PY2013-2014 CALIFORNIA STATEWIDE RESIDENTIAL AND NONRESIDENTIAL SPILLOVER STUDY

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1. Evaluator Contact Information

The residential and nonresidential spillover efforts are covered under California Public Utilities Commission (CPUC) Contract 12PS5095 between DNV GL and the CPUC. Opinion Dynamics and Itron are subcontractor to DNV GL for this work.

Table 1 presents the various people involved in this effort.

Table 1. Evaluation Staff and Contact Information

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2. Executive Summary

This report presents the findings from research designed to assess the extent to which energy efficiency programs offered by California's Investor Owned Utilities (IOUs) have resulted in savings outside of programs, or *spillover*. Specifically, spillover refers to the energy savings that are caused by energy efficiency programs but are not rebated by the program or included in program savings estimates. The study assesses both types of spillover, participant spillover (PSO) and nonparticipant spillover (NPSO), and definitions for each are provided in Section 2.2. This research quantifies the amount of spillover savings that occur in California markets and develops recommendations for assumptions to use in future program cycles. This report is comprised of two jointly-conducted studies—the residential study conducted by Opinion Dynamics and the nonresidential study conducted by Itron, Inc. Both firms are subcontractors to DNV GL.

2.1 Background and Policy Context

The primary objective of this study is to quantify and assess the levels of potential spillover savings that are being generated within California energy efficiency programs as well as those being claimed by California IOUs. Within the 2004-2012 period, the California Public Utilities Commission (CPUC) did not permit the IOUs to count spillover savings toward program and administrator goals and performance, including cost-benefit analyses. As such, few recent studies in California have attempted to estimate participant or nonparticipant spillover.[1]

However, in 2012, the CPUC decided to include spillover effects to the extent that they can be quantified to better reflect the broader impact of programs. In particular, CPUC Decision D.12-11-015 authorized a "…portfolio-level 'market effects adjustment' of 5% to the entire 2013-2014 portfolio cost-effectiveness calculation…" The decision also committed evaluation funds to develop research and estimates of spillover effects. This study is the outcome of that decision.

This study produces statewide spillover estimates for the residential and nonresidential sectors in California.[2] The study provides spillover values from data collection efforts for both program participants and nonparticipants that are combined to arrive at a single portfolio-level spillover rate for each fuel type (electricity and natural gas) and sector. This study also provides detailed findings from the research which are aimed at focusing future spillover research.

[1] For example, in the 2010-2012 evaluation of Custom programs, PSO was quantified but NPSO was not. Data collected as part of the 2010-2012 Downstream Lighting Evaluation have also been used to quantify lighting-related spillover.

[2] While the study team compared the results to the 5% planning assumption for context, we did not intend for the study to be a hypothesis testing exercise to assess whether we can reject the null hypothesis of a 5% spillover rate. We believe this approach was supported in Decision 12-11-015, in which the CPUC noted that the 5% "market effects adjustment" was only a placeholder value until further research could be conducted and described in several places a desire to avoid "false specificity and accuracy in this important area when the appropriate research and data does not yet exist."

2.2 Definition of Spillover

The working definition of spillover, as outlined in the research plan[3], is based on the 2006 EM&V Protocols, which defines spillover as "reductions in energy consumption and/or demand in a utility's service area caused by the presence of a Demand-Side Management (DSM) Program, beyond program-related gross or net savings of participants."[4]

Given the lack of consistent terminology used and in order to outline what is (and what is not) included in this spillover study, it is important to start with a conceptual framework[5] for the relationship between spillover, market effects, and market transformation. Our discussion of what is (and is not) included in this spillover study relies on the following conceptual framework, based on the 2006 EM&V Protocols:

> **Spillover** = reductions in energy consumption and/or demand in a utility's service area caused by the presence of a Demand-Side Management (DSM) Program, beyond program-related gross or net savings of participants.
>
> **Market Effects** = spillover savings that reflect meaningful changes in the structure or functioning of energy efficiency markets.
>
> **Market Transformation** = market effects that are substantial and long lasting.[6]

For example, consider a residential customer who participates in the Energy Upgrade California program and receives a rebate when purchasing a high efficiency central AC system. If this customer**, influenced by their experience participating** in the program, purchased other energy efficient equipment and **did not receive a rebate** for that measure (either due to lack of a rebate or for other reasons), the savings from that additional measure would be considered participant **spillover**. This is a relatively short-lived impact because it is caused by the program's influence on the customer at the decision point.

If that customer's HVAC contractor, spurred on by high sales of energy efficient systems from program participants, decided to change their stocking practice to only carry high efficiency systems, then the savings from those high efficiency systems that were not rebated by the program, would be considered **market effects**. The impact of market effects is longer lasting because the contractor would likely need to sell through the stock of energy efficient equipment if the program's influence went away.

If, over time, manufacturers and contractors only offered energy efficient systems due to high adoption and lower barriers, the savings above the original baseline would be considered **market transformation**. If market transformation has occurred, then the barriers to adoption of energy efficient equipment have been reduced to the point where the program no longer needs to intervene to increase adoption.

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[3] PY2013-14 California Statewide Residential Spillover Research Plan. Prepared by Opinion Dynamics Corporation for the California Public Utilities Commission Energy Division. September 18, 2014.

[4] In Version 5 of the EE Policy Manual, this definition is given for the term "market effects."

[5] This conceptualization of SO aligns with recent work by Prahl and coauthors (Prahl, Ridge, Hall, and Saxonis, 2013).

[6] Decision (D.)09-09-047 defines market transformation as "long-lasting, sustainable changes in the structure or functioning of a market achieved by reducing barriers to the adoption of energy efficiency measures to the point where continuation of the same publicly-funded intervention is no longer appropriate in that specific market."

Thus defined, conceptually, market effects are a subset of spillover and market transformation is a subset of market effects. However, market effects and market transformation have greater duration than other kinds of spillover and thus may have a greater cumulative magnitude. Spillover is inclusive of both market effects and market transformation but the latter have longer time dimensions. Market transformation, specifically, is permanent and lasting and—at least in theory—goes on into perpetuity.

This spillover study focuses on spillover that is perceived by end-users (i.e., residential and nonresidential customers). Given this focus, the study likely excludes some market effects, as there are bound to be market effects that end-users are not well positioned to observe.[7]

For example, an individual end-user can self-report that which they have experienced personally, but they may not be in a good position to report on larger, more pervasive structural changes in the market. Even if an end-user credits a program contractor with their decision to install an energy efficiency measure outside of the program which, in some way, could be associated with market effects, they are still conveying their individual experience at a specific moment in time. The contractor may be in a better position to speak to meaningful structural changes in the energy efficiency markets given their presence in those markets over-time, but the individual end-user is not so well equipped.

As such, by generally not accounting for market effects in our calculation of spillover, the evaluation team acknowledges that our spillover estimates likely constitutes a lower bound for overall spillover.

This study includes both end-user perceived *participant* spillover and *nonparticipant* spillover. *Participant spillover* occurs when a customer who installed a high efficiency measure under an IOU program installs another high efficiency measure outside of the program as a result of their interaction with the program. *Nonparticipant spillover* occurs when a customer, exposed to and influenced by a utility rebate program, installs a high efficiency measure without participating in the program.

The spillover rate is calculated as follows. The *numerator* represents spillover savings and the denominator represents overall program savings.

$$Spillover\ Rate = \frac{Spillover\ Savings}{Program\ Savings}$$

2.3 Participant Spillover Data Collection

The study team collected participant spillover data from phone surveys with Program Year (PY) 2013-2014 program participants. These surveys established: 1) past program participation; 2) installation of energy efficient measures after program participation; 3) installation of these measures outside the program; 4) program influence on measure installations; and 5) other information needed to calculate savings.

For the residential study, the team conducted 1,604 phone surveys with households sampled from the PY2013-2014 statewide program claims database. For the nonresidential study, 1,831 phone surveys were conducted with participants contacted as part of other ongoing program evaluations.

