view programs and the overall portfolio in terms of DORCE. This section details the regression modeling methods and findings.

4.1 METHODS

Regression analysis enables an assessment of which program characteristics are associated with effective outcomes. Regression analysis in this study modeled the associations between various program characteristics and program cost effectiveness, depth of retrofit, or DORCE score.

Program achievements are inevitably the result of complex, interacting phenomena. Outcomes are a function of various elements of program design and implementation, combined with the specific context of the customer population, economic and demographic dynamics outside the control of the program, weather patterns, and a multitude of other actions and considerations. While it is impossible to identify all of these dynamics and their influence on a program, the measurable program characteristics included in the regression modeling for this study may be associated with varying levels of success. These program characteristics are referred to as predictor or independent variables in the regression models. They include a program's target sector, associated building type(s), end use(s), and customer size(s), delivery mechanism, incentive structure, or the program budget areas of concentration.

In regression modeling it is important to guard against over-specifying a model with so many variables that essentially each program has its own predictor variable and no underlying patterns can be detected. An approach to avoid this is to carefully select program characteristics with known or theoretical relationships to effectiveness. Statistical tools, such as adjusted R^2, which estimates the amount of data variability accounted for by the regression model, can be used to identify when a model is appropriately specified. If the addition of one more predictor variable does not increase adjusted R^2, this serves as an indication that the new variable does not add anything substantive to the model. The task becomes one of optimally specifying the model by adding independent variable sets until the model approaches the ceiling of what can be explained by the model, but without adding variable sets that add complexity without adding to the explanatory power of the model.

4.1.1 Regression

The regression modeling exercise for this project was a matter of exploring the explanatory power of different variable sets and moving toward an optimally specified model. The final model would show the relative magnitude of how differences in various program characteristics are correlated with differences in DORCE score.

As discussed in Section 2 on Data Development, several predictor variables were defined as categorical variables while others were defined as continuous variables. For example, Program Administrator is a categorical variable, with a set of discrete values (PG&E, SCE, SCG, and SDG&E). In contrast, the percentage of a program's participating sites that are considered Very Small is a continuous variable that can range from 0%-100%. Based on data available in the comprehensive analysis dataset, the categorical variables explored in the modeling process included Sector, GPG, PA, program cycle, and DI program status. The continuous variables explored in the modeling process included percentage-based characterizations of: Customer Size, End Uses Addressed, Building Types Addressed, Incentive Structure (Deemed or Custom), HTR Participation, Distributed Generation (DG) participation, and Proportions of total program expenditures going to different sub-elements of program cost.

Stepwise Model Specification

Model development consisted of a stepwise, iterative process. Model results were reviewed at each step, including the amount of data variability accounted for in the model (adjusted R^2), and the coefficients associated with each predictor variable. In addition to adjusted R^2, collinearity among predictor variables was also monitored. A central assumption for linear regression is that the predictor variables are independent (i.e., no multicollinearity). Each additional predictor variable added to the model was checked for multicollinearity using the tolerance test statistic. Any value below 0.1 indicates potential multicollinearity among the predictor models. In cases where multicollinearity was suggested, the predictor variable most relevant to the study was retained.

In its first iteration, the model only included target sector as the sole predictor variable. While carefully monitoring to account for issues with collinearity, variable sets were added to the model for GPG, Program Administrator, Program cycle, Customer size, End use, Building type, Percent deemed, DI program status, and Percent of total program expenditure going to different sub-elements of program cost. The final model was, based on the evaluation team's judgment, the optimal set of predictor variables with a significant and distinct effect on DORCE outcomes.

Sensitivity Testing

If model outcomes are highly sensitive to different but mutually reasonable ways of defining the predictor variables and/or specifying the model, then the model is not considered stable. In these cases, model outcomes are likely sensitive to and driven by specific outliers in the dataset and/or improperly addressed issues of collinearity among predictor variables, rather than robustly capturing and characterizing meaningful relationships among the variables.

The stepwise model specification approach described above is itself a stability testing exercise, as it is based on looking for stable overall trends in the model coefficients with the addition of each additional predictor variable. The regression model's sensitivity to differences in the approach used to define certain continuous predictor variables was explored. The various sensitivity analyses gave no reasons for concern. As a result, the evaluation team is confident in the final model selection presented in the findings of this report section.

4.2 FINDINGS

Ultimately, we developed five separate final regression models. The sole difference in the construction of these models was the chosen program effectiveness outcome, either DORCE, cost effectiveness, depth of retrofit, technologies addressed, or savings achieved. In this section, we review the regression output of these models, offering a view of the relationships between various program characteristics and program effectiveness scores.

4.2.1 Overall Program Effectiveness Score

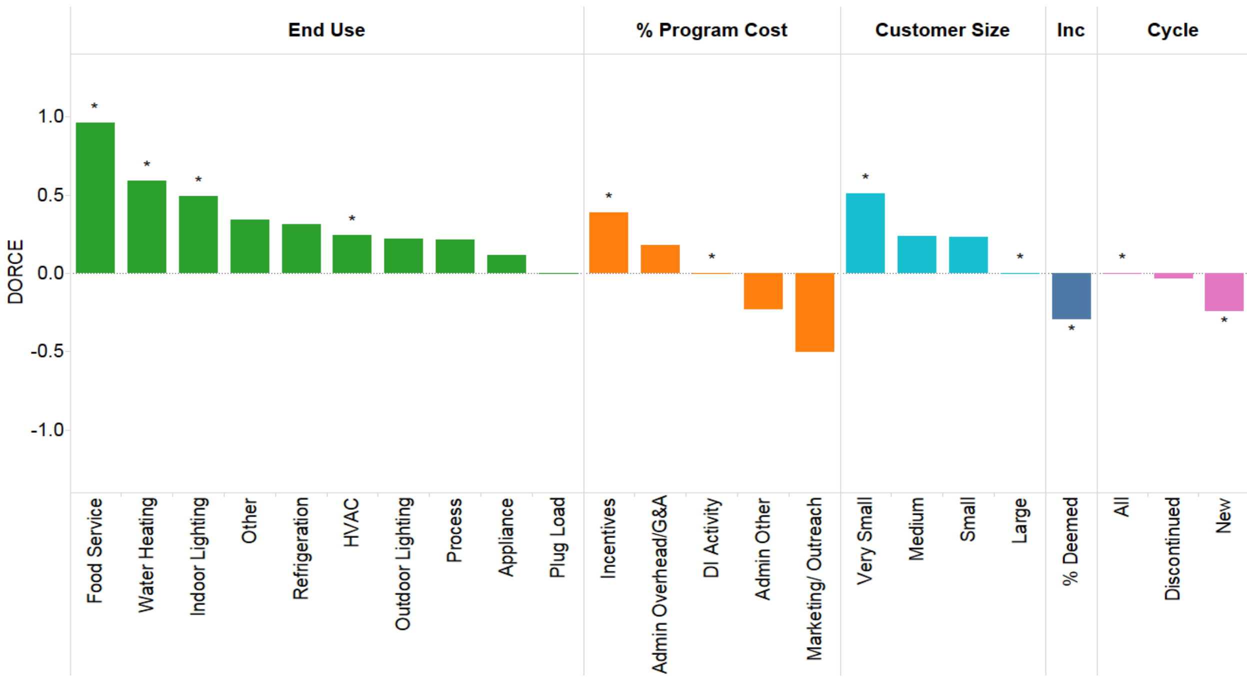
A variety of aspects of overall program structure are correlated with high or low DORCE scores. Figure 4-1 below shows the significant drivers of overall program effectiveness scores. In this Section we look at the overall predictor variable sets that significantly influence program effectiveness outcomes. Then in Sections 4.2.2 and 4.2.3 we look deeper into the roles played specifically by the depth of retrofit scores and the cost effectiveness scores, respectively, in driving overall program outcomes.

A note on interpreting regression coefficients:

For categorical variables such as Sector in Figure 4-1 below (as well as for all figures in Section 4.2), due to the basic structure of regression models, one of the values is arbitrarily assigned a coefficient estimate of zero, and the other values are defined in relation to that zero value. Hence, Commercial has been assigned a coefficient estimate of zero, and the coefficient estimates for other sectors are relative to that zero value. If, instead, Agriculture had been assigned a coefficient estimate of zero, then the whole group of coefficient values for sector would be shifted downward, but their relative relationships to each other would be preserved.

Because of this, coefficient estimates can be meaningfully compared across the values within a given color grouping. Coefficient estimates can also be meaningfully compared across color groupings in terms of the range in coefficient magnitude (for example, End Use has a slightly greater range in coefficient estimates than % of Program Cost). However, it is not meaningful to draw conclusions across color groupings in terms of vertical shift based on which value in a given color grouping has arbitrarily been assigned a value of zero.

FIGURE 4-1: OVERALL PROGRAM EFFECTIVENESS (DORCE) SIGNIFICANT COEFFICIENTS



As an overarching observation, the magnitudes of these significant effects all hover in the same range. That is, each of the aspects of program structure that demonstrate a statistically significant correlation with DORCE scores has a magnitude effect approximately on par with the others.

Several end uses stand out as being associated with higher DORCE scores on average. Food service, water heating, indoor lighting, and HVAC all show statistically significant, positive correlations with higher DORCE outcomes.

The distribution of overall program expenditures across administration, marketing, program incentives, and other needs shows a significant correlation with overall DORCE outcomes. Programs that attribute a larger proportion of overall program costs to incentives are associated with higher DORCE scores than those with a high proportion of program costs going to marketing and other functions. Although a high proportion of expenditure on marketing and outreach correlates with low DORCE scores, this does not necessarily indicate causation. That is, it is possible that low program performance as captured in the low

DORCE score for these programs may have motivated a high investment in marketing and outreach in response.

Programs targeting very small customers generally perform better on DORCE than those targeting larger customers. This is a relatively large magnitude effect in terms of coefficient size compared to other aspects of program structure. The coefficients for targeting small and medium customers are mid-range, followed by the lowest coefficients for targeting large customers, though this latter distinction is not significant at alpha 0.05.

As shown in Figure 4-1 above, program phase also has a statistically significant correlation with DORCE outcomes. Programs that have been in place only in the 2013-2015 timeframe have generally fared worse on overall DORCE score than programs that were in place for both the 2010-2012 and 2013-2015 phases or that were in place for just the 2010-2012 phase.

A program's focus on a given building type does not show a statistically significant correlation with overall DORCE outcomes. As is discussed in the sections that follow, within the subcomponents of the DORCE score there are statistically significant differences across some building types expressly in terms of cost effectiveness outcomes or expressly in terms of depth of retrofit outcomes. However, at the overall DORCE level, these have a net effect of dampening each other such that no particular building type fares best on DORCE overall.

Lastly, Programs focused on custom measures fare better on DORCE overall than those focused on deemed measures.

Comparison to Phase I

The regression results remained generally stable between Phase I and Phase II. Table 4-1 below shows the direction, magnitude, and statistical significance of the resulting coefficients across phases. The table shows the coefficient of each predictor variable in Phase I and Phase II, bold blue text indicates significance at 0.05 alpha. The rightmost column indicates the direction and magnitude of the coefficient difference moving from Phase I to Phase II. All of the variables that remained significant across phases (Very Small Customers, Large Customers, Food Service, HVAC, Indoor Lighting, Water Heating % Deemed, DI Activity, and Incentives) maintained the same direction and relative magnitude. A few variables lost significance in Phase II, including the Sector related variables, Medium Customers, Process End Use, and Offices. Additionally, one variable group, program cycle, became significant in the Phase II results.

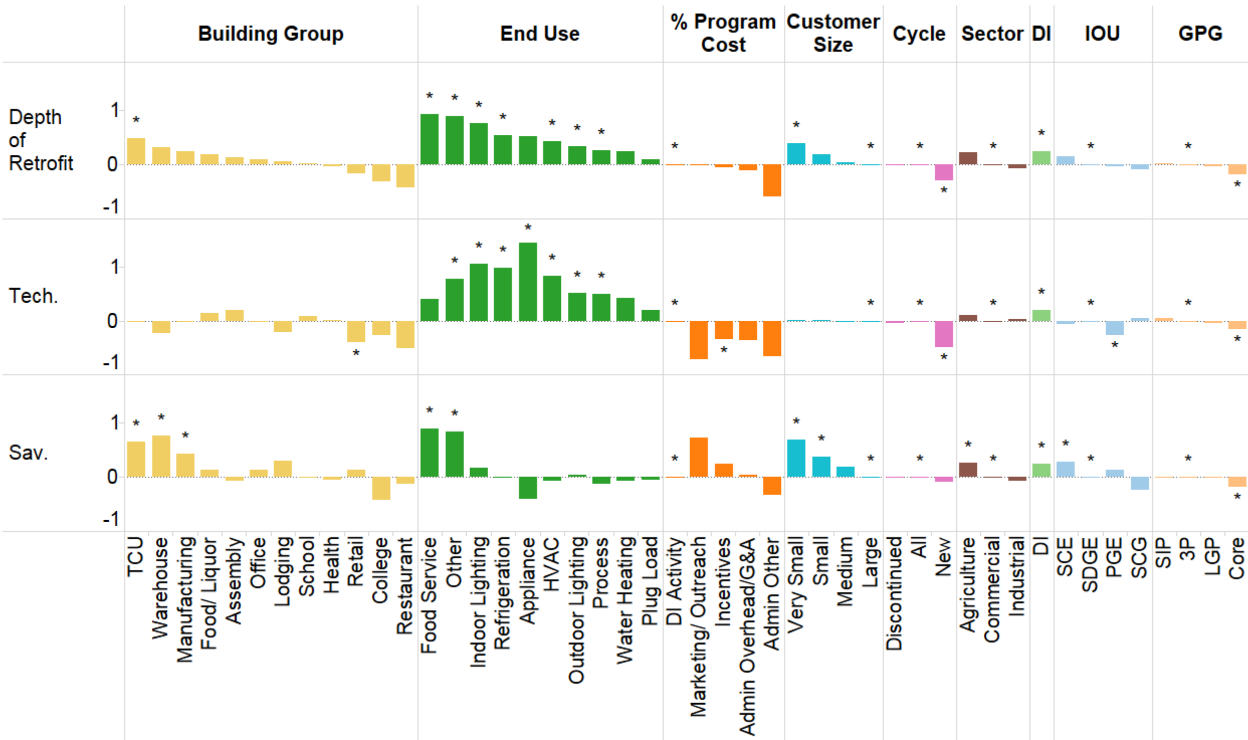
TABLE 4-1: DORCE REGRESSION COEFFICIENTS PHASE COMPARISON

Category	Variable	Coefficients		
		Phase I	Phase II	Δ
Sector	Agriculture	**0.30**	0.21	
	Industrial	0.17	0.16	
	Commercial	**0**	**0**	
Cycle	Discontinued	-0.08	-0.03	
	New	-0.17	**-0.25**	
	All	**0**	**0**	
Customer Size	Very Small	**0.52**	**0.51**	
	Small	0.16	0.23	
	Medium	**0.40**	0.24	
	Large	**0**	**0**	
End Use	Appliance	0.21	0.12	
	Food Service	**0.89**	**0.96**	
	HVAC	**0.19**	**0.24**	
	Indoor Lighting	**0.33**	**0.49**	
	Outdoor Lighting	0.26	0.22	
	Plug Load	-0.22	0.00	
	Process	**0.27**	0.22	
	Refrigeration	0.25	0.31	
	Other	-0.01	0.34	
	Water Heating	**0.63**	**0.59**	
Building Group	Assembly	-0.08	0.02	
	College	0.42	-0.23	
	Food/ Liquor	0.39	0.31	
	Health	0.17	0.01	
	Lodging	0.23	0.09	
	Manufacturing	0.29	0.25	
	Office	**0.41**	0.26	
	Retail	0.06	-0.18	
	Restaurant	-0.08	-0.30	
	School	0.19	0.04	
	TCU	-0.02	0.13	
	Warehouse	0.02	0.21	
Incentive	% Deemed	**-0.34**	**-0.30**	
% Program Cost	Admin Other	-0.50	-0.62	
	Admin Overhead/G&A	-0.17	-0.20	
	DI Activity	**-0.39**	**-0.39**	
	Marketing/ Outreach	-0.86	-0.89	
	Incentives	**0**	**0**	

4.2.2 Depth of Retrofit Score

Overall program effectiveness is evaluated in this study via the DORCE score that is equal parts depth of retrofit and cost effectiveness. Figure 4-2 below shows how different variable sets drive the depth of retrofit score in terms of its inputs.