[7] The changes in the structure of a market (market effects) can bring about additional energy efficient purchases. Market effects are not part of this study but are the focus of several targeted market effects studies carried out in separate CPUC Energy Division efforts. These efforts are tailored to specific markets which cannot be easily accommodated as part of an overarching global spillover study.

Table 2. Participant Spillover Data Collection Summary

	Residential	Nonresidential
Description	Telephone survey of PY2013-2014 residential utility program participants	Telephone survey as part of ongoing nonresidential energy efficiency program evaluations
Source	PY2013-2014 statewide program claims database	IOU tracking data for PY2013-2014 nonresidential energy efficiency programs
Sample Frame	677,856 California households	106,117 California nonresidential sites
Completed Interviews	1,604 California households	1,831 California nonresidential sites
Notes	Population does not include residential programs already claiming spillover and those with contact information not available at the end-user level	Also leveraged information from recent commercial saturation[8] and market share tracking studies

2.4 Nonparticipant Spillover Data Collection

Both the residential and nonresidential studies used data from past studies to identify if spillover measures might exist before contacting a household or business. In both cases, the study team identified: 1) when the equipment was installed; and 2) if it was high efficiency, and if the customer did not participate in any IOU program during the PY2010-2012 period.

For the residential sector, we used past studies to identify 724 nonparticipating households that had potential spillover measures and completed surveys with 197 of these households. The surveys verified the spillover measures and attributed program influence in the decision to install the measure. For the nonresidential study, we conducted 125 phone surveys with potential spillover sites identified using existing data.

[8] Saturation studies are research efforts to determine what types and quantities of equipment are present in residential or commercial facilities.

Table 3. Nonparticipant Spillover Data Collection Summary

	Residential	Nonresidential
Description	Telephone/internet survey with households audited as part of a recent saturation study[9]	Telephone survey with facilities contacted as part of recent saturation and market share tracking studies
Source	2010-2012 CLASS[10]	2010-2012 CSS/CMST[11,12]
Sample Frame	724 nonparticipating California homes where potential spillover measures exist	253 nonparticipating California sites where potential spillover measures exist
Completed Interviews	197 completed interviews	125 completed interviews
Notes	Results also include 268 homes ruled out for possible spillover savings due to either installation date or measure efficiency level	Included lighting, HVAC, refrigeration, and energy management system (EMS) measures

2.5 Results

2.5.1 Participant Spillover

Table 4 presents the residential and nonresidential participant lifecycle spillover savings and spillover rate for electric and gas savings. In terms of electric spillover savings (MWh), this study estimated participant spillover rates of 1.4% for the residential sector and 0.7% for the nonresidential sector. For example, this means that the energy efficiency portfolio achieved an additional 1.4% (totaling 126.3 GWh in lifecycle savings) in electric savings from additional installations of energy efficiency measures by residential program participants that were not rebated through the program but can be attributed to program effects. In terms of gas spillover savings (therms), this study estimated a participant spillover rate of 33.8% for the residential sector and a rate of 0.2% for the nonresidential sector.

[9] Saturation studies are research to determine what types and quantities of equipment are present in residential or commercial facilities.

[10] California Lighting and Appliance Saturation Study. KEMA, Inc. May 21, 2014

[11] *California Commercial Saturation Survey*, Prepared for the California Public Utilities Commission, Itron, August 2014.

[12] *California Commercial Market Share Tracking Study*, Prepared for the California Public Utilities Commission, Itron, November 2014

Table 4. Participant Spillover Results

Lifecycle Participant Spillover (2013-2014)	Electric Savings (GWh)			Gas Savings (Therms, Thousands)		
	Residential	Nonresidential	Total	Residential	Nonresidential	Total
Total Spillover Savings	126.0	118.0	244.0	28,280.3	1,326.9	29,607.3
Total Program Savings	8,902.9	16,759.0	25,661.9	83,619.3	630,951.6	714,570.9
Rate	1.4%	0.7%	1.0%	33.8%	0.2%	4.1%

A challenge for estimating natural gas spillover savings for both the residential and nonresidential sectors is that spillover savings and program savings (both the numerator and the denominator in the spillover savings equation) includes the impact of interactive effects.[13] Interactive effects for electric measures often result in a "therm penalty," or a decrease in overall therm savings.

Because residential electric-focused energy efficiency programs in California are relatively large in comparison to residential natural gas-focused programs, the end result is that overall program natural gas savings are relatively low, due to substantial therm penalties from much larger electric programs offsetting the achieved gas savings. Furthermore, the high natural gas spillover rate for the residential sector appears to be due to "cross-fuel effects" resulting from the coexistence of relatively small gas programs with much larger electric programs. These effects manifest when a customer participates in an electric program and is induced to purchase a non-program gas measure.[14] This results in a higher than expected spillover rate as a result of gas spillover savings that are achieved by customers who did not achieve any gas program savings. In addition, overall gas program savings are relatively low due to interactive effects.

2.5.2 Nonparticipant Spillover

Table 5 shows residential and nonresidential nonparticipant spillover savings and spillover rate for lifecycle electric and gas savings. In terms of electric savings (MWh), we estimated a nonparticipant spillover rate of 0.2% for the residential sector and 6.0% for the nonresidential sector. In terms of gas spillover savings (therms), this study estimated a nonparticipant spillover rate of 21.7% for the residential sector and -0.7% for the nonresidential sector. For example, this means that the energy efficiency portfolio achieved an additional 0.2% in electric savings (totaling 66.9 GWh) from additional installations of energy efficiency measures by program nonparticipants that were not rebated through the program but can be attributed to program effects.

[13] Interactive effects are increases or decreases in the use of one fuel that are a "side effect" of an energy efficiency measure of another fuel. For example, CFLs produce less heat than regular incandescent light bulbs and, therefore, installing CFLs to replace incandescent bulbs, while saving electricity, can result in increased natural gas use for heating.

[14] We considered cross-fuel effects from two perspectives. First, analysis of cases of residential natural gas participant spillover showed that the vast majority of spillover savings (both kWh and therms) were from participants of either electric-only programs or dual fuel programs with heavy focus on electric measures. Second, the ratio of electric savings to gas savings is much greater for the residential sector than for the nonresidential sector, suggesting that there is more potential for cross-fuel effects in the residential sector.

Table 5. Nonparticipant Spillover Results

Lifecycle Nonparticipant Spillover (2010-2012)	Electric Savings (GWh)			Gas Savings (Therms, Thousands)		
	Residential	Nonresidential	Total	Residential	Nonresidential	Total
Total Spillover Savings	66.9	1,546.2	1,613.1	67,207.8	-4,097.7	63,110.1
Total Program Savings	28,039.3	25,947.6	53,986.9	309,361.5	628,225.0	937,586.5
Rate	**0.2%**	**6.0%**	**3.0%**	**21.7%**	**-0.7%**	**6.7%**

As with the participant spillover results, the nonparticipant gas spillover rates are influenced by two additional factors: 1) the inclusion of therm penalties from interactive effects (e.g., CFLs produce less heat than regular incandescent light bulbs and, therefore, more therms are used to heat homes with natural gas heating), and 2) cross-fuel effects resulting from the coexistence of small residential gas programs and much larger residential electric programs.

2.5.3 Aggregated Statewide Spillover Results

The following table presents the results for participant and nonparticipant spillover with confidence intervals at 90% confidence.[15] Because spillover is not common and there is high variability in spillover savings, the precision around these estimates is relatively low, resulting in large confidence intervals.

Table 6. Spillover Rate Summary with Confidence Intervals at 90% Confidence

	Electric Savings (MWh)		Gas Savings (Therms)	
	Residential	Nonresidential	Residential	Nonresidential
Nonparticipant Spillover (2010-2012)	0.2% ± 0.3%	6.0% ± 3.9%	21.7% ± 31.2%	-0.7% ± 0.6%
Participant Spillover (2013-2014)	1.4% ± 1.2%	0.7% ± 0.3%	33.8% ± 39.6%	0.2% ± 0.2%
Total Spillover	**1.7% ± 1.2%**	**6.7% ± 3.9%**	**55.5% ± 50.4%**	**-0.4% ± 0.7%**

2.6 Recommendations to Policy Makers

This study demonstrates that spillover is real and varies across several important factors. In Decision 12-11-015 (D.12-11-015), the CPUC set in place a global 5% market effects adjustment value for the entire energy efficiency portfolio, including both residential and nonresidential sectors. Our study indicates that spillover varies significantly across program participants and nonparticipants and, within these groups, by sector and fuel type.

Given the variability in spillover observed among programs and measures, we recommend that program-specific spillover research be completed in the future and, as these studies are completed, the global participant spillover values applied by the IOUs be replaced with program-specific values. **Until program-**

[15] This means that there is a 90% probability that the true value falls between these two values.

specific research is conducted, the study team sees no basis to recommend changes to the current adopted market effects adjustment that the IOUs continue to use – the current 5% market effects adjustment value. It is important to note that the spillover savings rates developed from this study are not dramatically different from this adjustment at the portfolio level given the wide confidence intervals. Again, this research establishes that spillover exists and can vary quite significantly at the sector, fuel type and participant/nonparticipant level. While the evaluation team recommends careful consideration of the research conducted for this study when planning for future program activity, there are several important limitations to this study that preclude any recommendation to apply the specific quantitative spillover estimates developed in this research effort:

- As described in Section 2.2, the scope of spillover studied within this evaluation was limited to spillover perceived by end-users and did not include the overall impacts of market effects and market transformation. The methodology employed within this evaluation focused on a participant's experience with or a nonparticipant's knowledge of utility programs at a specific moment in time. This study did not include other types of program participants like contractors, builders, and architects – individuals in a better position to speak to meaningful structural changes in energy efficiency markets given their presence in those markets over time.

- As with any spillover study, we may not have captured all potential spillover due to the timing of the survey. In some cases, the length of time between the spillover activity and the survey may result in respondents' lack of recollection of the project or the program's influence on it.

- In other cases, not enough time may have passed for the respondent to implement all planned spillover activities. Energy efficiency projects often have lead times of several years and not all potential spillover projects may have been captured within the timeframe of this evaluation.

- Due to methodological decisions, this study did not directly cover all programs offered by IOUs:

  - This study does not cover codes and standards programs for both the residential and nonresidential sectors. The study team believes there is no direct causal effect for spillover from codes and standards programs from the end-user perspective because these target builders and code officials and the residential or nonresidential end-user would likely be unaware of the programs' interventions. While some additional savings may result from these programs, residential and nonresidential customers are not direct "participants" in these programs and therefore a participant spillover survey is not the appropriate method by which to assess these effects.

  - The residential participant survey excluded programs without contact information at the residential end user level from the sample. The claims database does not contain the necessary contact information to contact participants of programs such as multifamily, school-based, and new construction programs, as well as non-lighting upstream programs. While we did not survey participants of these programs, we applied the estimated spillover rate derived from other programs to these programs, and the true spillover rate may be higher or lower than the overall rate applied.

  - In order to minimize the amount of participant contact, the nonresidential participant survey questions were added only to surveys concurrently conducted on behalf of the nonresidential impact evaluations in 2013-14. This study relied upon samples developed on behalf of these evaluations. These studies were not developed at the program level, but addressed specific end-uses (e.g. Nonresidential Downstream Custom Lighting, Deemed Lighting, and Deemed Non-Lighting Impact Evaluation) or segments of the nonresidential sector (Industrial, Agricultural, and Large Commercial Evaluation) rather than a specific program. While those impact studies encompassed a significant percentage of portfolio level nonresidential lifecycle energy savings (81%), inherently some measures and programs were not included as a result. The spillover rate generated from the population of measures and market segments studied within the context of those impact evaluations was applied to the remainder of the nonresidential portfolio not studied. Spillover savings from these non-studied measures and market segments may not be similar in structure to those studied which could result in a larger or smaller overall spillover rate had the entire population of nonresidential measures and programs been evaluated as part of those impact evaluations.

- This was also true for the nonresidential nonparticipant study. While having access to the data from the CSS/CMST was unprecedented in terms of the quality of data available, the spillover study was limited to the specific end-uses and market segments studied in the CSS/CMST. Similar to the nonresidential participant spillover study, the spillover savings generated from nonparticipant spillover were compared to program-level savings excluding the specific end-uses and market segments mentioned above, but the spillover rate was ultimately applied to the whole population of nonresidential portfolio savings. If the magnitude of spillover within those segments is less than that of those studied, the overall spillover rate for nonparticipants would be less than what was developed for this study (and vice versa).

- The application of the spillover rates determined through this research is most pertinent to future program portfolios that have similar characteristics to the portfolio of programs studied here. As with any prospective research, if the mix of measures/programs included in future portfolios and their relative contribution to overall portfolio savings should shift significantly, this research may become less pertinent and less applicable.

- The study leveraged existing baseline research (i.e., the CLASS and CSS/CSMT studies) for the nonparticipant spillover research because using data collected onsite by trained auditors decreased the uncertainty around characteristics of the installed equipment and, therefore, the spillover savings (i.e., it reduced measurement error). However, utilizing these studies constrained our sample sizes for nonparticipant research, which, coupled with the low incidence of NPSO, led to lower levels of precision due to sampling error.

- This study explores the savings from equipment installed outside of IOU programs (i.e., the benefits), but the scope did not include researching the impact of the costs of this equipment on the customer or the portfolio's cost effectiveness. Under the total resource cost (TRC) test, the cost of a spillover measure must be accounted for as well as its benefits. Because the mix of spillover measures differs from the mix of measures in the portfolio (along with their respective benefit/cost ratios), it is not correct to apply the same multiplier to the portfolio's costs and benefits. Further, if the benefit/cost ratio of the spillover measures is significantly different than the portfolio's, then applying the actual costs of the spillover measures could have significant effects on portfolio's TRC results.

2.6.1 Considerations for Future Research

Given the variability in spillover observed among programs and measures, this study recommends that program-specific spillover research be completed in the future and that the global participant spillover values found here be refined with program-specific values. This study recommends the prioritization of future research for programs with high contributions to portfolio savings and for programs with high propensity for spillover (i.e., programs with high levels of customer contact and large customer investment). Additional findings that are worthy of future research include:

- **Complete spillover research as part of future program-specific impact evaluations.** While the statewide research approach provides reliable estimates of participant and nonparticipant spillover at the portfolio level, a number of study findings in the residential sector point toward the need to conduct participant spillover research on a program-by-program basis. For example, residential customers who participated in programs requiring a large customer investment and high customer contact had a higher propensity to take spillover actions than did customers who participated in programs that did not have these characteristics.

- **Conduct further research on cross-fuel effects resulting from the coexistence of small residential natural gas programs with relatively large residential electric programs.** High residential natural gas spillover rates occur when large electric programs, in tandem with few incentives with natural gas measures, create cross-fuel effects. This typically occurs when a household participates in an electric program but is induced to purchase a natural gas measure outside of a program. Therefore, future spillover research should address electric and natural gas fuel types as well as interactive effects.

- **Continue market effects research.** Market effects are a subset of spillover savings that reflect meaningful changes in the structure or functioning of energy efficiency markets. In order to form a complete picture of spillover, additional research on market effects is needed. Such research has to be tailored to a specific market which cannot be easily accommodated as part of an overarching global spillover study.

- **Complete cross-cutting non-participant research on a two- or three-year cycle.** Since nonparticipant research is global in nature, such research should be repeated on a frequent basis at a global level.

Given these findings and the global nature of this research, the unique issues associated with individual programs may not have been fully captured. Future research conducted at a program-specific level can address these issues and provide program-level spillover rates with greater precision.