FIGURE 4-2: DEPTH OF RETROFIT SIGNIFICANT COEFFICIENTS



Several observations are apparent from looking at Figure 4-2 above. The first is that depth of retrofit as measured by proportion of participants addressing multiple technologies (middle row) shows a somewhat different pattern of association with various program characteristics than depth of retrofit as measured by savings achieved (bottom row).

As discussed in Section 3.2.3, depth of retrofit as measured by proportion of participants addressing multiple technologies is effectively non-correlated with depth of retrofit as measured by savings achieved. This is an interesting and important finding from the analysis. Going after a larger number of end uses does not correlate with achieving a greater reduction in total energy consumed, on average. One likely interpretation of this is that more narrowly targeted programs, those that predominantly address a single end use, may also be typically targeting those end uses where a relatively high percentage reduction in total energy consumption is most achievable.

The modeling team also included Program Cycle as a variable in the regression model. It is worth noting that, on average, programs that were in existence as of the 2010-2012 program cycle fared somewhat better than programs that were new in 2013-2014. Note that otherwise well-designed, programs, with good depth of retrofit and/or cost effectiveness, may have been phased out in some cases simply due to lack of adequate participation.

Gross Program Group is also a statistically significant driver of depth of retrofit. However, the degree to which GPG is associated with differences in effectiveness score is quite small relative to some other variable sets. Core/Statewide programs fare somewhat worse than other GPGs in depth of retrofit, both in terms of technologies addressed and savings achieved.

4.2.3 Cost Effectiveness Score

The regression model built specifically around program cost effectiveness serves as a useful standalone outcome from the regression effort. It also provides useful perspective on the cost effectiveness component of overall DORCE score. As shown in Figure 4-3 below, the proportion of program costs going toward various sub-elements of program expense has the largest magnitude impact on cost effectiveness. Specifically, programs putting a significant proportion of total dollars into marketing and outreach efforts are, on balance, less cost effective than those with a low investment in that area. The useful message from this finding is not necessarily that marketing and outreach expenses should be minimized. Rather, they should be cautiously and strategically applied, with the awareness that a large marketing outlay may do much more to increase program costs than it does to increase program savings. When trying to optimize marketing expense in the design of a given program it is a good idea to look at high ranking programs from this analysis that have a similar basic design and explore how they may have made optimal use of marketing dollars. It's possible that programs which are not getting enough participation end up pouring larger amounts of money into marketing. In either case, it's important for program administrators to keep in mind that increasing marketing dollars might degrade cost effectiveness, and they should weigh competing priorities when making any increased marketing decisions. Similarly, it is a good idea to look at similar programs that have high residuals specifically with respect to cost effectiveness and/or to DORCE score overall. These are programs that have beaten the model's expectations based on their characteristics and may offer useful ideas.

FIGURE 4-3: COST EFFECTIVENESS COEFFICIENTS

There are several aspects of overall program design that are correlated with high or low cost effectiveness outcomes. The proportion of program costs going toward various sub-elements of program expense has the largest magnitude impact on cost effectiveness. Specifically, programs putting a significant proportion of total dollars into incentives are, on balance, more cost effective than those with a low investment in that area, while those putting a large proportion of total dollars into marketing and outreach are less cost effective. The useful message from this finding is not necessarily that marketing and outreach expenses should be minimized. Rather, they should be cautiously and strategically applied, with the awareness that a large marketing outlay may do much more to increase program costs than it does to increase program savings. When trying to optimize marketing expense in the design of a given program it is a good idea to look at high ranking programs from this analysis that have a similar basic design and explore how they may have made optimal use of marketing dollars. It's possible that programs which are not getting enough participation end up pouring larger amounts of money into marketing. In either case, it's important for PA's to keep in mind that increasing marketing dollars might degrade cost effectiveness, and they should weigh competing priorities when making any increased marketing decisions. Similarly, it is a good idea to look at similar programs that have high residuals specifically with respect to cost effectiveness and/or to DORCE score overall. These are programs that have beaten the model's expectations based on their characteristics and may offer useful ideas.

The degree of program focus on particular end uses also has significant impact on cost effectiveness. Similar to overall DORCE score, programs that focus on food service and water heating tend to be particularly cost effective.

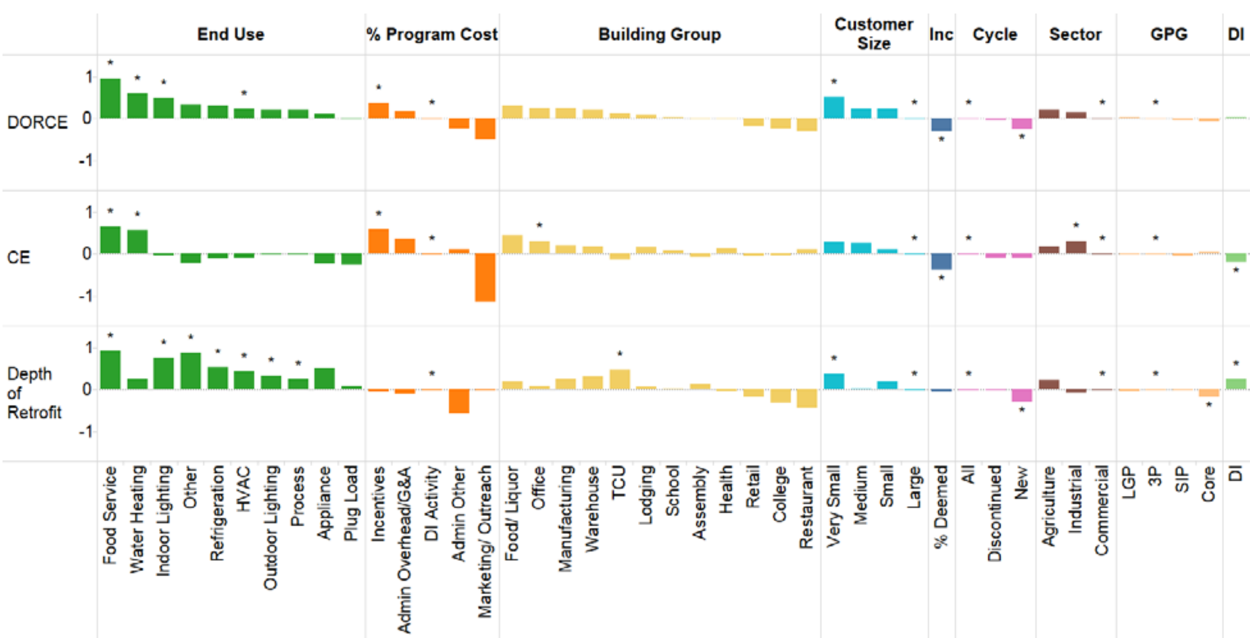
In terms of building type, energy savings are most cost effective in offices relative to other building types. Also, programs featuring custom measures are generally more cost effective than those featuring deemed measures. On balance, programs targeting the industrial sector fare best from a cost effectiveness standpoint, followed by those targeting the agricultural and commercial sectors. Also Direct Install measures are generally less cost effective than non-DI measures.

Several overarching aspects of program design do not show a statistically significant pattern with respect to cost effectiveness. These non-significant factors include differences in gross program group, program administrator, program cycle, and customer size.

4.2.4 Putting It All Together

Having walked through the regression model findings focused separately on depth of retrofit (DOR) and focused on cost effectiveness (CE), it is informative to look at the overall DORCE model again from the perspective of how the components contribute to the whole. Figure 4-4 below shows overall DORCE coefficient values as well as DOR and CE coefficient values for each variable set that was statistically significant in at least one of the three models.

FIGURE 4-4: DORCE, COST EFFECTIVENESS, AND DEPTH OF RETROFIT SIGNIFICANT COEFFICIENTS



In overall terms, depth of retrofit and cost effectiveness are meaningfully different. Though various sub components of the DOR and CE comparison within variable sets show similarities of different types and strengths, the overall message is that the paths taken to achieve greater depth of retrofit, on average, are not always accompanied with lower program cost effectiveness. This is surprising and counter-intuitive, and it yields a series of potentially useful insights about program and portfolio design.

End Use

In particular, the regression coefficients provide a map for where high levels of depth of retrofit may be achieved while nevertheless achieving average or even better than average cost effectiveness. Based on the 166 programs included in the analysis dataset, programs that target food service as an end use have performed better than their peers from both a depth of retrofit and cost effectiveness perspective.

Program Cost Allocation

Another potential opportunity to achieve better than average depth of retrofit while also achieving high cost effectiveness lies in the proportional allocation of total program costs across various categories of expense such as incentives, DI activity, administrative costs, and marketing/outreach. The regression models suggest that programs with a higher proportion of total program costs going toward incentives may fare better than their peers for both DOR and CE. Whereas cost effectiveness, as discussed previously, appears sensitive to marketing and outreach expenditures, DOR shows a more subdued response to all elements of program cost. The overall DORCE score therefore closely reflects the CE scores.

Customer Size

A program's focus on customers of different size appears to have a significant impact on DORCE scores, and the finding likely runs counter to expectations for some people. The patterns observed here may point the way to elements of the energy efficiency landscape where above-average depth of retrofit can be achieved while also achieving above-average cost effectiveness. Focusing on very small customers (<40 MWh or 8.5 Giga-therms annual consumption), on average, has yielded the best depth of retrofit outcomes while also yielding the best cost effectiveness outcomes relative to other customer size classes.

Sector

Programs focused on the commercial sector perform worse than the other sectors. This is driven by worse than average performance for both cost effectiveness and depth of retrofit.

Additional Factors

Programs with a greater focus on custom measures relative to deemed measures tend to score better on DORCE, and this is driven by the higher cost effectiveness of programs with custom measures. While programs with a higher focus on direct install measures generally achieve greater depth of retrofit, this is paired with slightly lower than average cost effectiveness and does not yield a significant correlation with overall DORCE scores. Program administrator is similarly not significantly correlated with overall DORCE scores. Lastly, GPG is not significantly associated with overall DORCE scores, though Core programs perform worse on average than non-Core programs with regard to depth of retrofit.

5 PROGRAM RANKINGS AND RESIDUALS

In addition to looking at general program performance trends across the portfolio as discussed in Section 4, the DORCE score can be used to evaluate and compare the performance of individual programs and groups of programs. Table A-4 in the appendix shows the rank ordering of all 166 programs in the study by overall DORCE score, along with rankings for each of the components that contribute to DORCE score. Table A-4 also shows the DORCE residuals rank ordered for all programs. These provide context of where a program has performed better or worse than other programs of similar design and can be used in conjunction with DORCE scores to put program performance in context. Residual rankings for each component of the score are also included in the table.

The individual program-level view of DORCE performance discussed in this section can also be used in conjunction with the portfolio level view provided by the regression models. For example, the portfolio view provides the context of general trends for DORCE performance. One can then identify and examine individual programs or sets of programs that embody and drive these trends, as well as programs that run counter to these trends in one way or another.

In this section we walk through some examples of viewing some individual programs and groups of programs through the lens of DORCE rankings and residuals. These examples fall into the following categories:

- Identifying distinct pathways to high DORCE scores
- Highlighting example programs where high DOR and CE have occurred together
- Focusing on subcomponents of the DORCE score for meaningful comparison of peer programs
- Highlighting poor DORCE performing programs
- Using high positive residuals to identify standout programs relative to peers

5.1 METHODS

As described in Section 3, DORCE score is the combination of technologies addressed, savings achieved, and cost effectiveness metrics developed using PCA. Each program was assigned a DORCE ranking by sorting all 166 programs in descending DORCE order. The program with the highest DORCE score was given rank 1, and the program with the lowest score was assigned rank 166 (programs with equal DORCE scores were assigned the same rank). In a similar manner, programs were also assigned a ranking for technologies addressed, savings achieved, and cost effectiveness.

A program's actual DORCE score may fall above, below, or exactly in line with the model's prediction, and the difference between actual and modeled DORCE score is called the residual. The residuals from each regression model (DORCE, technologies addressed, savings achieved, and cost effectiveness) were also ranked from 1 to 166. We can interpret a program associated with a high residual as a program that performed above modeled expectations. There is some aspect contributing to the program's success that has not been accounted for in the model. Similarly, a program with a low residual can be said to have performed below modeled expectations. Note that when reviewing residuals, we do not expect to see any patterns when comparing residuals to any of the program characteristics included in the model. They have already been controlled for in the regression model.

To understand the program rankings and residuals, the entire portfolio was ordered by DORCE ranking, while also showing each program's rank on the elements that contribute to DORCE. In this way, the ranking by DORCE is accompanied by a clear illustration of the degree to which technologies addressed, savings achieved, and cost effectiveness have served as the key drivers of overall DORCE score. The residual rankings for each component (DORCE, technologies addressed, savings achieved, and cost effectiveness) are also included in this view to incorporate an understanding of whether the characteristics included in the models predicted these rankings or if the program performed in unexpected ways.

As a reminder, Section 2 on data development notes data limitations and analytical decisions made in developing the comprehensive dataset. There are inherent challenges in site aggregation, matching program savings claims to customer billing accounts in some cases, and ex post savings availability. The evaluation team has taken steps to mitigate these inaccuracies or potential biases where we found it possible.

5.2 FINDINGS

To the extent that the DORCE metric successfully points in desired directions for program outcomes, then a rank-ordered listing of all programs by that metric can identify specific programs that stand out relative to their peers. Taken together, the full set of rankings in Table A-4 offer a detailed yet concise summary of relative program achievements and key components of those achievements.

5.2.1 Pathways to High DORCE Scores

An observation that is immediately apparent from reviewing Table A-4 is that there are a few main patterns with regard to high DORCE-scoring programs in terms of their component rankings for cost effectiveness and depth of retrofit. These can be regarded as "pathways" to high DORCE scores:

- High CE+DOR: Notably high cost effectiveness and depth of retrofit
- High CE: Very high cost effectiveness with mid-range depth of retrofit

- High DOR: Very high depth of retrofit with mid-range cost effectiveness

Of the top 20% of programs by DORCE score, approximately 20% reflect the High CE+DOR pathway, 35% reflect the High CE pathway, and 45% reflect the High DOR pathway.

Example Programs Where High DOR and CE Have Occurred Together

An example of an area of the portfolio where high DOR and CE outcomes have been achieved simultaneously is among programs that have dedicated a large proportion of total program costs to incentives. Across the portfolio, a typical program devotes approximately 40% of total program costs to incentives. However, the top third of all programs by DORCE score devotes an average 49% of total program costs to incentives, while the bottom third devotes an average of 30%. Table 5-1 below illustrates several programs that devote a conspicuously high proportion of total program expenditures to incentives while achieving above average outcomes for both cost effectiveness and depth of retrofit. SCE's Automatic Energy Review for Schools Program (SCE-TP-033) which devotes 66% of total expenditures to incentives, is a highly cost effective program that also scores in the top third of depth of retrofit scores. Its favorable depth of retrofit score is driven both by a relatively large proportion of participants addressing multiple technologies and relatively high proportional reduction in energy consumption. SDG&E's Savings By Design program (SDGE3118E/SDGE3222), described in other sections of this report as high scoring across all components of the DORCE score, devotes 65% of total program expenditures to incentives. PG&E's Department of Corrections And Rehabilitation program (PGE2110014) devotes 71% of program expenditures to incentives, and achieves scores in the top third of both cost effectiveness and depth of retrofit, especially driven by the high proportion of participants addressing multiple technologies.