3. Overview

This section provides a high-level overview of the California Statewide Residential and Nonresidential Spillover Study. The primary objective of this study is to quantify the amount of participant (PSO) and nonparticipant spillover (NPSO) savings that occur in California markets and to develop methods by which these savings can be captured and applied to the net savings claims for these programs. This study is comprised of two jointly-conducted studies – the residential study conducted by Opinion Dynamics and the nonresidential study conducted by Itron, Inc.

3.1 Background and Policy Context

The primary objective of this study is to conduct a comprehensive study in order to quantify and assess the levels of potential spillover savings that are being generated within California energy efficiency programs as well as those being claimed by California IOUs. Within the 2004-2012 period, the California Public Utilities Commission (CPUC) did not permit the IOUs to count spillover savings toward program and administrator goals and performance, including cost-benefit analyses. As such, few recent impact evaluations in California have attempted to estimate participant spillover or nonparticipant spillover.[16]

However, in 2012, the CPUC decided to include spillover effects to the extent that they can be quantified so as to better reflect the broader impact of programs. CPUC Decision (D.12-05-015) permits the IOUs "*to present estimates of market effects or 'spillover' that may result for their proposed programmatic activities, and propose the inclusion of spillover effects in their cost effectiveness analyses and results. This may be at either the program or portfolio level*". As a result of that decision, the IOUs submitted spillover estimates that were based on past market effect studies from California and studies from other states, thus resulting in a proposed spillover factor of 10% for some program within the portfolio. After reviewing the logic and theory of energy efficiency programs in the 2013–2014 cycle as well as secondary studies of spillover savings in California, New York and other states, the CPUC determined that the estimates were dated and may not be appropriate for California and released D.12-11-015, which authorized a "…portfolio-level 'market effects adjustment' of 5% to the entire 2013-2014 portfolio cost-effectiveness calculation…" in lieu of the 10% savings estimate. The decision also committed evaluation funds to develop research and estimates of spillover effects. This study is the outcome of that decision.

3.2 Goals and Objectives

The goal of this study is to develop statewide spillover estimates for the residential and nonresidential sectors in California and, based on the findings, provide recommendations that can further target and quantify spillover through future program planning.[17] The study provides portfolio-level spillover values from data collection efforts for both program participants and nonparticipants which are combined in order to arrive at

[16] For example, in the 2010-2012 evaluation of Custom programs, PSO was quantified but NPSO was not. Data collected as part of the 2010-2012 Downstream Lighting Evaluation have also been used to quantify participant like spillover.

[17] While the study team compared the results to the 5% planning assumption for context, we did not intend for the study to be a hypothesis testing exercise to assess whether we can reject the null hypothesis of a 5% spillover rate. We believe this approach was supported in Decision 12-11-015, in which the CPUC noted that the 5% "market effects adjustment" was only a placeholder value until further research could be conducted and described in several places a desire to avoid "false specificity and accuracy in this important area when the appropriate research and data does not yet exist."

a single portfolio-level spillover value. As such, the study yields portfolio-level estimates for both participant and nonparticipant spillover as well as a single (combined) portfolio level estimate for each sector. It is the discretion of the Commission to decide whether or not and how these spillover estimates will be applied.

Accordingly, this study has set the following objectives to address this goal.

- To determine what energy efficient measures are being installed without use of program incentives,
- To estimate the amount of savings that results from these measures, and
- To estimate the percent of those savings that can be attributed to program interventions (i.e., spillover from the program).
- Additionally, to the extent possible, the study seeks to understand why customers install/purchase energy efficient measures without program incentive or rebate support.

3.3 Definition of Spillover

Spillover refers to energy savings caused by the presence of an energy efficiency program that is not captured by the program. The CPUC 2006 Energy Efficiency Evaluation Protocols[18] defines spillover as:

> "Reductions in energy consumption and/or demand in a utility's service area caused by the presence of the DSM program, beyond program related gross or net savings of participants. These effects could result from: (a) additional energy efficiency actions that program participants take outside the program as a result of having participated; (b) changes in the array of energy-using equipment that manufacturers, dealers and contractors offer all customers as a result of program availability; and (c) changes in the energy use of non-participants as a result of utility programs, whether direct (e.g., utility program advertising) or indirect (e.g., stocking practices such as (b) above or changes in consumer buying habits)."

In contrast to "free ridership" that deducts from gross savings the savings that are not attributable to the program, the spillover effects add back in the extra savings that are not claimed by the program but are directly or indirectly attributable to the program.

This study includes both *participant* spillover and *nonparticipant* spillover that are not due to larger structural changes in the market.[19]

[18] California Energy Efficiency Evaluation Protocols. April 2006.

[19] The changes in the structure of a market (market effects) can bring about additional energy efficient purchases. Market effects are not part of this study but are the focus of several targeted market effects studies carried out in separate CPUC Energy Division efforts. These studies include: 1) Final Phase I Report: Baseline Characterization Market Effects Study of Investor-Owned Utility Multifamily Residential New Construction Programs in California. NMR Group, Final Report. 7/8/2014. CALMAC Study ID: CPU0089.01; 2) Baseline Characterization Market Effects Study of Investor-Owned Utility Residential and Small Commercial HVAC Quality Installation and Quality Improvement Programs in California (Work Order 054). NMR Group, Final Report. 1/14/2015. CALMAC Study ID: CPU0102.01; 3) Final Report: Baseline Characterization Market Effects Study of Investor-Owned Utility Programs to Support LED Lighting in California. KEMA, Inc. 6/4/2014. CALMAC Study ID: CPU0074.01; and 4) Final Report: Baseline Characterization Market Effects Study of Investor-Owned Utility Whole House Retrofit Programs in California. KEMA, Inc. 7/18/2014. CALMAC Study ID: CPU0073.01.

- *Participant spillover* occurs when a customer who installed a high efficiency measure under an IOU program installs another high efficiency measure outside of the program as a result of their interaction with the program. An example of this would be a customer that completes an HVAC upgrade through the program and then, based on that experience, decides to complete a lighting upgrade without the receipt of an IOU program incentive.

- *Nonparticipant spillover* occurs when a customer installs a high efficiency measure but has not participated in a utility rebate program. This could result from their increased awareness or understanding of energy efficient equipment (as a result of program outreach, education, or communications). An example of non-participant spillover would include a customer who chooses to install high efficiency lighting after his neighbor remarks positively about the high efficiency lighting she installed as a program participant.

In short, participant spillover refers to the spillover that results from customers who previously participated in an IOU incentive program, whereas nonparticipant spillover refers to the spillover that results from customers who did not participate but were otherwise exposed to a program (and influenced by it).

One of the biggest challenges to estimating spillover is differentiating savings due to spillover from savings that may accrue from market effects.[20] The evaluation team understands that there is neither a universal agreement on how spillover and market effects are different nor where a clear dividing line may be between the two. The working definition of spillover that is being used for this study[21] is based on the 2006 EM&V Protocols and the EE Policy Manual Version 4, which defines spillover as "reductions in energy consumption and/or demand in a utility's service area caused by the presence of a Demand-Side Management (DSM) Program, beyond program-related gross or net savings of participants."

Given the lack of consistent terminology used and in order to outline what is (and what is not) included in this spillover study, it is important to start with a conceptual framework[22] for the relationship between spillover, market effects, and market transformation. Our discussion of what is (and is not) included in this spillover study relies on the following conceptual framework, based on the 2006 EM&V Protocols:

> **Spillover** = reductions in energy consumption and/or demand in a utility's service area caused by the presence of a Demand-Side Management (DSM) Program, beyond program-related gross or net savings of participants.
>
> **Market Effects** = spillover savings that reflect meaningful changes in the structure or functioning of energy efficiency markets.

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[20] These changes in the structure of a market (market effects) can bring about additional energy efficient purchases, but are the focus of targeted market effects studies.

[21] PY2013-14 California Statewide Residential Spillover Research Plan. Prepared by Opinion Dynamics Corporation for the California Public Utilities Commission Energy Division. September 18, 2014.

[22] This conceptualization of SO aligns with recent work by Prahl and coauthors (Prahl, Ridge, Hall, and Saxonis, 2013).

Market Transformation = market effects that are substantial and long lasting.[23]

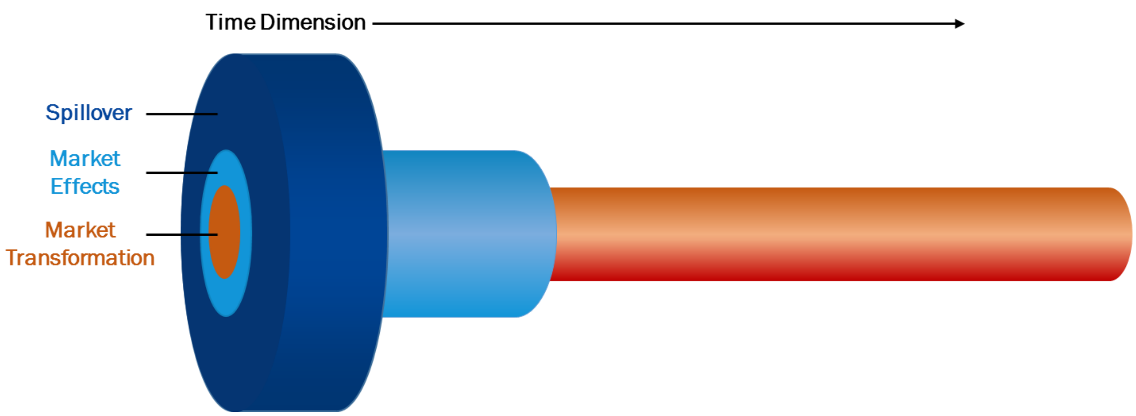
For example, consider a residential customer who participates in the Energy Upgrade California program and receives a rebate when purchasing a high efficiency central AC system. If this customer**, influenced by their experience participating** in the program, purchased other energy efficient equipment and **did not receive a rebate** for that measure (either due to lack of a rebate or for other reasons), the savings from that additional measure would be considered participant **spillover**. This is a relatively short-lived impact because it is caused by the program's influence on the customer at the decision point.

If that customer's HVAC contractor, spurred on by high sales of energy efficient systems from program participants, decided to change their stocking practice to only carry high efficiency systems, then the savings from those high efficiency systems that were not rebated by the program, would be considered **market effects**. The impact of market effects is longer lasting because the contractor would likely need to sell through the stock of energy efficient equipment if the program's influence went away.

If, over time, manufacturers and contractors only offered energy efficient systems due to high adoption and lower barriers, the savings above the original baseline would be considered **market transformation**. If market transformation has occurred, then the barriers to adoption of energy efficient equipment have been reduced to the point where the program no longer needs to intervene to increase adoption.

Thus defined, conceptually, market effects are a subset of spillover and market transformation is a subset of market effects. However, market effects and market transformation have greater duration than other kinds of spillover and thus may have a greater cumulative magnitude. Spillover is inclusive of both market effects and market transformation but the latter have longer time dimensions. Market Transformation, specifically, is permanent and lasting and—at least in theory—goes on into perpetuity.

Figure 1.Visual Depiction of Spillover, Market Effects, and Market Transformation



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[23] Decision (D.)09-09-047 defines market transformation as "long-lasting, sustainable changes in the structure or functioning of a market achieved by reducing barriers to the adoption of energy efficiency measures to the point where continuation of the same publicly-funded intervention is no longer appropriate in that specific market."

This spillover study focuses on spillover that is perceived by end-users (i.e., residential and nonresidential customers). Given this focus, the study likely excludes some market effects, as there are bound to be market effects that end-users are not well positioned to observe.[24]

For example, an individual end-user can self-report that which they have experienced personally, but they may not be in a good position to report on larger, more pervasive structural changes in the market. Even if an end-user credits a program contractor with their decision to install an energy efficiency measure outside of the program which, in some way, could be associated with market effects, they are still conveying their individual experience at a specific moment in time. The contractor may be in a better position to speak to meaningful structural changes in the energy efficiency markets given their presence in those markets over-time, but the individual end-user is not so well equipped.

As such, by generally not accounting for market effects in our calculation of spillover, the evaluation team acknowledges that our spillover estimates likely constitutes a lower bound for overall spillover.

3.4 Data Sources and Sample Development

3.4.1 Participant

Data Sources

Both residential and nonresidential spillover research leveraged phone surveys with PY2013-2014 program participants.

The residential participant spillover research used a participant phone survey with PY2013-2014 residential program participants to assess spillover. We used the PY2013-2014 statewide program claims database to draw a sample of households that installed energy efficient program measures in PY2013-2014.

The nonresidential participant spillover research leveraged participant phone survey data that was collected on behalf of the PY2013-2014 Nonresidential Downstream Impact Evaluations (conducted under the Commercial Roadmap) and the Custom Impact Evaluations (conducted under the Industrial, Agricultural and Large Commercial Roadmap). These studies are collectively referred to as the nonresidential impact evaluations. A secondary objective was to research potential nonresidential participant spillover using data that was collected from PY2010-2012. These data sources, sample development and data collection methods are discussed in more detail below under the nonparticipant section. These data were ultimately included in the evaluation based on the fact that: a) the data were readily available; b) the same methodology was being used to assess potential spillover from PY2010-2012 nonparticipants; c) it allowed for a comparison and frame of reference to the PY2013-2014 participant spillover study.

Sample Development

The evaluation team drew a sample for the residential participant spillover survey from the PY2013-2014 statewide program claims database. It was necessary to conduct extensive cleaning of the program claims data to develop a final sample frame from which we could draw a sample for fielding the residential participant

[24] The changes in the structure of a market (market effects) can bring about additional energy efficient purchases. Market effects are not part of this study but are the focus of several targeted market effects studies carried out in separate CPUC Energy Division efforts. These efforts are tailored to specific markets which cannot be easily accommodated as part of an overarching global spillover study.

survey. The team's overarching goal was to draw a sample that represented the varied programs and participants in the 65 programs in the residential portfolio and to do so in a cost-effective manner. Our sampling methods are described in depth in Appendix C and Appendix D. For various reasons, we could not include all 65 residential programs in our sample frame. Our final sample frame included 37 programs.

For nonresidential participant spillover, in order to minimize the amount of customer contact, spillover survey questions were added to the surveys that were already being conducted on behalf of the nonresidential impact evaluations – the Nonresidential Downstream Impact Evaluations (COM) and the Industrial, Agricultural and Large Commercial (IALC). Collectively, COM and IALC represent a wide variety of end-uses and segments of the nonresidential sector and account for roughly 60% of total portfolio-level ex post lifecycle MWh savings throughout PY2013-2014.[25]

Data Collection

We conducted phone interviews with 1,604 PY2013-14 IOU program participants to estimate residential participant spillover. We conducted the surveys in two waves between January 15th and March 23rd, 2016.

We conducted phone interviews with 1,831 PY2013-14 IOU program participants to estimate nonresidential participant spillover. These surveys were conducted for both the 2013 and 2014 COM and IALC impact evaluations.

The phone interviews collected data to accomplish the following:

- Establish past program participation
- Establish installation of self-reported energy efficient measures after program participation
- Establish that these measures were installed outside of the program
- Determine program influence on measure installations
- Collect information to support savings calculations for program-influenced measures

For residential spillover, the survey was conducted in two waves to accomplish several objectives: to maximize precision, to limit survey fielding costs, and to test hypotheses about which programs are most likely to produce spillover and allow an opportunity to refine our sampling strategy midway as needed. We oversampled programs with a small number of participants to ensure that the study represents a variety of programs.