TABLE 5-1: HIGH-PERFORMING PROGRAMS WITH A HIGH PERCENTAGE OF TOTAL PROGRAM EXPENDITURE GOING TO INCENTIVES

Itron Program ID	Itron Program Name	% Spending on Incentives	Rank			Residual Rank		
			DORCE	CE	DOR	DORCE	CE	DOR
SCE-TP-033	Automatic Energy Review for Schools Program	66%	1	5	30	5	3	24
SDGE3118E/ SDGE3222	SW-Com-Savings by Design	65%	4	14	16	124	65	125
SCE-13-SW-002G	Savings by Design	61%	5	22	10	25	50	17
PGE2110014	Department of Corrections and Rehabilitation	71%	13	42	31	70	38	94
SCE-13-SW-003C	Industrial Deemed Energy Efficiency Program	64%	17	23	53	75	73	62

Table 5-2 below shows more details on the programs featured in Table 5-1. These include the target sector of the program, the gross program group, whether the program features custom (C) or deemed (D) measures, whether it features direct install measures, the target fuel, and statistics about program participation.

TABLE 5-2: MORE DETAIL ON HIGH-PERFORMING PROGRAMS WITH A HIGH PERCENTAGE OF TOTAL PROGRAM EXPENDITURE GOING TO INCENTIVES

Itron Program ID	Itron Program Name	Target Sector	GPG	Incentive Structure	DI/non	Fuel	Sites	Claims	% Sties Interior Lighting
SCE-TP-033	Automatic Energy Review for Schools Program	Com	3P	C	non-DI	Elec	3	6	33%
SDGE3118E/ SDGE3222	SW-Com-Savings by Design	Com	Core	C	non-DI	Both	1,044	3,279	76%
SCE-13-SW-002G	Savings by Design	Com	Core	C	non-DI	Elec	907	1,620	58%
PGE2110014	Department of Corrections and Rehabilitation	Com	SIP	C	non-DI	Both	37	225	69%
SCE-13-SW-003C	Industrial Deemed Energy Efficiency Program	Ind	Core	D	non-DI	Elec	2,646	9,161	96%

Example Programs for the High Cost Effectiveness Pathway to High DORCE

Notably, from an overall DORCE ranking perspective, two of the top three DORCE scoring programs included in the analysis are gas-focused programs. SCG's Industrial Deemed Incentives program and SCG's Industrial Calculated Incentives program are both gas-focused programs that perform exceptionally well on the DORCE metric. These two SCG programs follow the high DORCE score pathway of extremely high cost effectiveness, "High CE."

Alongside their high DORCE scores, both programs also have a high DORCE residual, scoring in the top third of program residuals overall and in the top third for CE residual. This means both programs are outperforming what the regression model would predict, based on the overall features of the program, especially in terms of cost effective savings.

TABLE 5-3: TOP DORCE GAS TARGETING PROGRAMS

Itron Program ID	Itron Program Name	Fuel Target	Rank			Residual Rank		
			DORCE	CE	DOR	DORCE	CE	DOR
SCG3716	SW-Ind-Deemed Incentives	Gas	2	1	135	1	1	134
SCG3715	SW-Ind-Calculated Incentives	Gas	3	2	115	22	18	86

Looking specifically at TRC and PAC scores, both programs score at or near the top of the entire portfolio for one or both of these cost effectiveness metrics.

TABLE 5-4: DETAILS ON TOP DORCE GAS TARGETING PROGRAMS

Itron Program ID	Itron Program Name	Sector	GPG	Incentive Structure	Evaluated TRC	Evaluated PAC
SCG3716	SW-Ind-Deemed Incentives	Industrial	Core/Statewide	Deemed	5.9	5.9
SCG3715	SW-Ind-Calculated Incentives	Industrial	Core/Statewide	Custom	6.6	6.4

Based on the exceptional performance of these programs, Itron recommends that program planners look expressly at particular avenues of unrealized opportunity for cost effective gas savings. In addition to both programs noted here, there are an additional 10 programs in the top 20% of overall programs by DORCE score that are either gas-focused or both gas- and electric-focused.

Example Programs for the High Depth of Retrofit Pathway to High DORCE

Programs targeting indoor lighting are consistently among the highest in the portfolio in terms of depth of retrofit, as shown by the high DOR rankings in Table 5-5 below. This is especially driven by high savings as a proportion of consumption.

TABLE 5-5: TOP DOR SCORING PROGRAMS, INDOOR LIGHTING FOCUS

Itron Program ID	Itron Program Name	% Addressing Indoor Lighting	Rank				Residual Rank			
			DORCE	DOR	Tech.	%Sav.	DORCE	DOR	Tech.	%Sav.
PGE210118	Furniture Store Energy Efficiency	91%	9	2	69	3	7	4	16	5
SDGE3226	Sw-com Direct Install	90%	18	4	10	13	94	43	90	21
SCE-13-L-002D	City of Santa Ana Energy Leader Partnership	33%	16	5	105	2	41	27	99	29
PGE210115	Rightlights	76%	21	6	40	5	109	56	78	36
PGE210114	Energy Savers	90%	19	9	67	4	78	90	61	91
PGE210113	Energy Fitness Program	91%	14	11	45	9	13	55	68	41
SCE-13-L-003F	State of California Energy Efficiency Partnership	65%	24	12	35	12	62	38	84	14
PGE211014	Mendocino County	81%	35	13	62	6	49	44	72	42
SCE-13-L-002T	West Side Energy Leader Partnership	88%	37	14	13	38	90	48	43	50

As shown in the additional details on these same programs in Table 5-6 below, many of these high depth of retrofit programs predominantly address small or very small commercial customers. Most often these programs feature deemed incentives, and they are generally characterized by a high proportion of total program expenditures going to direct install activity and going to incentives.

TABLE 5-6: DETAILS ON TOP DOR SCORING PROGRAMS, INDOOR LIGHTING FOCUS

Itron Program ID	Itron Program Name	% Addressing Indoor Lighting	% Small or vSmall	Commercial Sector	% Deemed	% Expenditures to DI Activity	% Expenditures to Incentives
PGE210118	Furniture Store Energy Efficiency	91%	96%	X	100%		66%
SDGE3226	SW-Com Direct Install	90%	98%	X	100%		89%
SCE-13-L-002D	City of Santa Ana Energy Leader Partnership	33%	59%	X		42%	34%
PGE210115	Rightlights	76%	87%	X		35%	44%
PGE210114	Energy Savers	90%	90%	X	81%		41%
PGE210113	Energy Fitness Program	91%	95%	X	99%	32%	42%
SCE-13-L-003F	State of California Energy Efficiency Partnership	65%	44%	X	45%	36%	53%
PGE211014	Mendocino County	81%	85%	X	83%	57%	
SCE-13-L-002T	West Side Energy Leader Partnership	88%	47%	X	93%	38%	40%

5.2.2 Focusing on Subcomponents of the DORCE Score for Meaningful Comparison of Peer Programs

While the overall DORCE score may often provide the most useful indication of program achievement, there are cases where comparisons restricted to one or two subcomponents of the overall score may be the most informative and useful form of comparison. One example is cases where programs are intentionally narrowly focused to achieve a specific objective.

Narrow Technology Focus Programs

Some programs have a deliberately narrow technology focus. These programs will, by definition, achieve low scores on the Technologies Addressed component of the DORCE score. To put achievements for these programs in context it may be appropriate to de-emphasize the Technologies Addressed component and focus on program achievements expressly from the standpoint of Savings Achieved and CE. One way to do this is to focus the peer group comparison on programs with a similar narrow technology focus and to identify programs that are achieving high Savings Achieved and/or high CE outcomes after controlling for this factor. This can be done looking broadly across the portfolio or in concert with further restricting the peer group comparison based on additional areas of interest.

As a high level exercise looking at the Savings Achieved and CE components of DORCE, overall the 50% of all programs with the narrowest technology focus achieve a simple average CE rank of 69 (the midpoint ranking in the whole portfolio is a rank of 83, so this is modestly above average) and a Savings Achieved rank of 99 (modestly below average). The takeaway message from this informal exercise is that narrowly technology focused programs generally perform mildly below average on Savings Achieved and mildly above average on cost effectiveness. Zooming out to overall DORCE scores, the 50% of all programs with the narrowest technology focus achieve a simple average DORCE rank of 100, modestly below average.

5.2.3 Poor DORCE Performance

In addition to highlighting conspicuously effective programs, the DORCE score and its associated components also highlights programs that are performing below average on both cost effectiveness and depth of retrofit. Table 5-7 below shows the 20% of programs with the lowest DORCE scores in the portfolio, including their DORCE component scores and residuals. In the large majority of these cases, programs with the lowest DORCE scores are performing in the bottom third or bottom half of programs for both cost effectiveness and depth of retrofit.

There are any number of reasons why a program may get a low DORCE score. Some of these reasons may reflect the fact that the program is targeting an area of the overall portfolio where cost effective, deep energy savings are particularly hard to achieve. A program may also get a low DORCE score due to ineffective elements of its design or implementation that could be improved through re-visiting and potentially re-vamping the program. Itron recommends that PAs review programs with conspicuously low DORCE scores to try to evaluate and understand the drivers of low scores and whether program modifications are warranted. An important tool to assist in the assessment of low DORCE-scoring programs is the residual, which is discussed in the next section.

TABLE 5-7: PROGRAMS WITH POOR DORCE PERFORMANCE

Itron Program ID	Itron Program Name	Rank			Residual Rank		
		DORCE	CE	DOR	DORCE	CE	DOR
PGE210124	Ozone Laundry Energy Efficiency	134	59	129	115	118	72
PGE210131	PECI AERCx	135	151	85	99	140	35
SCE-13-TP-004	Data Center Energy Efficiency	136	90	118	127	71	146
PGE21039	Comprehensive Food Process Audit & Resource Efficiency Pgm	137	56	138	162	153	164
SDGE3239	SW-Ag-Deemed Incentives	138	111	113	143	147	112
PGE2191	Medical Building Tune-Up	139	75	128	60	35	80
PGE210117	Energy-Efficient Parking Garage	140	76	132	150	155	115
SCG3720	SW-Ag-Deemed Incentives	141	68	137	102	54	132
PGE2220	Assessment, Implementation, And Monitoring (AIM) Program	142	36	165	101	39	155
SCE-13-L-002A	City of Beaumont ELP	143	161	86	123	101	133
SCE-13-SW-005B	Lighting Innovation Program	144	95	125	92	51	117
PGE210123	Healthcare Energy Efficiency Program	145	128	117	140	145	97
SCE-TP-008	Comprehensive Beverage Manufacturing & Resource Efficiency	146	46	161	126	58	162
PGE210133	Staples Low Pressure Irrigation Di	147	116	127	118	99	105
PGE210129	Nexant AERCx	148	120	133	50	63	40
PGE2204	SmartVent for Energy-Efficient Kitchens	149	73	157	23	27	70
PGE210128	Enovity Smart	150	94	151	144	158	116
SCE-13-TP-010	Comprehensive Petroleum Refining	151	126	140	155	160	118
SCE-13-SW-002F	Nonresidential HVAC Program	152	122	141	142	127	145
SDGE3224	SW-Com-Deemed Incentives-HVAC Commercial	153	117	145	125	122	111
PGE210119	Led Accelerator	154	106	154	165	163	165
PGE210210	Industrial Recommissioning Program	155	81	162	160	156	156
SCE-TP-018	Chemical Products Efficiency Program	156	108	152	151	138	129
SCE-13-TP-013	Cool Schools	157	146	144	105	47	123
SCE-13-TP-020	Ideea365 Program	158	150	142	111	105	100
PGE21006/ PGE21015	Commercial HVAC	159	127	158	161	164	144
SDGE3237	SW-Ag-Calculated Incentives-Calculated	160	148	156	132	159	74
PGE2242	Cool Cash	161	155	148	156	165	122
PGE21037	Light Exchange Program	162	160	155	166	154	166
PGE210130	RSG AERCx	163	147	163	157	134	151
SCE-L-004D	Energy Leader Partnership Program	164	162	164	149	116	150
SCE-13-SW-001E	Residential HVAC Program	165	163	160	163	152	163
SCG3712	SW-Com-Nonres HVAC	166	166	166	164	166	153

5.2.4 Residuals

A program's actual DORCE score may fall above, below, or exactly in line with what the regression model would predict for that program, and the difference between actual and modeled DORCE score is called the residual. The residual may highlight factors associated with program achievement that are not captured in the regression models, but it also may serve as a useful flag for spotting exceptional programs that complements the overall DORCE score. For example, as with the overall DORCE rankings, programs can be ranked 1 to 166 in terms of their residual, and programs at the top of this ranking would be those that outperform their modeled DORCE scores by the greatest amount. These programs are scoring notably higher than programs of similar design in the IOU portfolio, and this may serve as a guide for further inquiry into how this success can be characterized and emulated. In particular, high residuals for programs in areas of the portfolio with relatively low DORCE scores may help flag those programs that are outperforming others in cases where high cost-effectiveness and depth of retrofit outcomes are inherently difficult to achieve. Additionally, programs at the bottom of the residuals ranking would be those that have achieved outcomes well below what would be expected for programs with their design elements and may be in need of review and revision. When viewed alongside overall DORCE score rankings, residuals rankings can help provide an especially clear picture of program performance. In this section we focus on programs with high positive residuals, first on programs with high positive cost effectiveness residuals, then programs with high positive residuals for depth of retrofit, and finally programs with high residuals for both CE and DOR simultaneously.

Programs with High Cost Effectiveness Residuals

Table 5-8 below shows the 20 programs in the dataset with cost effectiveness achievements that particularly stand out relative to programs of similar design in the portfolio. These programs all have positive residuals on cost effectiveness in the top third of programs, which are driving their high overall DORCE residuals in the top third of programs. Note that while their cost effectiveness achievements stand out in a positive sense, some programs in the table are nevertheless in the middle third or bottom third of all programs from an overall DORCE rank standpoint. The table also notes whether each program in the list focuses on deemed measures and/or the commercial sector, two characteristics that show a general trend toward low cost effectiveness outcomes. Given their strong positive CE residuals, programs in the table marked as addressing those areas are pushing against the low CE trends that generally characterize this segment of the portfolio.

TABLE 5-8: PROGRAMS WITH HIGH CE RESIDUALS

Itron Program ID	Itron Program Name	Low CE Trend		Rank		Residual Rank	
		Commercial	Deemed	DORCE	CE	DORCE	CE
SCG3716	SW-Ind-Deemed Incentives		X	2	1	1	1
SCG3715	SW-Ind-Calculated Incentives			3	2	22	18
PGE21019	Enhanced Automation Initiative	X		7	3	4	2
PGE21029	Refinery Energy Efficiency Program			8	4	8	6
SDGE3117E	Energy Savings Bid (Encumbered)	X		11	7	51	13
PGE210120	Monitoring-Based Commissioning	X		22	6	2	4
PGE211010	Fresno	X	X	25	71	37	19
PGE211025	Savings by Design (SBD)	X		31	18	45	42
SCE-TP-027	Monitoring-Based Commissioning	X		36	8	10	5
SDGE3220	SW-Com-Calculated Incentives-Calculated	X		41	11	54	46
PGE21032	Agricultural Deemed Incentives		X	44	15	31	7
SCE-13-SW-002C	Commercial Deemed Incentives Program	X	X	49	39	44	26
PGE21018	Energysmart Grocer	X	X	65	28	30	20
PGE21026	Energy Efficiency Services for Oil Production			94	17	43	55
SCE-13-TP-003	Healthcare EE Program	X		102	63	18	15
SDGE3221	SW-Com-Calculated Incentives-RCx	X		111	33	29	11
PGE2183	Comprehensive Retail Energy Management	X		127	82	24	10
PGE2198	Data Centers Cooling Controls Program	X		130	64	35	32
PGE2204	SmartVent for Energy-Efficient Kitchens	X	X	149	73	23	27

Programs with High Depth of Retrofit Residuals

Table 5-9 below shows the 15 programs in the dataset with depth of retrofit achievements that particularly stand out relative to programs of similar design in the portfolio. These programs all have positive residuals on depth of retrofit in the top third of programs, which are driving their high overall DORCE residuals in the top third of programs. While their depth of retrofit achievements stand out in a positive sense, some programs in the table are nevertheless in the middle third or bottom third of all programs from an overall DORCE rank standpoint. These latter programs are outperforming programs of similar design, but in areas of the portfolio where low depth of retrofit tends to dominate. The table also notes whether each program in the list is a core/statewide program and whether it focuses on large customers, two characteristics that show a general trend toward low depth of retrofit outcomes. Programs marked as addressing those areas are pushing against those trends

TABLE 5-9: PROGRAMS WITH HIGH DOR RESIDUALS

Itron Program ID	Itron Program Name	Low DOR Trend Features		Rank		Residual Rank	
		Core	Large Customers	DORCE	DOR	DORCE	DOR
SCE-13-L-002R	Western Riverside Energy Leader Partnership			6	1	3	2
SCE-13-L-002D	City of Santa Ana Energy Leader Partnership			16	5	41	27
SCE-13-L-003B	California Dept. of Corrections and Rehabilitation EE Partnership		100%	20	7	36	34
PGE21031	Agricultural Calculated Incentives	X	29%	23	68	16	3
SCG3710	SW-Com-Calculated Incentives	X		26	110	38	10
PGE211014	Mendocino County			35	13	49	44
PGE2110051	Local Government Energy Action Resources (LGEAR)			46	19	47	28
SCE-13-L-002P	South Santa Barbara County Energy Leader Partnership			80	25	19	22
SCE-TP-037	Private Schools and Colleges Program			81	47	40	16
SCE-13-L-003A	California Community Colleges Energy Efficiency Partnership		62%	84	50	46	36
SCG3758	3P-Preps			93	64	6	1
PGE210112	School Energy Efficiency			100	69	48	42
SCE-13-L-002K	Kern County Energy Leader Partnership			113	52	55	37
SCE-13-L-002H	Eastern Sierra Energy Leader Partnership			119	46	42	30
PGE210129	Nexant Aercx			148	133	50	40

Programs with High Residuals for Both Cost Effectiveness and Depth of Retrofit

Table 5-10 below shows the 21 programs in the dataset that simultaneously have depth of retrofit achievements and cost effectiveness achievements that particularly stand out relative to programs of similar design in the portfolio. These programs all have positive residuals on both depth of retrofit and cost effectiveness in the top third of programs, which are driving their high overall DORCE residuals in the top third of programs. The table also notes whether each program in the list focuses on large customers, deemed measures, and/or the commercial sector, each of which shows a general trend toward low DORCE outcomes.