For nonresidential spillover, the survey was conducted to meet the evaluation requirements for the COM and IALC studies in 2013 and 2014. Additional surveys were administered in Q1 2015 to increase the total number of phone survey completes. Follow-ups engineering interviews were conducted for all potential non-lighting spillover measures (select lighting measures also required a callback given an omission of quantity installed by the respondent or to confirm a large quantity installed). Finally, on-site visits were conducted on several sites where the follow-up interview provided corroborating but insufficient evidence or information regarding the self-reported installation.

[25] This percentage does not include savings that derive from Codes and Standards programs.

Attribution

Both the residential and nonresidential studies used the same attribution threshold to determine program influence and therefore spillover for participants. If a respondent reported installing a self-reported energy efficient measure without program assistance after participating in an IOU energy efficiency program, we then asked questions designed to determine if the energy efficient purchase or improvement could qualify as spillover. To assess this, we asked all respondents the following open-ended question: “Why did you make this energy efficient purchase or energy efficient home improvement?” Respondents who did not explicitly mention IOU program influence in the open-ended question were then asked if their experience with the IOU program encouraged them “in any way” to make the energy efficient purchase or energy efficient home improvement. If the response was yes (or if they previously explicitly mentioned program influence), they were asked to rate the IOU program influence on a scale of 0 to 10, where 0 is no influence and 10 is a great deal of influence. Measures for which a respondent gave an influence rating of seven or higher were considered to be program-influenced.[26]

Note that this threshold differs from the spillover threshold for nonparticipants, in which we awarded nonparticipant spillover to respondents who gave a rating of five or greater. We used the higher threshold of seven or greater because participants, by virtue of their past participation, are already inclined to seek out energy efficient products and are aware of utility programs and therefore require a higher attribution threshold.

3.4.2 Non-Participant

Data Sources

Both the residential and nonresidential studies leverage past baseline study research to allow us to understand what potential spillover measures might exist in advance of contacting nonparticipants.

The residential nonparticipant spillover research leverages data from the 2010-2012 California Lighting and Appliance Efficiency Saturation Study (CLASS) conducted by DNV GL.[27] This study conducted site visits in 2012 on a stratified sample of 1,987 single family, multifamily, and mobile home residences with individually metered electric accounts in the PG&E, SCE, and SDG&E service territories.

The site visits collected information on home characteristics and energy-using equipment, such as lighting, HVAC equipment, appliances, and electronics, as well as building envelope measures. Trained auditors collected relevant equipment characteristics, including quantity, fuel type, efficiency rating, and age.

The evaluation team used information from the CLASS data to develop the sample of households with potential nonparticipant spillover savings. Whereas traditional spillover studies depend on respondents’ self-report of the presence of energy efficient equipment, by basing the sample on information gathered through the CLASS

[26] In addition to a rating of seven or higher, two other decision rules were used to identify cases of spillover: 1) participants who mentioned the utility program, unprompted, in the initial open ended question were considered influenced if they provided a score of five (5) or higher on the influence scale question; and 2) Participants who initially said that their participation in the utility program did not encourage them “in any way” to make the energy efficient purchase or energy efficient home improvement, but later reversed course by indicating they were highly unlikely (3 or less on a likelihood scale of 0 to 10) to have made the additional energy efficient purchase or energy efficient home improvement had they not participated in the utility program, were also considered influenced.

[27] Final Report: WO21: Residential On-site Study: California Lighting and Appliance Saturation Study (CLASS 2012). KEMA, Inc. May 21, 2014

site visits we knew the equipment present in each home at the time of the site visit. Because the site visits were conducted by trained auditors, the CLASS data also provides information on equipment characteristics from which energy savings can be calculated.

The approach used in developing nonresidential nonparticipant spillover estimates (as well as participant) leveraged the comprehensive on-site equipment inventories of over 1,500 commercial premises in California that were conducted as part of the 2010-2012 Commercial Saturation Survey[28] (CSS) and the Commercial Market Share Tracking Survey[29] (CMST). The main goal of the CSS study was to capture the baseline of equipment in buildings, whereas the main goal of the CMST study was to track the market share of select energy-efficiency measures.

The CSS/CMST surveys drew upon overlapping samples to collect data regarding the year of installation, quantity installed, and the make/model information from many end uses within the facility. The CSS study analyzed the baseline of electric equipment of food stores, liquor stores, medical clinics, offices, restaurants, retail, schools, warehouses and other miscellaneous businesses. The CSS did not include hotels, hospitals, industrial businesses, agriculture or colleges and universities. The on-site data collected on behalf of the CMST study included the same businesses types surveyed for the CSS but also included a limited number of hotels, hospitals, industrial businesses, and colleges/universities. Agriculture was not included in the CMST data collection effort.[30]

Sample Development

DNV GL designed the CLASS sample to represent the entire population of residential IOU electric customers. As such, the CLASS data contained some households that are not eligible for nonparticipant spillover. We developed the NPSO sample eligible for our study, at the site level, by removing low-income households as well as households that participated in IOU programs during the PY2010-2012 cycle. After removing these households, we identified a population of interest including 992 homes in the CLASS database.

Out of this population, we reviewed available CLASS data to determine which homes had measures that could potentially be a result of spillover. We included homes with potential spillover measures in our sample.

The CSS/CMST on-site data were analyzed to identify any customers who had installed new measures, regardless of efficiency level. This analysis focused on four end-uses: lighting, HVAC, refrigeration measures and energy management systems (EMS). The following measures were analyzed to determine if the newly installed measure was high-efficiency:

- **Lighting:** linear fluorescents, LEDs, compact fluorescents, lighting controls
- **HVAC:** chillers, furnaces, package single zone systems, split-system single zone systems, package terminal units, evaporative coolers, central plant

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[28] *California Commercial Saturation Survey*, Prepared for the California Public Utilities Commission, Itron, August 2014.

[29] *California Commercial Market Share Tracking Study*, Prepared for the California Public Utilities Commission, Itron, November 2014

[30] For more information, see Appendix B of the 2013-14 Nonresidential Spillover Study research plan, Prepared for the California Public Utilities Commission, Itron, January 16, 2015.

- **Refrigeration:** auto-closers, case lighting, condensers, refrigerators, freezers, strip curtains, night covers, refrigeration motors, controllers
- **EMS:** any applicable EMS measures

After identifying newly installed measures, equipment efficiency levels were determined by using the make and model numbers collected from the CSS/CMST studies to search in energy efficiency databases. The new equipment was then classified as high efficiency based on information gathered on site in combination with the make and model number lookup.[31]

IOU program tracking data was then referenced to: a) confirm that the high-efficiency measure purchased during the 2010-12 period did not receive a rebate from an IOU program; b) if the customer did not receive a rebate for the measure, the tracking data was referenced to determine if the customer received any IOU energy-efficiency rebates or services during the PY2010-12 period. The participant and nonparticipant samples were drawn from this determination of program participation – 253 nonparticipants and 282 participants.

Data Collection

For residential spillover, we conducted a mixed-mode telephone and internet survey with 724 residential households where potential spillover measures exist and completed 197 interviews. For nonresidential spillover, we conducted telephone surveys for each of the potential spillover candidates and completed 125 nonparticipant interviews.[32] For each eligible measure, we asked respondents questions about two concepts:

- **Measure verification.** The survey included questions to verify that the measures in the CLASS database or the CSS/CMST on-site inventory were installed between 2010 and 2012 at the address on record. Although we knew the year of installation for many measures, we verified the installation date for all eligible measures.
- **Attribution.** We asked questions to determine whether the installation of potential spillover measures was due to IOU rebates and information (i.e., energy efficiency programming).

We also included eligibility verification questions at the start of the survey to confirm that we were speaking to the correct contact. Due to the types of measures under residential study as well as the time elapsed from the CLASS site visits, we did not interview renters as part of this survey. Instead, we asked the respondents we identified as renters for the contact information of their landlord. We attempted to interview the identified 15 landlords but were unable to complete any interviews with landlords.