TABLE 5-10: PROGRAMS WITH HIGH DOR AND CE RESIDUALS

Itron Program ID	Itron Program Name	Low DORCE Trend			Rank			Residual Rank		
		Large Customers	Deemed	Commercial	DORCE	DOR	CE	DORCE	DOR	CE
SCE-TP-033	Automatic Energy Review for Schools Program			X	1	5	30	5	3	24
SCE-13-SW-002G	Savings by Design			X	5	22	10	25	50	17
PGE210118	Furniture Store Energy Efficiency		X	X	9	97	2	7	24	4
SCE-13-TP-005	Lodging EE Program	55%		X	10	61	8	12	34	8
SCE-13-TP-012	Refinery Energy Efficiency Program	80%			12	13	66	14	16	21
PGE210113	Energy Fitness Program		X	X	14	62	11	13	9	55
PGE21035	Dairy Energy Efficiency Program		X		15	55	15	9	21	5
SCE-13-TP-006	Food & Kindred Products	89%			27	24	73	53	30	54
SCE-13-L-002B	City of Long Beach Energy Leader Partnership		X	X	29	101	17	17	22	32
PGE211012	Madera		X	X	32	84	26	39	25	50
SDGE3223	SW-Com-Deemed Incentives-Commercial Rebates		X	X	45	35	75	20	23	26
PGE21022	Industrial Deemed Incentives		X		47	26	89	32	33	18
SCE-13-TP-014	Commercial Utility Building Efficiency	79%		X	48	31	81	33	43	19
SCE-TP-015	Industrial Gasses	100%			59	58	59	34	49	29
PGE210311	Process Wastewater Treatment Em Pgm for Ag Food Processing	70%			68	44	83	21	44	13
PGE211007	Association of Monterey Bay Area Governments (AMBAG)			X	72	113	43	52	45	53
PGE21017	Boiler Energy Efficiency Program	53%		X	86	47	93	28	40	11
PGE21012	Commercial Deemed Incentives		X	X	89	34	114	15	14	46
SDGE3162	3P-Nres02 - SaveGas - Hot Water Control	67%	X	X	104	19	147	26	37	47
PGE21042	Lighting Innovation		X	X	115	37	130	11	8	20
PGE21016	Air Care Plus		X	X	117	78	100	27	52	14

Details on Specific Programs

In the paragraphs that follow we walk through some examples of programs with high DORCE residuals at varying levels of overall DORCE score. We note some particular characteristics and features of these programs in terms of the score components that drive the high residuals and in terms of some of the customer characteristics and measure characteristics for program participants.

As one example, focusing on process efficiency generally trends negatively with overall DORCE score relative to other end uses, as does focusing on large customers relative to other customer sizes. However, within the set of seven programs across the state that generally target gas savings from process efficiency for large customers (process efficiency for at least 30% of total claims and large customers for at least 30% of total claims), several programs stand out with high DORCE residuals and high overall DORCE scores.

PG&E's Enhanced Automation Initiative (PGE21019) is a small, third party-implemented program that targets industrial and commercial participants, with a total program budget of approximately $1.3M and just 8 unique participants. It stands out in the portfolio from a DORCE standpoint, both for high positive DORCE residual, ranked #4, as well as its high overall DORCE ranking at #7. Of the total budget of $2.2M, approximately 29% went to incentives for participants. The high DORCE residual and DORCE ranking are particularly driven, in turn, by exceptionally high achievements in cost-effectiveness, with a TRC of 4.83 and a PAC of 5.51. This is a narrowly focused program that targets HVAC (50%) and Process (50%) efficiency predominantly via a Direct Install approach. It's 50% large participants, 25% medium, and 25% small. The program achieved average ex post lifetime savings equal to 39% of total gas consumption for its participants. More than half of total program savings were from a single industrial participant that focused on process efficiency improvements, with most of these savings generated during the participant's initial participation year in 2011 and follow up participation generating additional savings in 2014.

PG&E's Refinery Energy Efficiency Program also stands out as yielding a high positive DORCE residual in an area of the portfolio that generally yields low DORCE scores. This is a small program with 43 claims across 11 sites and a total budget of approximately $23M, with approximately 37% of the total program budget going toward incentives. It is a third party-implemented industrial program that is built around Custom measures. Similar to PG&E's Enhanced Automation Initiative, it has achieved very high TRC of 4.52 and PAC of 4.51. Lifetime gross MMBtu savings per program dollar is high at 0.82, these achievements can be compared to TRC and PAC scores of approximately 2.0 and MMBtu savings of approximately 0.4 for the overall set of programs that target process efficiency gas savings for large customers. Refinery Energy Efficiency Program participants consist of 40% large customers, 40% medium, and 20% small. It is 100% process focused. The program has a very high positive DORCE residual ranking at #8 in the whole portfolio as well as an overall DORCE ranking of #8 in the portfolio. Similar to the Enhanced Automation Initiative, these very high scores are driven in turn by an exceptionally high cost effectiveness residual and overall cost effectiveness ranking.

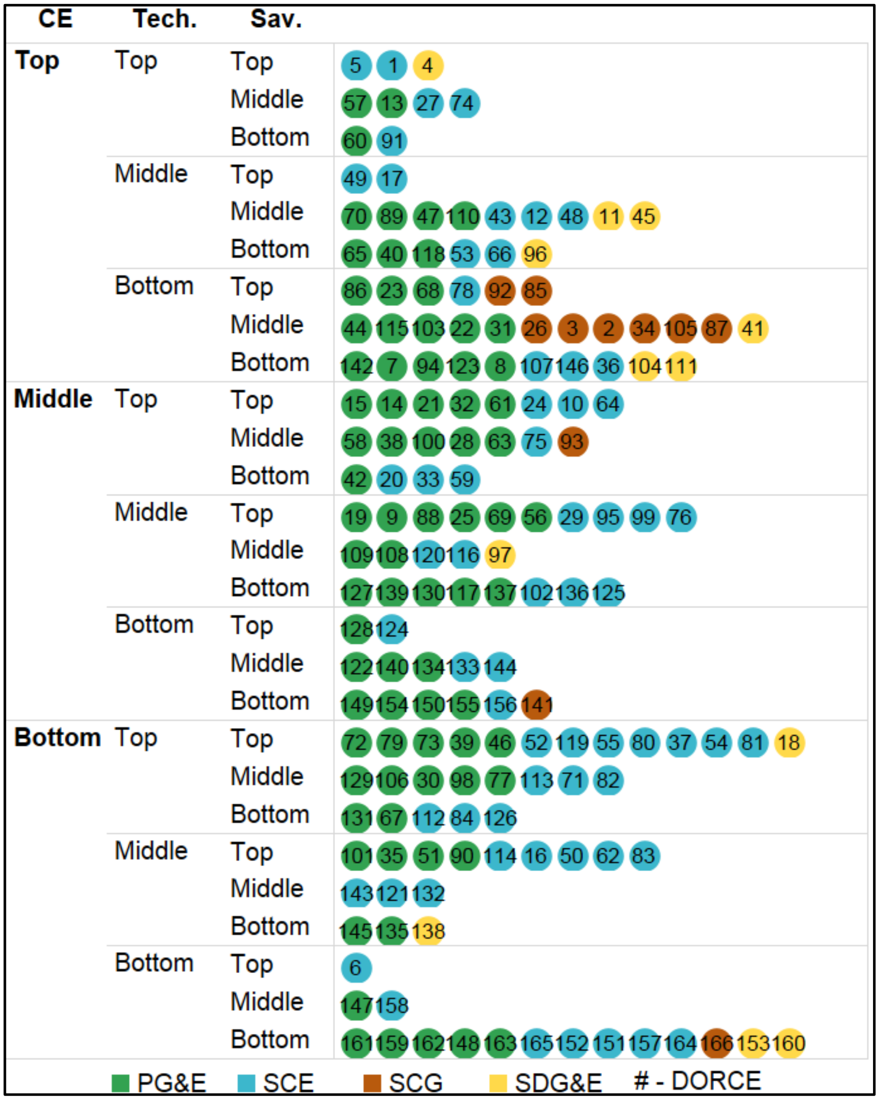
PG&E's Industrial Calculated Incentives program also fares well from this perspective. This is a relatively large program, with approximately 3,400 claims across approximately 400 sites and total program cost of approximately $83M. It has an overall DORCE ranking in the top third of programs at #40 driven by an exceptionally strong cost effectiveness ranking at #9. Despite its relatively low Technologies Addressed ranking near the bottom of the middle third of programs at #109, it has a high positive residual ranking for Technologies Addressed at #7.

DORCE Pathways Illustration

Figure 5-1 below is one means of illustrating distribution of DORCE outcomes throughout the portfolio. The figure shows all 166 programs as small circles, labeled with their DORCE ranking. They are categorized with respect to their performance on the cost effectiveness metric (CE), technologies addressed metric (Tech.), and savings achieved metric (Sav.). Each program is shown as being in the top third, the middle third, or the bottom third in the rank order of scores for a given metric. Any program with a DORCE rank of 55 or better is in the top third of all programs. One can observe programs in the figure whose high DORCE rankings was driven especially by high cost effectiveness, by strong performance on one or both of the depth indicators, or all of the above.[1]

[1] See Appendix A.4 for the full listing of program name and program ID by DORCE ranking

FIGURE 5-1: PROGRAMS BY DORCE RANKING COMPONENTS THIRD

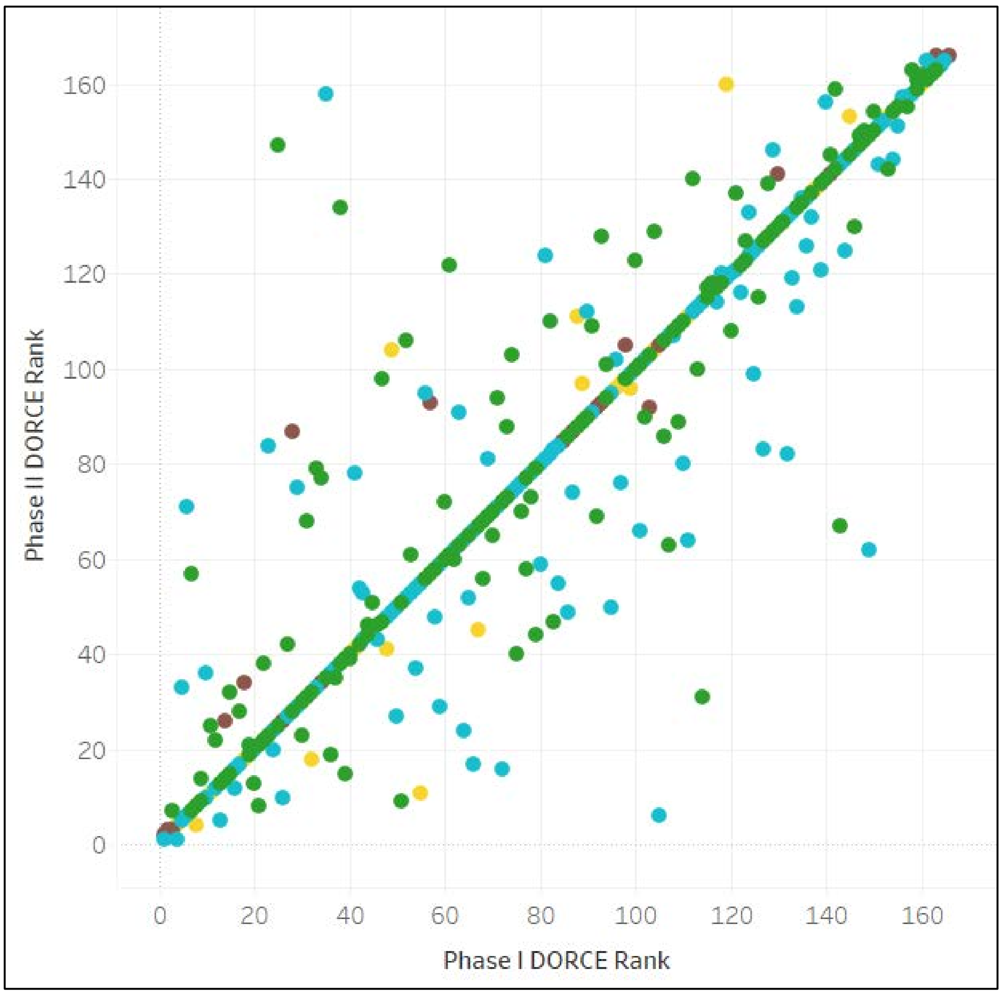


5.2.5 Rankings Comparison to Phase I

Due to the changes made to the database and scoring structure in Phase II, programs experienced a change in their relative rankings. When comparing program rankings across phases it's important to note a couple caveats. Firstly, there are three additional programs included in the Phase II analysis, therefore a shift in relative program ranking is necessary to accommodate these new programs. Rankings now range from 1 to 166 instead of from 1 to 163. Additionally, it is important to note that a change in rank does not necessarily indicate a change in program performance. Since a program's rank represents its place within the portfolio, a change in rank could occur to a program solely due to the performance of the rest of the portfolio. For example, if one program's DORCE rank increased due to a higher TRC score, other programs would now be ranked lower accordingly. With these caveats in mind, we will review the changes in program rankings across phases.

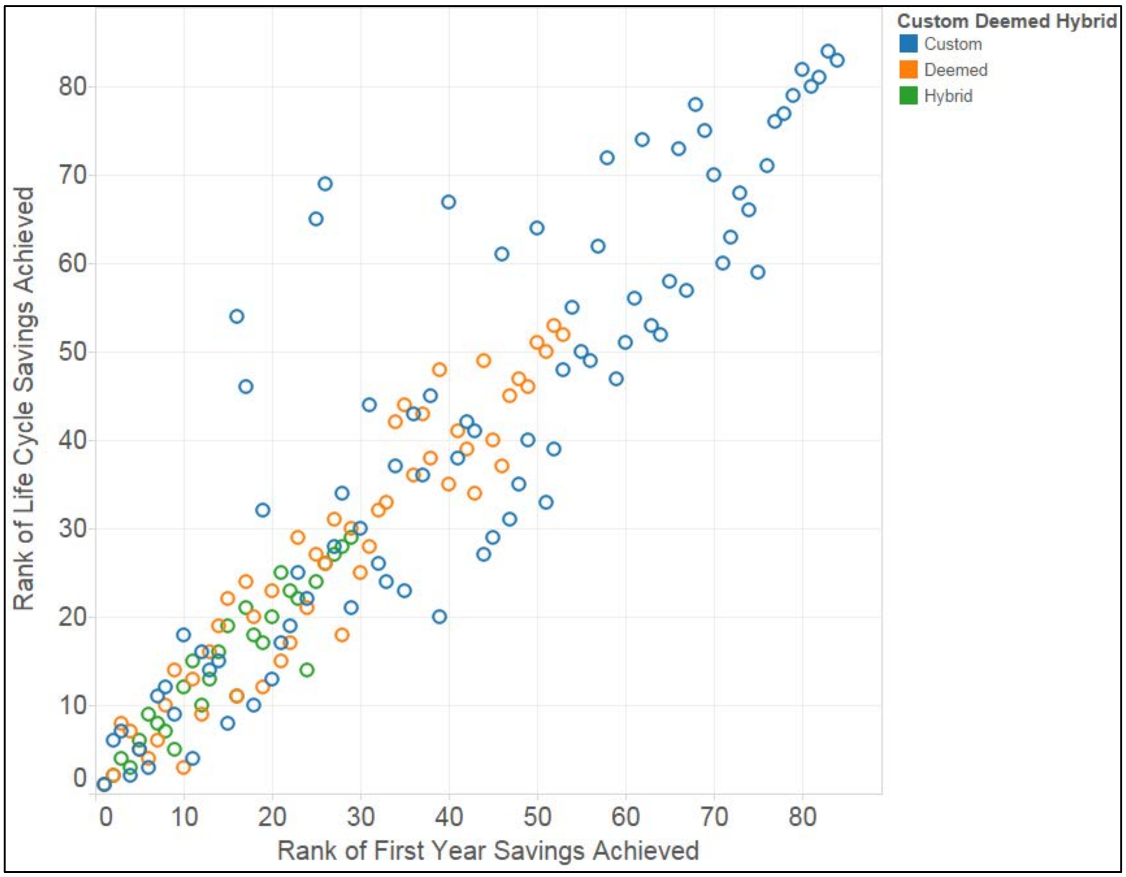
The figure below shows a scatter plot of the nonresidential programs by their DORCE score ranking in Phase I (x-axis) and Phase II (y-axis). Any program that deviates from the diagonal line indicates a program that increased or decreased rank from Phase I to Phase II. Programs that fall below the diagonal line were ranked lower in Phase I than in Phase II. Similarly, program that fall above the diagonal line were ranked higher in Phase I than in Phase II. A majority of programs (113 out of 163) remained within the same third of program ranked performance (i.e. top third, middle third, bottom third) relative to their original Phase I ranking.

FIGURE 5-2: PROGRAM DORCE RANK BY PHASE



One of the sources of change in the scoring structure is the shift from using first year savings to lifecycle savings in the savings achieved metric. Figure 5-3 below shows the effect of this change within each program. The figure displays a scatterplot of programs, where the x-axis represents the rank order program placement of first year savings achieved in Phase II, and the y-axis represents the rank order program placement of lifecycle savings achieved in Phase II. Generally, we see the programs remain near the diagonal line, representing a small shift in the rank order of the program. However, we also notice quite a few programs falling far above the diagonal, indicating that the shift to lifecycle savings improved a program's rank order. Interestingly, these programs are mostly custom programs, which seem to get a boost in their Savings Achieved performance by the move to lifecycle savings.

FIGURE 5-3: FIRST YEAR VERSUS LIFECYCLE SAVINGS ACHIEVED PROGRAM RANK ORDER

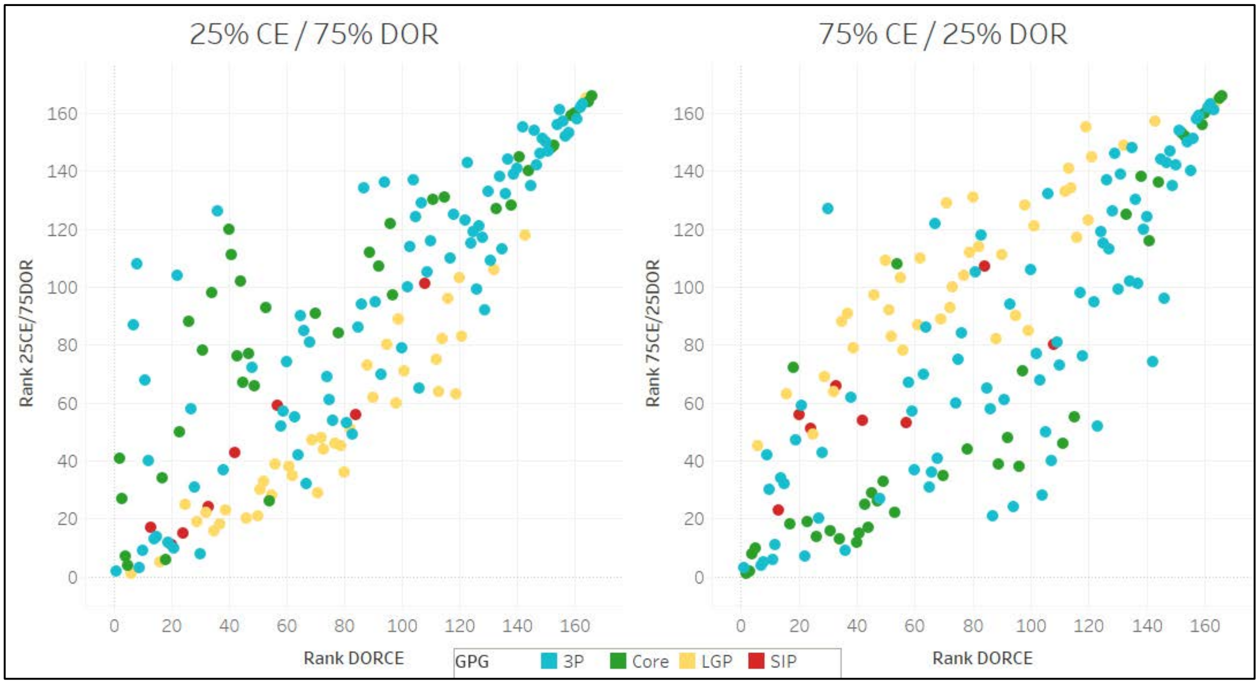


5.2.6 DORCE Component Weight Sensitivity

The two main components of DORCE, depth of retrofit and cost effectiveness are combined with equal weights in the DORCE score. However, it is possible to design a score that attributes more weight to either DOR or CE. In order to understand how an uneven weighting between DOR and CE would affect program performance, we calculated DORCE two other ways. The first case gives a 75% weight to DOR and 25% to

CE (75DOR). The second case gives a 25% weight to DOR and 75% to CE (75CE). Figure 5-4 below shows how these alternate weighting schemes compare to the 50/50 weighting chosen for the DORCE score. The scatter plot on the left shows the program ranks of 75DOR while the scatter plot on the right shows the ranks of 75CE. The colors of each circle indicate the program's gross program group. Note that in each plot, being located near the origin corresponds with having a high ranking. The 75DOR plot on the left shows that a number of high DORCE ranking programs perform significantly worse when the weighting is shifted to 75DOR (as shown by the clustering of dots above the diagonal in the left side of the 75DOR image). Whereas 75CE tends to have more of a mixture of high DORCE programs that performed worse and low DORCE programs that performed better. This is likely because some programs have very high CE scores, so when the effect of CE is reduced, those programs drop performance significantly. However, DOR is more evenly distributed, so by reducing the effect of DOR in the score the rank changes are more evenly spaced. It is also interesting to note that 75DOR sees a general decrease in 3P and Core program performance and an increase in LGP performance. Consistent with these results we see that 75CE corresponds with a general increase in 3P and Core performance and a decrease in LGP performance.

FIGURE 5-4: SENSITIVITY OF DOR AND CE RELATIVE WEIGHTINGS



6 CONCLUSIONS

The overarching purpose of this research effort is to be both backward-looking and forward-looking. Reflecting on the 2010-2014 period (and including 2015 in Phase II), which specific programs and general patterns in program design have correlated most with high program effectiveness in terms of achieving cost-effective, deep energy savings? Looking forward, how can the DORCE score best be used to inform program- and portfolio design toward achieving the stated objectives of the CA Strategic Plan? What are the next steps that will further refine and increase the usefulness of this approach?

6.1 KEY FINDINGS

Key findings from this study are listed below. Most key findings were robust across the addition of data and modifications to the DORCE score between Phase I and Phase II. Where a finding changed across the phases it is noted below and discussed at greater length in Section 3.

- Generally, an increase in technologies addressed does not necessarily mean either an increase, or a decrease, in savings achieved.
- Tradeoffs are not always necessary between depth of retrofit and cost-effectiveness, since depth of retrofit success minimally corresponds with poor cost-effectiveness.
- On balance, focus on very small customers coincides with higher DORCE returns versus focus on large customers. This DORCE score's depth of retrofit portion drives this difference. In the Phase I models, higher DORCE scores were typically associated with very small customers, followed by medium, then small, and large customers had the lowest DORCE scores. In the Phase II models, this order remained except there was no statistically significant difference between small and medium customers in the middle of this spread.
- A focus on food service, a focus on water heating, and a focus on indoor lighting are each associated with above-average DORCE scores. For food service and water heating, this is especially driven by their high cost-effectiveness. In the Phase I models, process efficiency was also associated with above average DORCE scores, but this was not a statistically significant finding in the Phase II models.
- Highly cost-effective gas programs represent several of the top DORCE-scoring programs in the entire portfolio.
- A relatively high proportion of total program cost toward incentives and, conversely, a low proportion of total program costs toward DI activity correspond with better DORCE scores and cost-effectiveness outcomes, without a notable overall impact on depth of retrofit outcomes.
- No single building type corresponds with significantly higher or lower DORCE scores than other building types overall. However, office buildings generally achieve higher cost effectiveness than

average, and TCU (buildings associated with transportation, communication, or utilities) achieves above-average depth of retrofit outcomes. In the Phase I models, offices displayed a higher DORCE score than other building types, but this was not a significant finding in the Phase II models.

- Programs achieve high effectiveness scores (top 20%) via three pathways:
  - Notably high scores on both depth of retrofit and cost-effectiveness
  - Exceptionally strong cost-effectiveness with reasonable depth of retrofit
  - Exceptionally strong depth of retrofit with reasonable cost-effectiveness
- Programs targeting the commercial sector achieve lower DORCE scores than those targeting the agricultural or industrial sectors, driven mainly by lower cost effectiveness.
- Programs featuring custom measures fare better on DORCE than those featuring deemed measures, driven by lower cost effectiveness for deemed measures. In the Phase I models, deemed measures fared worse than custom measures for both cost effectiveness and depth of retrofit, but only the cost effectiveness piece remained significant in the Phase II models.
- Some particular programs significantly outperform similarly designed peer programs as evidenced by their high positive residuals.

All of the findings noted above, in addition to being informative at the portfolio level, may be most useful when viewed in narrower contexts, such as for subsets of programs that share one or more similar features. When viewed among subsets of programs, program rankings and residuals can put a program's achievements in context and may be particularly relevant from a program planning perspective. In effect, this type of sub-setting provides the opportunity to control for additional ways in which programs differ from one another.

6.2 PROGRAM AND PORTFOLIO PLANNING TOOLS

The tools developed in this research effort may serve planners in working to meet program- and portfolio level objectives. Importantly, the fact that a particular type of program has been highly effective in the past does not necessarily indicate that the same type of program would be highly effective looking forward. It's possible that most of the achievable potential in a given niche has been realized and that continuing to go after very similar savings would become less cost-effective and/or achieve less deep savings with continued effort.

Findings from this research effort could be used in conjunction with additional data sources to fill out a more complete picture of where cost-effective, deep energy savings opportunities remain. Potential studies provide a useful and detailed characterization of the technical and economic potential for additional savings across geographic, firmographic, and demographic strata. Details about effective program design from this research effort may help target that potential in carefully tailored ways. Census data, when used alongside program data, CIS/billing data, and possibly additional data sources, may serve a similar purpose.

7 RECOMMENDATIONS

The evaluation team has distilled a series of recommendations flowing from the research conducted in this report, aimed at program administrators and other stakeholders. These recommendations range from the general to the specific. They center on using the DORCE metric and other findings from this work to evaluate program performance and to refine program and portfolio planning in service of meeting the state's energy savings goals. All of these recommendations remained robust across the Phase I and Phase II models and program rankings. The only exception is that several recommendations make reference to high-scoring programs or low-scoring programs. Because some program rankings shifted between the Phase I and Phase II models, it means there is a corresponding adjustment in the particular program sets where these recommendations apply. Section 5.2.5 addresses changes in program performance moving from Phase I to Phase II. Below we describe how program administrators and other stakeholders might use the DORCE score as it is currently structured, opportunities to expand the score, and opportunities to set forward-looking goals in terms of DORCE performance.

7.1 USING DORCE

- **Stakeholders should consider using DORCE as a metric for evaluating program performance**. The score presents an opportunity to incorporate depth of savings into quantitative program performance evaluation not previously available. If adopted and used actively by program administrators and other stakeholders, it may facilitate better targeting of energy efficiency resources in service of ambitious statewide goals.
- **Programs can be viewed as having achieved high, medium, or low outcomes in terms of DORCE and its constituent score elements when applying and interpreting DORCE rankings**. This may provide more useful and more accurate feedback than drawing conclusions at the level of small scale distinctions between individual programs.
- **Reinforcing and building on programs with high positive residuals may help programs with lower scores achieve success**. Consider prioritizing additional funding for programs with conspicuously high positive residuals as well as those with high DORCE scores overall, as these programs have shown themselves to stand out positively relative to peer programs. Nevertheless, forward-looking program performance expectations depend sensitively on the remaining technical and economic potential and should be informed by the most recent potential study.[1] Used in conjunction with other appropriate resources, the DORCE score may help anticipate and guide a program's lifecycle through growth, maturation, and potential retirement.
- **DORCE can be used as an approach to characterizing source energy savings. Consider assessing and prioritizing gas savings on equal footing with electricity savings using DORCE outcomes as**

[1] See http://www.cpuc.ca.gov/General.aspx?id=2013

a guide. Several gas-focused programs performed among the highest of all programs in this study, driven primarily by exceptionally high scores on both the TRC and PAC cost-effectiveness tests. Where relevant, program administrators should make a point of exploring and potentially targeting highly cost effective and unrealized gas savings potential that may be under-attended relative to electricity savings.

- **Consider putting special focus on the DORCE score's cost effectiveness and savings achieved portions (while minimizing focus on technologies addressed) when evaluating the effectiveness of programs that are intentionally, strategically narrowly focused on a single technology**. This is one example of making use of the fact that the component elements of DORCE are meant to be retained and used in evaluating program performance.
- **Low DORCE scores may represent an inefficient use of program administrator resources or a particularly challenging set of circumstances for generating cost-effective savings, or both. Consider using DORCE residuals alongside DORCE scores to help chart a course for program improvement, revamping, or elimination**. The DORCE score can be used to help take a closer look at programs that score low on cost-effectiveness, depth of retrofit, or both, to see if outcomes are in line with expectations at the program planning level. In addition to looking at low-scoring programs overall in this regard, it may be instructive to look at low-scoring programs specifically compared against peers that target similar elements of the portfolio.

Setting Program Performance Goals with DORCE

- **By freezing the DORCE development structure, DORCE can be a forward-looking benchmarking tool calculated and expressed independently of the set of considered programs**. One option is to establish the 2010-2015 period as the baseline for the score. This would mean setting the relative weights of the seven input metrics as stable weights going forward, such that a program's DORCE score for each year after 2015 could be compared on equal footing to that baseline. A benchmarking approach to DORCE scores would provide numeric values for DORCE score, similar to TRC, in place of or possibly alongside program rankings. Note, though, that if the basis changes for inputs to some DORCE metrics, such as avoided cost, the baseline may be in need of updating to provide an accurate reflection of program achievements in future years.
- **Consider using DORCE as a standard tool to set goals and expected outcomes in the business planning process.** The DORCE score can provide a consistent and detailed lens for anticipating and evaluating program performance. Program planners can frame expected outcomes from a given potential program design from a DORCE perspective. If adapted for use on a forward-looking basis, the DORCE score can provide the basis for setting depth of savings goals and cost-effectiveness goals for individual programs and for the whole IOU portfolio.