Attribution

Both the residential and nonresidential studies used the same attribution threshold to determine program influence and therefore spillover for nonparticipants. We relied on self-reported program attribution for each potential spillover measure. Specifically, we asked if the respondent's awareness of IOU rebates and information had *any* influence on their decision to purchase or install the measure. If the respondent answered that the program influenced their decision, we then asked them to rate the level of influence using a scale of

[31] All new EMS, LED and CFL installations were classified as high-efficiency.

[32] The evaluation team also completed 112 nonresidential participant surveys.

0 to 10, where 0 is no influence and 10 is a great deal of influence. We considered a measure installation to be "attributable" to IOU rebates and information if respondents scored program influence greater than four on the above scale.[33] This means that we assigned attribution and the spillover savings to any measure for which the respondent provided an IOU influence score of five or greater.

Note that this threshold differs from the primary participant spillover threshold of seven or greater. Whereas we awarded participant spillover to respondents providing a rating of seven or greater in cases of prompted attribution and five or greater in cases of unprompted attribution, we awarded nonparticipant spillover to respondents who gave a rating of five or greater in the cases of either prompted or unprompted attribution.[34] We used the lower threshold of five or greater for nonparticipant spillover because nonparticipants may have less knowledge of utility programs and propensity to seek out energy efficient products than participants. Additionally, the study team conducted a sensitivity analysis on the responses to assess the impact of the program influence threshold on nonparticipant spillover savings and found that nearly all respondents who indicated at least some program influence gave an influence rating of greater than four.[35]

3.5 Results, Conclusions, and Recommendations

The primary objective of this study is to assess the extent to which California's Investor Owned Utilities (IOUs) energy efficiency programs have resulted in program-induced participant and nonparticipant spillover in both the residential and nonresidential sectors. The California Public Utilities Commission (CPUC), in Decision 12-11-015 (D.12-11-015, issued on November 15, 2012) set in place a global 5% spillover value for the energy efficiency portfolio, including both the residential and nonresidential sectors. This research produces statewide spillover estimates for the residential and nonresidential sectors in California and develops recommendations for values to use in future program cycles.[36]

This section summarizes the results of our study at a statewide level and provides recommendations on both when and how to apply the results as part of future IOU program impact reporting. Detailed results are available in the body of the report.

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[33] If respondents indicated before they reached this question that the program had no influence on their decisions, we did not consider the associated savings attributable to the program.

[34] Unprompted attribution refers to when a respondent identifies the program, unprompted, as a response to the question "Why did you make this energy efficient purchase or improvement." Prompted attribution refers to when a respondent does not identify the program in the response to that question but then answers yes to the question "Did your experience participating in the utility program encourage you in ANY WAY to make this energy efficient purchase or improvement." Note that 97% of residential cases used the prompted PSO threshold of 7 or greater.

[35] See Appendix B for the NPSO program influence sensitivity analysis.

[36] As described in the evaluation plan for this study, the goal of this study is to calculate a point estimate for spillover in California. While the study team compared the results to the 5% planning assumption for context, we did not intend for the study to be a hypothesis testing exercise to assess whether we can reject the null hypothesis of a 5% spillover rate. We believe this approach was supported in Decision 12-11-015, in which the CPUC noted that the 5% "market effects adjustment" was only a placeholder value until further research could be conducted and described in several places a desire to avoid "false specificity and accuracy in this important area when the appropriate research and data does not yet exist."

3.5.1 Derivation of Overall Spillover Rates

The general approach used to calculate spillover rates is presented in Equation 1. The same equation is used to calculate both participant and nonparticipant spillover rates, with the denominator always represented by overall program savings and the numerator represented by either participant spillover savings or nonparticipant spillover savings.[37]

Equation 1. Spillover Rate

$$Spillover\ Rate = \frac{Spillover\ Savings}{Program\ Savings}$$

The residential study focused on programs while the nonresidential study focused on specific end-uses and segments of the nonresidential sector. Sections 4 & 5 describe the calculation of the spillover savings for the residential and nonresidential sectors, respectively.

As described in those sections, due to limitations in data availability, the study team included most, but not all, program savings in the residential and nonresidential spillover rate analyses.

3.5.2 Statewide Spillover Results

This section provides a summary of the statewide nonparticipant and participant spillover results, including both residential and nonresidential spillover rates, and then presents the combined sector-level statewide spillover results. Because the 5% spillover value that was detailed in CPUC Decision D.12-11-015 is applied to gross lifecycle portfolio savings, this section shows total lifecycle spillover MWh and therm savings in order to accurately compare the evaluation results to the 5% adder. Comparisons between first year and lifecycle savings can be found in Sections 4.2 and 5.2.

Statewide Nonparticipant Spillover Results

Table 7 presents the lifecycle statewide nonparticipant results for MWh, including both residential and nonresidential nonparticipant spillover. The study team estimated a lifecycle nonparticipant kWh spillover rate of 0.2% for the residential sector and 6.0% for the nonresidential sector. However, these values have relatively large confidence intervals at the 90% level: ±0.3% and ±3.9%, respectively.

[37] It is important to keep in mind, however, that the participant study spanned the 2013-14 program cycle while the nonparticipant study spanned the 2010-12 program cycle. And, therefore, the spillover savings rates were calculated using program savings from the applicable cycle (i.e., 2013-14 for participant spillover and associated program savings and 2010-12 for nonparticipant spillover and associated program savings).

Table 7. Statewide Lifecycle MWh Nonparticipant Spillover Results

Lifecycle Nonparticipant Spillover (2010-2012)	Sector		
	Residential	Nonresidential	Total
Total Spillover Savings (MWh)	66,890	1,546,218	1,613,108
Total 2010-12 Program Savings (MWh)[38]	28,039,300	25,947,598	53,986,898
Rate	0.2%	6.0%	3.0%
Confidence Interval at 90% Confidence	±0.3%	±3.9%	±1.9%
Lower Bound	-0.1%	2.1%	1.1%
Upper Bound	0.5%	9.8%	4.9%

Table 8 shows the lifecycle statewide nonparticipant results for lifecycle therms. The study team estimates a lifecycle nonparticipant therm spillover rate of 21.7% for the residential sector and -0.7% for the nonresidential sector.

Table 8. Statewide Lifecycle Therms Nonparticipant Spillover Results

Lifecycle Nonparticipant Spillover (2010-2012)	Sector		
	Residential	Nonresidential	Total
Total Spillover Savings (Therms)	67,207,812	-4,097,735	63,110,077
Total 2010-12 Program Savings (Therms)	309,361,549	628,224,960	937,586,509
Rate	21.7%	-0.7%	6.7%
Confidence Interval at 90% Confidence	±31.2%	±0.6%	±10.3%
Lower Bound	-9.5%	-1.3%	-3.6%
Upper Bound	53.0%	0.0%	17.1%

A challenge for estimating natural gas spillover savings for both the residential and nonresidential sectors is that spillover savings and program savings (both the numerator and the denominator in the spillover savings equation) includes the impact of interactive effects. Interactive effects for electric measures effectively decrease overall therm savings (e.g., CFLs produce less heat than regular incandescent light bulbs and, therefore, more therms are used to heat homes with natural gas heating). The end-result is expressing overall therm related spillover savings (the numerator in the spillover rate equation), for either program participants or nonparticipants, over relatively low program therm savings (the denominator in the spillover rate equation).

Additionally, the high spillover rate for the residential sector appears to be due to cross-fuel effects resulting from the coexistence of relatively small gas programs with much larger electric programs, in which a customer may participate in an electric program and is induced to purchase a non-program gas measure.[39] This results

[38] The 2010-12 nonresidential program savings represent the total ex post lifecycle gross MWh savings associated with nonresidential programs excluding programs savings from specific end-uses not covered under the CSS/CMST study - plug loads, food service, water heating, building envelope, and process equipment.