- **As a consistent and detailed lens, consider maintaining its use through the implementation planning and program evaluation processes so as to structure and evaluate programs on the same terms with which they were designed**. Reviewers using the DORCE score could check to see whether planned programs are likely to meet goals framed in the business plans in terms of DORCE and could recommend structural adjustments and/or budget adjustments accordingly.

Expanding DORCE

- **DORCE score provides details on program effectiveness but does not explicitly identify the drivers of program effectiveness. Consider conducting process evaluation to help identify specific program design elements and implementation strategies possibly driving program outcomes**. The DORCE score and associated regression modeling in this study offer detailed information about program performance and patterns in performance across different elements of program design and targeting. Through interviews with program managers, program implementers, participants, and trade allies, a focused process evaluation would help identify the particular practices and dynamics that appear most responsible for influencing a program's effectiveness score.
- **Consider expanding DORCE to the residential sector, since DORCE is based on program performance characteristics that can be assessed and applied consistently across sectors.** In the current study, the DORCE score is developed for nonresidential resource programs across the industrial, agricultural, and commercial sectors. Extending the score to the residential sector would enable the same kinds of program planning and performance measurement functions for residentially targeted programs. It would also enable whole portfolio-wide analysis to help inform program design decisions and resource investment decisions across sectors.

APPENDIX A

A.1 PROGRAM LIST

TABLE A-1: PROGRAM LIST

IOU	Itron Program ID	Itron Program Name	Program ID - 1012	Program ID - 1315
PGE	PGE21006/ PGE21015	Commercial HVAC	PGE21061/ PGE21063/ PGE21065	PGE21015
PGE	PGE21011	Commercial Calculated Incentives	PGE21011	PGE21011
PGE	PGE210110	Monitoring-based Persistence Commissioning	PGE2187	PGE210110
PGE	PGE210111	Lodgingsavers	PGE2190	PGE210111
PGE	PGE210112	School Energy Efficiency	PGE2193	PGE210112
PGE	PGE210113	Energy Fitness Program	PGE2194	PGE210113
PGE	PGE210114	Energy Savers	PGE2195	PGE210114
PGE	PGE210115	Rightlights	PGE2196	PGE210115
PGE	PGE210116	Small Business Commercial Comprehensive	PGE2197	PGE210116
PGE	PGE210117	Energy-efficient Parking Garage	PGE2199	PGE210117
PGE	PGE210118	Furniture Store Energy Efficiency	PGE2200	PGE210118
PGE	PGE210119	Led Accelerator	PGE2202	PGE210119
PGE	PGE21012	Commercial Deemed Incentives	PGE21012	PGE21012
PGE	PGE210120	Monitoring-based Commissioning		PGE210120
PGE	PGE210122	Casino Green	PGE2205	PGE210122
PGE	PGE210123	Healthcare Energy Efficiency Program	PGE2206	PGE210123
PGE	PGE210124	Ozone Laundry Energy Efficiency	PGE2209	PGE210124
PGE	PGE210125	California Preschool Energy Efficiency Program	PGE2212	PGE210125
PGE	PGE210126	K-12 Private Schools and Colleges Audit Retro	PGE2213	PGE210126
PGE	PGE210128	Enovity Smart		PGE210128
PGE	PGE210129	Nexant Aercx		PGE210129
PGE	PGE210130	Rsg Aercx		PGE210130
PGE	PGE210131	Peci Aercx		PGE210131
PGE	PGE210133	Staples Low Pressure Irrigation DI		PGE210133
PGE	PGE210141	Lincus Commercial Mid-Market Program		PGE210141
PGE	PGE21016	Air Care Plus	PGE2181	PGE21016
PGE	PGE21017	Boiler Energy Efficiency Program	PGE2182	PGE21017
PGE	PGE21018	Energysmart Grocer	PGE2185	PGE21018
PGE	PGE21019	Enhanced Automation Initiative	PGE2186	PGE21019

IOU	Itron Program ID	Itron Program Name	Program ID - 1012	Program ID - 1315
PGE	PGE21021	Industrial Calculated Incentives	PGE21021	PGE21021
PGE	PGE210210	Industrial Recommissioning Program	PGE2228	PGE210210
PGE	PGE21022	Industrial Deemed Incentives	PGE21022	PGE21022
PGE	PGE21025	California Wastewater Process Optimization	PGE2221	PGE21025
PGE	PGE21026	Energy Efficiency Services for Oil Production	PGE2222	PGE21026
PGE	PGE21027	Heavy Industry Energy Efficiency Program	PGE2223	PGE21027
PGE	PGE21028	Industrial Compressed Air Program	PGE2224	PGE21028
PGE	PGE21029	Refinery Energy Efficiency Program	PGE2225	PGE21029
PGE	PGE21031	Agricultural Calculated Incentives	PGE21031	PGE21031
PGE	PGE210310	Dairy Industry Resource Advantage Pgm	PGE2235	PGE210310
PGE	PGE210311	Process Wastewater Treatment Em Pgm For Ag Food Processing	PGE2236	PGE210311
PGE	PGE21032	Agricultural Deemed Incentives	PGE21032	PGE21032
PGE	PGE21035	Dairy Energy Efficiency Program	PGE2230	PGE21035
PGE	PGE21036	Industrial Refrigeration Performance Plus	PGE2231	PGE21036
PGE	PGE21037	Light Exchange Program	PGE2232	PGE21037
PGE	PGE21038	Wine Industry Efficiency Solutions	PGE2233	PGE21038
PGE	PGE21039	Comprehensive Food Process Audit & Resource Efficiency Pgm	PGE2234	PGE21039
PGE	PGE21042	Lighting Innovation		PGE21042
PGE	PGE2110011	California Community Colleges	PGE21261	PGE2110011
PGE	PGE2110012	University of California/California State University	PGE21262	PGE2110012
PGE	PGE2110013	State of California	PGE21263	PGE2110013
PGE	PGE2110014	Department of Corrections and Rehabilitation	PGE21264	PGE2110014
PGE	PGE2110051	Local Government Energy Action Resources (LGEAR)	PGE2125/ PGE2140	PGE2110051
PGE	PGE211007	Association of Monterey Bay Area Governments (AMBAG)	PGE2130	PGE211007
PGE	PGE211009	East Bay	PGE2132	PGE211009
PGE	PGE211010	Fresno	PGE2131/ PGE2133	PGE211010
PGE	PGE211011	Kern	PGE2134	PGE211011
PGE	PGE211012	Madera	PGE2135	PGE211012
PGE	PGE211013	Marin County	PGE2136	PGE211013
PGE	PGE211014	Mendocino County	PGE2137	PGE211014
PGE	PGE211015	Napa County	PGE2138	PGE211015
PGE	PGE211016	Redwood Coast	PGE2139	PGE211016

IOU	Itron Program ID	Itron Program Name	Program ID - 1012	Program ID - 1315
PGE	PGE211018	San Luis Obispo County	PGE2141	PGE211018
PGE	PGE211019	San Mateo County	PGE2142	PGE211019
PGE	PGE211020	Santa Barbara	PGE2143	PGE211020
PGE	PGE211021	Sierra Nevada	PGE2144	PGE211021
PGE	PGE211022	Sonoma County	PGE2145	PGE211022
PGE	PGE211023	Silicon Valley	PGE2146	PGE211023
PGE	PGE211024	San Francisco	PGE2147	PGE211024
PGE	PGE211025	Savings by Design (SBD)	PGE21042	PGE211025
PGE	PGE2183	Comprehensive Retail Energy Management	PGE2183	
PGE	PGE2189	Cool Controls Plus	PGE2189	
PGE	PGE2191	Medical Building Tune-Up	PGE2191	
PGE	PGE2198	Data Centers Cooling Controls Program	PGE2198	
PGE	PGE2201	California High Performance Lighting Program	PGE2201	
PGE	PGE2204	SmartVent for Energy-Efficient Kitchens	PGE2204	
PGE	PGE2214	Energy Efficiency Program for Entertainment Centers	PGE2214	
PGE	PGE2220	Assessment, Implementation, and Monitoring (AIM) Program	PGE2220	
PGE	PGE2227	Cement Production and Distribution Energy Efficiency	PGE2227	
PGE	PGE2242	Cool Cash	PGE2242	
SCE	SCE-13-L-002A	City of Beaumont Energy Leader Partnership	SCE-L-004A	SCE-13-L-002A
SCE	SCE-13-L-002B	City of Long Beach Energy Leader Partnership	SCE-L-004B	SCE-13-L-002B
SCE	SCE-13-L-002C	City of Redlands Energy Leader Partnership	SCE-L-004C	SCE-13-L-002C
SCE	SCE-13-L-002D	City of Santa Ana Energy Leader Partnership	SCE-L-004E	SCE-13-L-002D
SCE	SCE-13-L-002E	City of Simi Valley Energy Leader Partnership	SCE-L-004F	SCE-13-L-002E
SCE	SCE-13-L-002F	Gateway Cities Energy Leader Partnership	SCE-L-004G	SCE-13-L-002F
SCE	SCE-13-L-002G	COMMUNITY ENERGY LEADER PARTNERSHIP	SCE-L-004H	SCE-13-L-002G
SCE	SCE-13-L-002H	Eastern Sierra Energy Leader Partnership	SCE-L-004J	SCE-13-L-002H
SCE	SCE-13-L-002J	Desert Cities Energy Leader Partnership	SCE-L-004I/ SCE-L-004N	SCE-13-L-002J
SCE	SCE-13-L-002K	Kern county energy leader partnership	SCE-L-004L	SCE-13-L-002K
SCE	SCE-13-L-002L	Orange County Cities Energy Leader Partnership	SCE-L-004M	SCE-13-L-002L
SCE	SCE-13-L-002M	San Gabriel Valley Energy Leader Partnership	SCE-L-004O	SCE-13-L-002M
SCE	SCE-13-L-002N	San Joaquin Valley Energy Leader Partnership	SCE-L-004P	SCE-13-L-002N
SCE	SCE-13-L-002O	South Bay Energy Leader Partnership	SCE-L-004Q	SCE-13-L-002O

IOU	Itron Program ID	Itron Program Name	Program ID - 1012	Program ID - 1315
SCE	SCE-13-L-002P	South Santa Barbara County Energy Leader Partnership	SCE-L-004R	SCE-13-L-002P
SCE	SCE-13-L-002Q	Ventura County Energy Leader Partnership	SCE-L-004S	SCE-13-L-002Q
SCE	SCE-13-L-002R	Western Riverside Energy Leader Partnership	SCE-L-004U	SCE-13-L-002R
SCE	SCE-13-L-002S	City of Adelanto Energy Leader Partnership	SCE-L-004V	SCE-13-L-002S
SCE	SCE-13-L-002T	West Side Energy Leader Partnership	SCE-L-004W	SCE-13-L-002T
SCE	SCE-13-L-003A	California Community Colleges Energy Efficiency Partnership	SCE-L-005A	SCE-13-L-003A
SCE	SCE-13-L-003B	California dept. Of Corrections and Rehabilitation EE Partnership	SCE-L-005B	SCE-13-L-003B
SCE	SCE-13-L-003C	County of Los Angeles Energy Efficiency Partnership	SCE-L-005C	SCE-13-L-003C
SCE	SCE-13-L-003D	County of Riverside Energy Efficiency Partnership	SCE-L-005D	SCE-13-L-003D
SCE	SCE-13-L-003E	County of San Bernardino Energy Efficiency Partnership	SCE-L-005E	SCE-13-L-003E
SCE	SCE-13-L-003F	State of California Energy Efficiency Partnership	SCE-L-005F	SCE-13-L-003F
SCE	SCE-13-L-003G	UC/CSU Energy Efficiency Partnership	SCE-L-005G	SCE-13-L-003G
SCE	SCE-13-SW-001E	HVAC Program	SCE-SW-007E	SCE-13-SW-001E
SCE	SCE-13-SW-002B	Commercial Calculated Program	SCE-SW-002B	SCE-13-SW-002B
SCE	SCE-13-SW-002C	Commercial Deemed Incentives Program	SCE-SW-002C	SCE-13-SW-002C
SCE	SCE-13-SW-002D	Commercial Direct Install Program	SCE-SW-002D	SCE-13-SW-002D
SCE	SCE-13-SW-002F	Non-Residential HVAC Program	SCE-SW-007A	SCE-13-SW-002F
SCE	SCE-13-SW-002G	Savings by Design	SCE-SW-005a	SCE-13-SW-002G
SCE	SCE-13-SW-003B	industrial Calculated Energy Efficiency Program	SCE-SW-003B	SCE-13-SW-003B
SCE	SCE-13-SW-003C	Industrial Deemed Energy Efficiency Program	SCE-SW-003C	SCE-13-SW-003C
SCE	SCE-13-SW-004B	Agriculture Calculated Energy Efficiency Program	SCE-SW-004B	SCE-13-SW-004B
SCE	SCE-13-SW-004C	Agriculture Deemed Energy Efficiency Program	SCE-SW-004C	SCE-13-SW-004C
SCE	SCE-13-SW-005B	Lighting Innovation Program		SCE-13-SW-005B
SCE	SCE-13-TP-003	Healthcare EE Program	SCE-TP-006	SCE-13-TP-003
SCE	SCE-13-TP-004	Data Center Energy Efficiency	SCE-TP-010	SCE-13-TP-004

IOU	Itron Program ID	Itron Program Name	Program ID - 1012	Program ID - 1315
SCE	SCE-13-TP-005	Lodging EE Program	SCE-TP-012	SCE-13-TP-005
SCE	SCE-13-TP-006	Food & Kindred Products	SCE-TP-013	SCE-13-TP-006
SCE	SCE-13-TP-007	Primary and Fabricated Metals	SCE-TP-014	SCE-13-TP-007
SCE	SCE-13-TP-008	Nonmetallic Minerals and Products	SCE-TP-016	SCE-13-TP-008
SCE	SCE-13-TP-009	Comprehensive Chemical Products	SCE-TP-017	SCE-13-TP-009
SCE	SCE-13-TP-010	Comprehensive Petroleum Refining	SCE-TP-019	SCE-13-TP-010
SCE	SCE-13-TP-011	Oil Production	SCE-TP-020	SCE-13-TP-011
SCE	SCE-13-TP-012	Refinery energy efficiency program	SCE-TP-021	SCE-13-TP-012
SCE	SCE-13-TP-013	Cool Schools	SCE-TP-023	SCE-13-TP-013
SCE	SCE-13-TP-014	Commercial Utility Building Efficiency	SCE-TP-026	SCE-13-TP-014
SCE	SCE-13-TP-017	Energy Efficiency for Entertainment Centers	SCE-TP-036	SCE-13-TP-017
SCE	SCE-13-TP-018	School Energy Efficiency Program	SCE-TP-024/ SCE-TP-038	SCE-13-TP-018
SCE	SCE-13-TP-020	IDEEA365 Program		SCE-13-TP-020
SCE	SCE-13-TP-021	Enhanced Retrocommissioning		SCE-13-TP-021
SCE	SCE-L-004D	Energy Leader Partnership Program	SCE-L-004D	
SCE	SCE-TP-008	Comprehensive Beverage Manufacturing & Resource Efficiency	SCE-TP-008	
SCE	SCE-TP-015	Industrial Gasses	SCE-TP-015	
SCE	SCE-TP-018	Chemical Products Efficiency Program	SCE-TP-018	
SCE	SCE-TP-025	Retail Energy Action Program	SCE-TP-025	
SCE	SCE-TP-027	Monitoring-Based Commissioning		SCE-TP-027
SCE	SCE-TP-028	Monitoring-Based Persistence Commissioning Program		SCE-TP-028
SCE	SCE-TP-031	Management Affiliates Program	SCE-TP-031	
SCE	SCE-TP-033	Automatic Energy Review for Schools Program	SCE-TP-033	
SCE	SCE-TP-037	Private Schools and Colleges Program	SCE-TP-037	
SCE	SCE-TP-0608	Coin Operated Laundry Program	SCE-TP-0608	
SCG	SCG3710	SW-COM-Calculated Incentives	SCG3607/ SCG3625	SCG3710
SCG	SCG3711	SW-COM-Deemed Incentives	SCG3608	SCG3711
SCG	SCG3712	SW-COM-Nonres HVAC		SCG3712
SCG	SCG3715	SW-IND-Calculated Incentives	SCG3611	SCG3715
SCG	SCG3716	SW-IND-Deemed Incentives	SCG3612	SCG3716
SCG	SCG3719	SW-AG-Calculated Incentives	SCG3602	SCG3719
SCG	SCG3720	SW-AG-Deemed Incentives	SCG3603	SCG3720

IOU	Itron Program ID	Itron Program Name	Program ID - 1012	Program ID - 1315
SCG	SCG3757	3P-Small Industrial Facility Upgrades	SCG3662	SCG3757
SCG	SCG3758	3P-Preps	SCG3663	SCG3758
SCG	SCG3766	3P-Savegas	SCG3673	SCG3766
SCG	SCG3793	3P-IDEEA365-Instant Rebates! Point-OF-Sale Foodservice Rebate Program		SCG3793
SDGE	SDGE3117E	Energy Savings Bid (Encumbered)	SDGE3117	
SDGE	SDGE3118E/ SDGE3222	SW-COM-Savings by Design	SDGE3118	SDGE3222
SDGE	SDGE3162	3P-NRes02 - SaveGas - Hot Water Control	SDGE3162	
SDGE	SDGE3220	SW-COM-Calculated Incentives-Calculated	SDGE3105	SDGE3220
SDGE	SDGE3221	SW-COM-Calculated Incentives-RCX	SDGE3170	SDGE3221
SDGE	SDGE3223	SW-COM-Deemed Incentives-Commercial Rebates	SDGE3106	SDGE3223
SDGE	SDGE3224	SW-COM-Deemed Incentives-Hvac Commercial	SDGE3161	SDGE3224
SDGE	SDGE3226	SW-COM Direct Install	SDGE3167/ SDGE3174	SDGE3226
SDGE	SDGE3231	SW-IND-Calculated Incentives-Calculated	SDGE3109	SDGE3231
SDGE	SDGE3233	SW-IND-Deemed Incentives	SDGE3110	SDGE3233
SDGE	SDGE3237	SW-AG-Calculated Incentives-Calculated	SDGE3100	SDGE3237
SDGE	SDGE3239	SW-AG-Deemed Incentives	SDGE3101	SDGE3239

A.2 MEASURE GROUP TO MEASURE CLASS

TABLE A-2: MEASURE GROUP TO MEASURE CLASS

Measure Class	Measure Group
Ag Irrigation	Ag Irrigation
Ag Pumping	Ag Pump Controls
	Ag Pump Other
	Ag Pump Overhaul
	Ag pump testing
	Ag Pump VFD
Appliance	Appliance Clothes Washer
	Appliance Dishwasher
	Appliance Freezer
	Appliance Recycle Freezer
	Appliance Recycle Refrigerator
	Appliance Recycle Room AC
	Appliance Refrigerator
	Vending Machine
Food Service	Food Service
HVAC Chillers	HVAC Central Plant
	HVAC Chiller Air Cooled
	HVAC Chiller Other
	HVAC Chiller Water Cooled
HVAC Controls	HVAC Controls Boiler
	HVAC Controls Compressor
	HVAC Controls EMS
	HVAC Controls FAN
	HVAC Controls Fume Hood
	HVAC Controls Other
	HVAC Controls PTAC
	HVAC Controls Reset
	HVAC Controls Steam System
	HVAC Controls Thermostat
	HVAC Controls Timer
	HVAC DCV
HVAC Distribution System Components	HVAC Compressor VFD
	HVAC Cooling Other
	HVAC Cooling Tower
	HVAC Duct Insulation
	HVAC Duct Sealing
	HVAC Economizer Addition
	HVAC Economizer Water Side

Measure Class	Measure Group
	HVAC fan VFD
	HVAC Motor Replacement
	HVAC other VFD
	HVAC Pump Other
	HVAC Pump Replacement
	HVAC Pump System Optimization
	HVAC Pump VFD
	HVAC Vav Conversion
	HVAC Ventilation Fan
	HVAC Ventilation Other
	HVAC VRF/Mini Split
HVAC DX Equipment	HVAC Compressor Replacement
	HVAC EVAP Cooler
	HVAC PTAC-PTHP
	HVAC Rooftop or Split System
	HVAC Room AC
HVAC Envelope	Building Envelope Ceiling-Roof Insulation
	Building Envelope Cool Roof
	Building Envelope Insulation Other
	Building Envelope New Windows
	Building Envelope Other
	Building Envelope Wall Insulation
	Building Envelope Window Film
	Building Envelope Window Other
HVAC Heating Equipment	HVAC Boiler
	HVAC Boiler Stack Economizer
	HVAC Furnace
HVAC Maintenance	HVAC Air Filter Replacement
	HVAC Coil Cleaning
	HVAC Economizer Repair
	HVAC Fan Repair
	HVAC Maintenance
	HVAC RCA
HVAC Other	HVAC Heating Other
	HVAC Other
Indoor Lighting - CFL	Lighting Indoor CFL > 30 Watts
	Lighting Indoor CFL 3 Way
	Lighting Indoor CFL A Lamp

Measure Class	Measure Group
	Lighting Indoor CFL Basic
	Lighting Indoor CFL Fixture
	Lighting Indoor CFL Globe
	Lighting Indoor CFL Other
	Lighting Indoor CFL Reflector
Indoor Lighting - Controls	Lighting Indoor Controls Daylighting
	Lighting Indoor Controls HI-LO
	Lighting Indoor Controls Other
	Lighting Indoor Controls Wall or Ceiling Mounted Occupancy Sensor
	Lighting Indoor Fixture Integrated Occupancy Sensor
Indoor Lighting - HID	Lighting Indoor HID
Indoor Lighting - LED	Lighting Indoor LED Fixture
	Lighting Indoor LED Lamp
	Lighting Indoor LED Other
	Lighting Indoor LED Reflector Lamp
Indoor Lighting - Linear	Lighting Indoor High Bay Fluorescent
	Lighting Indoor Linear Fluorescent
	Lighting Indoor Linear Fluorescent Delamping
Indoor Lighting - Other	Lighting Indoor Cold Cathode
	Lighting Indoor Induction
	Lighting Indoor LED Exit Sign
	Lighting Indoor LED Signage
	Lighting Indoor Other
LED Streetlight	Lighting Outdoor LED Street Light
	Lighting Outdoor LED Streetlight
Other	Other
Outdoor Lighting	Lighting Outdoor CFL > 30 WATTS
	Lighting Outdoor CFL BASIC
	Lighting Outdoor CFL FIXTURE
	Lighting Outdoor COLD CATHODE
	Lighting Outdoor Controls Other
	Lighting Outdoor CONTROLS PHOTOCELL
	Lighting Outdoor CONTROLS TIME CLOCK
	Lighting Outdoor HID
	Lighting Outdoor INDUCTION
	Lighting Outdoor LED FIXTURE
	Lighting Outdoor LED HOLIDAY

Measure Class	Measure Group
	Lighting Outdoor LED Other
	Lighting Outdoor LED SIGNAGE
	Lighting Outdoor Linear Fluorescent
	Lighting Outdoor Other
Plug Loads	Plug Load Desktop Computer
	Plug Load Monitor
	Plug Load Other
	Plug Load PC Power Management
	Plug Load Printer Copier Multifunction
	Plug Load Sensor
	Plug Load Television
Pool	Pool Cover
	Pool Heater
	Pool Pump
Process compressed air	Process Compressed Air Compressor
	Process Compressed Air Controls
	Process Compressed Air Other
	Process Compressed Air System Configuration
	Process Compressed Air VFD
Process cooling	Pipe Insulation Cold Application
	Process Computing Operations Data Center Air Flow Management
	Process Cooling
	Process Cooling Controls
	Tank Insulation Cold Application
Process heating	Pipe Insulation Hot Application
	Process Boiler
	Process Boiler Burner Upgrade
	Process Boiler Condensate Heat Recovery
	Process Boiler Controls Other
	Process Boiler Stack Heat Recovery
	Process Boiler Tuneup
	Process Heat Recovery
	Process Heating
	Steam Trap HP
	Steam Trap LP
	Tank Insulation Hot Application
Process other	Process Computing Operations Data Center HVAC Other
	Process Computing Operations Data Center UPS

Measure Class	Measure Group
	Process Computing Operations Server Virtualization
	Process Dehydrator
	Process Fan
	Process Greenhouse Heat Curtain
	Process Greenhouse IR FILM
	Process Injection Molding
	process Other
	Process Other Controls
	Process Ozone Laundry
	Process Wastewater Aerator
	Process Wastewater Control
	Process Wastewater Other
	Process Water Supply Control
	Process Water Supply Other
Process Pumping & Motors	Other Motor Replacement
	Process Fan VFD
	Process Motor Controls
	Process Motor Replacement
	Process Oil Well Pump Off Controllers
	Process Oil Well Pumping Other
	Process Other VFD
	Process Pumping
	Process Pumping Controls
	Process Pumping VFD
	Process Vacuum Pump
	Process Vacuum Pump VFD
	Process Wastewater Pump
	Process Wastewater VFD
	Process Water Supply Pump
	Process Water Supply VFD
RCX	Retrocommissioning HVAC
	Retrocommissioning Lighting
	Retrocommissioning Process
	Retrocommissioning Refrigeration
Refrigeration Controls	Refrigeration Controls Ash
	Refrigeration Controls Evaporator Fan
	Refrigeration Controls Floating Head Pressure
	Refrigeration Controls Floating Suction Pressure

Measure Class	Measure Group
	Refrigeration Controls Other
	Refrigeration EMS
Refrigeration End-Use Measures	Refrigeration Case Door
	Refrigeration Case LED Lighting
	Refrigeration Case Lighting Other
	Refrigeration Case Replacement
	Refrigeration Door Closer
	Refrigeration Door Gasket
	Refrigeration Ice Machine
	Refrigeration Night Cover
	Refrigeration Strip Curtain
Refrigeration Other	Refrigeration Coil Cleaning
	Refrigeration Other
Refrigeration Plant Equipment	Refrigeration Compressor
	Refrigeration Compressor VFD
	Refrigeration Condenser
	Refrigeration Condenser VFD
	Refrigeration Evaporator EC Motors
	Refrigeration Evaporator VFD
Water Heating	Water Heating Boiler
	Water Heating Controls
	Water Heating Faucet Aerator
	Water Heating Other
	Water Heating Pumping
	Water Heating Showerhead
	Water Heating Storage Water Heater
	Water Heating Tankless Water Heater
Whole Building	Whole Building NRNC
	Whole Building Retrofit
	Whole Building RNC

A.3 BUILDING TYPE TO BUILDING GROUP MAP

TABLE A-3: BUILDING TYPE TO BUILDING GROUP

Building Group	Building Type
Agricultural	Ag & Water Pump
	Agricultural
	Agricultural Produce Farms
	Farm/Agriculture
	Greenhouse
Assembly	Assembly
Both Residential and Commercial	Both Residential and Commercial
Commercial	Commercial
Education - College	Education - College
	Education - Community College
	Education - University
Education - School	Education - Primary School
	Education - Relocatable Classroom
	Education - School
	Education - Secondary School
Food/Liquor	Food Store
	Food/Liquor
	Grocery
Health/Medical	Health/Medical - Care
	Health/Medical - Clinics
	Health/Medical - Hospital
	Health/Medical - Med Office
	Health/Medical - Nursing Home
Industrial	Industrial
Lodging	Hotel/Motel
	Lodging - Guest Room
	Lodging - Hotel
	Lodging - Motel
Manufacturing	Manufacturing Biotech
	Manufacturing Light Industrial
Mining	Mining
Miscellaneous Commercial	Miscellaneous Commercial
Office	Office
	Office - Large
	Office - Small
	Property Managers
Restaurant	Restaurant
	Restaurant - Fast-Food

Building Group	Building Type
	Restaurant - Sit-Down
Retail	Retail
	Retail - Multistory Large
	Retail - Single-Story Large
	Retail - Small
Transportation - Communication - Utilities	Transportation - Communication - Utilities
Unknown	Street Lights
	Unknown
Upstream	Upstream
Warehouse	Storage - Conditioned
	Storage - Unconditioned
	Warehouse
	Warehouse - Refrigerated

A.4 PROGRAM RANKING

TABLE A-4: PROGRAM SCORE AND RESIDUAL RANKINGS

Itron Program ID	Itron Program Name	Score Rank					Residuals Rank				
		DORCE	Cost Effectiveness	Depth of Retrofit	Technologies Addressed	Savings Achieved	DORCE	Cost Effectiveness	Depth of Retrofit	Technologies Addressed	Savings Achieved
SCE-TP-033	Automatic Energy Review for Schools Program	1	5	30	31	33	5	3	24	92	6
SCG3716	SW-IND-Deemed Incentives	2	1	135	133	104	1	1	134	136	110
SCG3715	SW-IND-Calculated Incentives	3	2	115	112	89	22	18	86	54	98
SDGE3118E/ SDGE3222	SW-COM-Savings by Design	4	14	16	9	51	124	65	125	127	94
SCE-13-SW-002G	Savings by Design	5	22	10	32	11	25	50	17	25	22
SCE-13-L-002R	Western Riverside Energy Leader Partnership	6	149	1	113	1	3	68	2	117	1
PGE21019	Enhanced Automation Initiative	7	3	146	157	111	4	2	143	162	61
PGE21029	Refinery Energy Efficiency Program	8	4	159	126	162	8	6	124	64	144
PGE210118	Furniture Store Energy Efficiency	9	97	2	69	3	7	24	4	16	5
SCE-13-TP-005	Lodging EE Program	10	61	8	14	19	12	34	8	17	4
SDGE3117E	Energy Savings Bid (Encumbered)	11	7	112	99	103	51	13	130	114	133
SCE-13-TP-012	Refinery Energy Efficiency Program	12	13	66	56	69	14	16	21	21	32
PGE2110014	Department of Corrections and Rehabilitation	13	42	31	6	87	70	38	94	37	129
PGE210113	Energy Fitness Program	14	62	11	45	9	13	9	55	68	41
PGE21035	Dairy Energy Efficiency Program	15	55	15	20	24	9	21	5	8	7
SCE-13-L-002D	City of Santa Ana Energy Leader Partnership	16	115	5	105	2	41	78	27	99	29
SCE-13-SW-003C	Industrial Deemed Energy Efficiency Program	17	23	53	100	20	75	73	62	124	38
SDGE3226	SW-COM Direct Install	18	133	4	10	13	94	144	43	90	21

Itron Program ID	Itron Program Name	Score Rank					Residuals Rank				
		DORCE	Cost Effectiveness	Depth of Retrofit	Technologies Addressed	Savings Achieved	DORCE	Cost Effectiveness	Depth of Retrofit	Technologies Addressed	Savings Achieved
PGE210114	Energy Savers	19	87	9	67	4	78	85	90	61	91
SCE-13-L-003B	California Dept. Of Corrections and Rehabilitation EE Partnership	20	98	7	2	114	36	81	34	42	93
PGE210115	Rightlights	21	100	6	40	5	109	143	56	78	36
PGE210120	Monitoring-Based Commissioning	22	6	136	157	90	2	4	64	116	37
PGE21031	Agricultural Calculated Incentives	23	20	68	111	30	16	80	3	30	3
SCE-13-L-003F	State OF California Energy Efficiency Partnership	24	86	12	35	12	62	110	38	84	14
PGE211010	Fresno	25	71	32	58	17	37	19	65	75	51
SCG3710	SW-COM-Calculated Incentives	26	12	110	131	57	38	96	10	22	15
SCE-13-TP-006	Food & Kindred Products	27	24	73	43	98	53	30	54	62	62
PGE210122	Casino Green	28	60	34	7	95	100	17	149	143	134
SCE-13-L-002B	City of Long Beach Energy Leader Partnership	29	101	17	57	10	17	22	32	111	10
PGE210141	Lincus Commercial Mid-Market Program	30	164	3	2	62	56	103	51	129	8
PGE211025	Savings by Design (SBD)	31	18	103	117	58	45	42	93	57	122
PGE211012	Madera	32	84	26	52	16	39	25	50	48	64
SCE-13-L-003G	UC/CSU Energy Efficiency Partnership	33	88	28	4	140	136	83	148	160	114
SCG3719	SW-AG-Calculated Incentives	34	10	120	136	68	131	133	107	146	73
PGE211014	Mendocino County	35	132	13	62	6	49	88	44	72	42
SCE-TP-027	Monitoring-Based Commissioning	36	8	153	157	135	10	5	161	159	138
SCE-13-L-002T	West Side Energy Leader Partnership	37	135	14	13	38	90	102	48	43	50
PGE210111	Lodgingsavers	38	74	36	12	86	153	128	154	140	156
PGE211019	San Mateo County	39	114	22	39	21	76	64	69	89	43

Itron Program ID	Itron Program Name	Score Rank					Residuals Rank				
		DORCE	Cost Effectiveness	Depth of Retrofit	Technologies Addressed	Savings Achieved	DORCE	Cost Effectiveness	Depth of Retrofit	Technologies Addressed	Savings Achieved
PGE21021	Industrial Calculated Incentives	40	9	139	102	163	68	92	71	7	159
SDGE3220	SW-COM-Calculated Incentives-Calculated	41	11	126	121	107	54	46	75	34	108
PGE2110011	California Community Colleges	42	65	48	11	118	107	115	96	36	126
SCE-13-SW-002B	Commercial Calculated Program	43	25	90	82	84	71	59	98	52	103
PGE21032	Agricultural Deemed Incentives	44	15	119	110	106	31	7	141	100	150
SDGE3223	SW-COM-Deemed Incentives-Commercial Rebates	45	35	75	76	73	20	23	26	40	34
PGE2110051	Local Government Energy Action Resources (LGEAR)	46	138	19	41	15	47	97	28	49	33
PGE21022	Industrial Deemed Incentives	47	26	89	106	55	32	33	18	59	19
SCE-13-TP-014	Commercial Utility Building Efficiency	48	31	81	89	63	33	43	19	23	31
SCE-13-SW-002C	Commercial Deemed Incentives Program	49	39	74	92	53	44	26	84	80	74
SCE-13-L-002Q	Ventura County Energy Leader Partnership	50	143	18	65	8	74	120	41	77	28
PGE211021	Sierra Nevada	51	125	27	64	14	58	67	59	102	39
SCE-13-L-002G	Community Energy Leader Partnership	52	110	33	28	37	61	29	77	63	54
SCE-13-SW-003B	Industrial Calculated Energy Efficiency Program	53	21	108	85	116	110	132	68	19	117
SCE-13-SW-002D	Commercial Direct Install Program	54	140	21	24	28	128	141	114	44	132
SCE-13-L-002J	Desert Cities Energy Leader Partnership	55	134	24	23	34	117	136	78	31	107
PGE211022	Sonoma County	56	99	37	66	23	86	79	89	71	87
PGE2110012	University of California/California State University	57	54	61	26	97	139	91	135	123	106
PGE21038	Wine Industry Efficiency Solutions	58	70	54	27	72	77	94	63	51	60

Itron Program ID	Itron Program Name	Score Rank					Residuals Rank				
		DORCE	Cost Effectiveness	Depth of Retrofit	Technologies Addressed	Savings Achieved	DORCE	Cost Effectiveness	Depth of Retrofit	Technologies Addressed	Savings Achieved
SCE-TP-015	Industrial Gasses	59	58	59	15	124	34	49	29	15	100
PGE21027	Heavy Industry Energy Efficiency Program	60	41	78	37	130	108	130	23	14	77
PGE211023	Silicon Valley	61	109	35	46	32	73	69	73	96	48
SCE-13-L-003D	County of Riverside Energy Efficiency Partnership	62	137	29	91	7	83	162	9	45	16
PGE210310	Dairy Industry Resource Advantage Pgm	63	72	56	30	75	65	48	91	93	71
SCE-TP-031	Management Affiliates Program	64	107	39	21	54	93	111	83	50	85
PGE21018	Energysmart Grocer	65	28	102	73	117	30	20	101	125	58
SCE-13-TP-007	Primary and Fabricated Metals	66	38	91	60	112	69	89	39	39	76
PGE2227	Cement Production and Distribution Energy Efficiency	67	152	23	2	165	66	125	15	4	160
PGE210311	Process Wastewater Treatment EM Pgm For Ag Food Processing	68	44	83	118	43	21	44	13	28	11
PGE211015	Napa County	69	105	45	70	25	103	82	106	86	104
PGE21011	Commercial Calculated Incentives	70	32	101	86	94	59	86	25	10	56
SCE-13-L-002S	City of Adelanto Energy Leader Partnership	71	158	20	5	99	148	142	159	161	152
PGE211007	Association of Monterey Bay Area Governments (AMBAG)	72	113	43	54	35	52	45	53	73	44
PGE211016	Redwood Coast	73	121	40	42	39	114	104	99	60	101
SCE-13-TP-009	Comprehensive Chemical Products	74	53	72	48	93	96	123	52	47	86
SCE-TP-028	Monitoring-Based Persistence Commissioning Program	75	79	58	25	88	85	149	6	3	65
SCE-13-TP-018	School Energy Efficiency Program	76	92	51	79	31	146	139	137	131	136

Itron Program ID	Itron Program Name	Score Rank					Residuals Rank				
		DORCE	Cost Effectiveness	Depth of Retrofit	Technologies Addressed	Savings Achieved	DORCE	Cost Effectiveness	Depth of Retrofit	Technologies Addressed	Savings Achieved
PGE211020	Santa Barbara	77	123	42	18	61	72	72	95	55	128
SCE-13-SW-004B	Agriculture Calculated Energy Efficiency Program	78	45	84	139	26	80	113	31	147	13
PGE211011	Kern	79	130	38	22	52	88	95	104	70	120
SCE-13-L-002P	South Santa Barbara County Energy Leader Partnership	80	157	25	16	42	19	61	22	41	20
SCE-TP-037	Private Schools and Colleges Program	81	119	47	51	46	40	98	16	26	17
SCE-13-L-003E	County of San Bernardino Energy Efficiency Partnership	82	129	44	19	64	84	77	81	87	75
SCE-TP-0608	Coin Operated Laundry Program	83	136	41	71	22	152	151	131	121	97
SCE-13-L-003A	California Community Colleges Energy Efficiency Partnership	84	112	50	8	139	46	60	36	35	66
SCG3793	3P-IDEEA365-Instant Rebates! Point-OF-Sale Foodservice Rebate Program	85	52	82	157	18	119	100	119	109	119
PGE21017	Boiler Energy Efficiency Program	86	47	93	128	41	28	40	11	148	2
SCG3766	3P-SAVEGAS	87	16	143	157	108	87	41	136	132	137
PGE211009	East Bay	88	80	67	97	40	97	53	110	122	95
PGE21012	Commercial Deemed Incentives	89	34	114	96	109	15	14	46	38	84
PGE211024	San Francisco	90	118	55	87	27	130	114	109	115	88
SCE-13-TP-008	Nonmetallic Minerals and Products	91	48	94	47	146	113	117	85	33	140
SCG3711	SW-COM-Deemed Incentives	92	43	105	135	48	116	129	79	79	57
SCG3758	3P-Preps	93	91	64	36	92	6	56	1	1	18
PGE21026	Energy Efficiency Services For Oil Production	94	17	150	145	127	43	55	57	139	12
SCE-13-L-002L	Orange County Cities Energy Leader Partnership	95	85	71	109	36	145	66	157	88	162

Itron Program ID	Itron Program Name	Score Rank					Residuals Rank				
		DORCE	Cost Effectiveness	Depth of Retrofit	Technologies Addressed	Savings Achieved	DORCE	Cost Effectiveness	Depth of Retrofit	Technologies Addressed	Savings Achieved
SDGE3231	SW-IND-Calculated Incentives-Calculated	96	30	123	94	152	122	146	49	29	111
SDGE3233	SW-IND-Deemed Incentives	97	57	92	90	83	91	31	126	145	68
PGE211018	San Luis Obispo County	98	145	49	34	59	104	107	113	66	135
SCE-13-L-003C	County of Los Angeles Energy Efficiency Partnership	99	77	77	103	49	147	109	138	135	116
PGE210112	School Energy Efficiency	100	96	69	38	100	48	76	42	83	46
PGE211013	Marin County	101	124	60	72	47	121	84	127	113	124
SCE-13-TP-003	Healthcare EE Program	102	63	96	59	126	18	15	87	101	79
PGE210116	Small Business Commercial Comprehensive	103	49	109	114	79	129	135	103	138	53
SDGE3162	3P-NRes02 - SaveGas - Hot Water Control	104	19	147	157	115	26	37	47	104	27
SCG3757	3P-Small Industrial Facility Upgrades	105	40	122	122	91	158	161	121	157	52
PGE210126	K-12 Private Schools And Colleges Audit Retro	106	144	57	33	74	120	108	128	110	125
SCE-13-TP-011	Oil Production	107	27	134	116	137	79	75	60	56	82
PGE2110013	State of California	108	67	95	104	67	81	74	61	98	40
PGE2189	Cool Controls Plus	109	66	97	74	102	133	150	45	9	123
PGE210110	Monitoring-Based Persistence Commissioning	110	51	107	95	101	98	126	33	32	45
SDGE3221	SW-COM-Calculated Incentives-RCX	111	33	131	115	133	29	11	108	154	30
SCE-13-L-002E	City of Simi Valley Energy Leader Partnership	112	142	62	17	113	134	62	142	103	153
SCE-13-L-002K	Kern County Energy Leader Partnership	113	159	52	29	65	55	57	37	11	112
SCE-13-L-002C	City of Redlands Energy Leader Partnership	114	139	65	78	50	67	87	66	120	23

Itron Program ID	Itron Program Name	Score Rank					Residuals Rank				
		DORCE	Cost Effectiveness	Depth of Retrofit	Technologies Addressed	Savings Achieved	DORCE	Cost Effectiveness	Depth of Retrofit	Technologies Addressed	Savings Achieved
PGE21042	Lighting Innovation	115	37	130	147	81	11	8	20	46	26
SCE-13-L-002N	San Joaquin Valley Energy Leader Partnership	116	102	80	81	76	89	12	147	95	154
PGE21016	Air Care Plus	117	78	100	68	122	27	52	14	6	115
PGE21036	industrial Refrigeration Performance Plus	118	50	121	101	129	154	137	160	137	158
SCE-13-L-002H	Eastern Sierra Energy Leader Partnership	119	165	46	49	45	42	90	30	24	59
SCE-13-L-002M	San Gabriel Valley Energy Leader Partnership	120	104	87	93	70	137	36	158	69	163
SCE-13-L-002F	Gateway Cities Energy Leader Partnership	121	156	63	63	56	112	131	88	67	83
PGE21025	California Wastewater Process Optimization	122	69	111	119	77	106	124	67	27	55
PGE21028	Industrial Compressed Air Program	123	29	149	157	121	95	121	76	155	9
SCE-TP-025	Retail Energy Action Program	124	93	99	132	44	57	28	92	134	67
SCE-13-TP-021	Enhanced Retrocommissioning	125	83	104	61	151	63	112	12	2	146
SCE-13-TP-017	Energy Efficiency for Entertainment Centers	126	131	79	44	119	82	70	102	85	102
PGE2183	Comprehensive Retail Energy Management	127	82	106	75	132	24	10	82	12	141
PGE2201	California High Performance Lighting Program	128	103	98	157	29	159	157	139	165	78
PGE210125	California Preschool Energy Efficiency Program	129	154	70	53	85	138	148	120	106	118
PGE2198	Data Centers Cooling Controls Program	130	64	124	88	154	35	32	58	18	105
PGE2214	Energy Efficiency Program for Entertainment Centers	131	141	88	50	125	64	119	7	5	72
SCE-13-L-002O	South Bay Energy Leader Partnership	132	153	76	84	60	141	93	152	82	161

Itron Program ID	Itron Program Name	Score Rank					Residuals Rank				
		DORCE	Cost Effectiveness	Depth of Retrofit	Technologies Addressed	Savings Achieved	DORCE	Cost Effectiveness	Depth of Retrofit	Technologies Addressed	Savings Achieved
SCE-13-SW-004C	Agriculture Deemed Energy Efficiency Program	133	89	116	129	66	135	106	140	156	113
PGE210124	Ozone Laundry Energy Efficiency	134	59	129	157	80	115	118	72	107	47
PGE210131	PECI Aercx	135	151	85	55	110	99	140	35	76	25
SCE-13-TP-004	Data Center Energy Efficiency	136	90	118	98	128	127	71	146	105	147
PGE21039	Comprehensive Food Process Audit & Resource Efficiency Pgm	137	56	138	107	159	162	153	164	74	166
SDGE3239	SW-AG-Deemed Incentives	138	111	113	77	147	143	147	112	20	155
PGE2191	Medical Building Tune-Up	139	75	128	108	149	60	35	80	58	69
PGE210117	Energy-Efficient Parking Garage	140	76	132	134	96	150	155	115	108	90
SCG3720	SW-AG-Deemed Incentives	141	68	137	124	131	102	54	132	97	131
PGE2220	Assessment, Implementation, and Monitoring (AIM) Program	142	36	165	157	161	101	39	155	151	99
SCE-13-L-002A	City of Beaumont Energy Leader Partnership	143	161	86	80	82	123	101	133	144	96
SCE-13-SW-005B	Lighting Innovation Program	144	95	125	143	71	92	51	117	152	49
PGE210123	Healthcare Energy Efficiency Program	145	128	117	83	150	140	145	97	94	92
SCE-TP-008	Comprehensive Beverage Manufacturing & Resource Efficiency	146	46	161	157	155	126	58	162	150	149
PGE210133	Staples Low Pressure Irrigation Di	147	116	127	142	78	118	99	105	81	121
PGE210129	Nexant Aercx	148	120	133	120	123	50	63	40	13	109
PGE2204	SmartVent for Energy-Efficient Kitchens	149	73	157	157	143	23	27	70	128	24

Itron Program ID	Itron Program Name	Score Rank					Residuals Rank				
		DORCE	Cost Effectiveness	Depth of Retrofit	Technologies Addressed	Savings Achieved	DORCE	Cost Effectiveness	Depth of Retrofit	Technologies Addressed	Savings Achieved
PGE210128	Enovity Smart	150	94	151	140	136	144	158	116	126	81
SCE-13-TP-010	Comprehensive Petroleum Refining	151	126	140	126	144	155	160	118	119	80
SCE-13-SW-002F	Nonresidential HVAC Program	152	122	141	130	142	142	127	145	149	127
SDGE3224	SW-COM-Deemed Incentives-HVAC Commercial	153	117	145	123	153	125	122	111	65	142
PGE210119	LED Accelerator	154	106	154	146	138	165	163	165	164	164
PGE210210	Industrial Recommissioning Program	155	81	162	138	166	160	156	156	141	145
SCE-TP-018	Chemical Products Efficiency Program	156	108	152	157	134	151	138	129	153	63
SCE-13-TP-013	Cool Schools	157	146	144	127	148	105	47	123	91	139
SCE-13-TP-020	IDEEA365 Program	158	150	142	157	105	111	105	100	118	70
PGE21006/PGE21015	Commercial HVAC	159	127	158	137	156	161	164	144	112	143
SDGE3237	SW-AG-Calculated Incentives-Calculated	160	148	156	157	141	132	159	74	53	89
PGE2242	Cool Cash	161	155	148	157	120	156	165	122	158	35
PGE21037	Light Exchange Program	162	160	155	144	145	166	154	166	166	165
PGE210130	RSG AERCX	163	147	163	157	158	157	134	151	130	148
SCE-L-004D	Energy Leader Partnership Program	164	162	164	157	160	149	116	150	133	151
SCE-13-SW-001E	Residential HVAC Program	165	163	160	141	157	163	152	163	163	157
SCG3712	SW-COM-Nonres HVAC	166	166	166	157	164	164	166	153	142	130