[39] We considered cross-fuel effects from two perspectives. First, analysis of cases of residential participant spillover showed that the majority of spillover savings (both kWh and therms) were from participants of either electric-only programs or dual fuel programs with

in a higher than expected spillover rate because the total therm spillover savings (the numerator) is divided by over relatively low program therm savings (the denominator). Interactive effects amplify the cross-fuel effects: the therm penalties from the larger electric programs have a disproportionately negative impact on the program therm savings, reducing the denominator in the spillover equation and increasing the residential sector spillover rate.

Statewide Participant Spillover Results

Table 9 presents the lifecycle statewide participant results for MWh, including both residential and nonresidential participant spillover. The study team estimated a residential MWh lifecycle participant spillover rate of 1.4% (±1.2%) and a 0.7% (±0.3%) rate for nonresidential participants.

Table 9. Statewide Lifecycle MWh Participant Spillover Results

Lifecycle Participant Spillover (2013-2014)	Sector		
	Residential	Nonresidential	Total
Total Spillover Savings (MWh)	126,031	117,972	244,003
Total 2013-14 Program Savings (MWh)[40]	8,902,921	16,758,958	25,661,879
Rate	1.4%	0.7%	1.0%
Confidence Interval at 90% Confidence	±1.2%	±0.3%	±0.5%
Lower Bound	0.2%	0.4%	0.5%
Upper Bound	2.6%	1.0%	1.4%

Table 10 shows these results for lifecycle therms. The study team found a lifecycle therm participant spillover rate of 33.8% (±39.6%) for the residential sector and 0.2% (±0.2%) for the nonresidential sector.

heavy focus on electric measures. Second, the ratio of electric savings to gas savings is much greater for the residential sector than for the nonresidential sector, suggesting that there is more potential for cross-fuel effects in the residential sector.

[40] The 2013-14 nonresidential program savings represent the total ex post lifecycle gross MWh savings associated with nonresidential end-uses and sectors that were explicitly evaluated as part of the commercial and IALC impact evaluation along with the savings associated with any additional program measures that the sample of participants installed throughout the 2013-14 program period.

Table 10. Statewide Lifecycle Therms Participant Spillover Results

Lifecycle Participant Spillover (2013-2014)	Sector		
	Residential	Nonresidential	Total
Total Spillover Savings (Therms)	28,280,323	1,326,934	29,607,258
Total 2013-14 Program Savings (Therms)	83,619,332	630,951,616	714,570,948
Rate	33.8%	0.2%	4.1%
Confidence Interval at 90% Confidence	±39.6%	±0.2%	±4.6%
Lower Bound	-5.8%	0.0%	-0.5%
Upper Bound	73.4%	0.4%	8.8%

As discussed above, the gas spillover rate is affected by both the inclusion of therm penalties from interactive effects and cross-fuel effects resulting from the coexistence of electric and gas programs.

3.5.3 Aggregated Statewide Spillover Results

Table 11 and Table 12combine the results that were detailed above for nonparticipant and participant spillover. Notably, given the relatively low incidence of spillover and the high variability of spillover savings, the precision around these estimates is relatively low resulting in large confidence intervals.

Table 11. Statewide kWh Total Spillover Rate Summary

	Residential	Nonresidential
Nonparticipant Spillover	0.2% ± 0.3%	6.0% ± 3.9%
Participant Spillover	1.4% ± 1.2%	0.7% ± 0.3%
Total Spillover	**1.7% ± 1.2%**	**6.7% ± 3.9%**

Table 12. Statewide Therms Total Spillover Rate Summary

	Residential	Nonresidential
Nonparticipant Spillover	21.7% ± 31.2%	-0.7% ± 0.6%
Participant Spillover	33.8% ± 39.6%	0.2% ± 0.2%
Total Spillover	**55.5% ± 50.4%**	**-0.4% ± 0.7%**

Comparing the spillover results by fuel, sector, and participation (participants vs. nonparticipants) revealed differences in the magnitude of spillover rates. Although the MWh participant spillover rate estimates for each sector are similar, the sector level estimated nonparticipant MWh spillover rates and both participant and nonparticipant therm spillover rates are substantially different.

3.5.4 Additional Observations

There are a number of additional observations that bear on the spillover results presented in this study. The following observations provide important context when reviewing the results of this research.

- **Differences between nonparticipant and participant spillover.** In most cases, the spillover rate estimates for participant spillover were higher than for nonparticipant spillover. Participants and nonparticipants may not install the same types of measures outside of utility programs, resulting in different levels of spillover savings. Additionally, differences in the program types included in the analysis, the savings associated with those programs, and the large difference in the number of participants and nonparticipants may result in disparate participant and nonparticipant spillover rates.

- **Differences in the incidence of residential participant spillover by program.** We can confirm, at a statistically significant level, that residential customers who participated in programs requiring a large customer investment and high customer contact had a higher propensity to take spillover actions than did customers who participated in programs that did not have these characteristics.

- **Differences in the nonresidential participant spillover rates by project type.** While the lifecycle MWh spillover rate for 2013-14 nonresidential participants was 0.7%, this rate was not developed at a program level. Rather, it represents a combination of rates from the commercial population (1.20%) and the industrial, agricultural and large commercial population (0.22%). The differences between these rates may be due to the fact that large custom projects (the IALC population) involve significant planning and utility involvement throughout all phases of the project (from inception to completion). The detailed planning can often lead to deeper savings when compared to prescriptive projects and may result in few potential spillover opportunities after program participation.

3.6 Recommendations to Policymakers

In this section, we recommend how to apply the spillover rates determined through this study.

This study demonstrates that spillover is real and varies across several important factors. In Decision 12-11-015 (D.12-11-015), the CPUC set in place a global 5% market effects adjustment value for the entire energy efficiency portfolio, including both residential and nonresidential sectors. Our study indicates that spillover varies significantly across program participants and nonparticipants and, within these groups, by sector and fuel type.

Given the variability in spillover observed among programs and measures, we recommend that program-specific spillover research be completed in the future and, as these studies are completed, the global participant spillover values applied by the IOUs be replaced with program-specific values. **Until program-specific research is conducted, the study team sees no basis to recommend changes to the current adopted market effects adjustment that the IOUs continue to use – the current 5% market effects adjustment value.** It is important to note that the spillover savings rates developed from this study are not dramatically different from this adjustment at the portfolio level given the wide confidence intervals. Again, this research establishes that spillover exists and can vary quite significantly at the sector, fuel type and participant/nonparticipant level. While the evaluation team recommends careful consideration of the research conducted for this study when planning for future program activity, there are several important limitations to this study that preclude any recommendation to apply the specific quantitative spillover estimates developed in this research effort:

- As described in Section 2.2, the scope of spillover studied within this evaluation was limited to spillover perceived by end-users and did not include the overall impacts of market effects and market transformation. The methodology employed within this evaluation focused on a participant's experience with or a nonparticipant's knowledge of utility programs at a specific moment in time. This study did not include other types of program participants like contractors, builders, and architects – individuals in a better position to speak to meaningful structural changes in energy efficiency markets given their presence in those markets over time.

- As with any spillover study, we may not have captured all potential spillover due to the timing of the survey. In some cases, the length of time between the spillover activity and the survey may result in respondents' lack of recollection of the project or the program's influence on it.

- In other cases, not enough time may have passed for the respondent to implement all planned spillover activities. Energy efficiency projects often have lead times of several years and not all potential spillover projects may have been captured within the timeframe of this evaluation.
- Due to methodological decisions, this study did not directly cover all programs offered by IOUs:
  - This study does not cover codes and standards programs for both the residential and nonresidential sectors. The study team believes there is no direct causal effect for spillover from codes and standards programs from the end-user perspective because these target builders and code officials and the residential or nonresidential end-user would likely be unaware of the programs' interventions. While some additional savings may result from these programs, residential and nonresidential customers are not direct "participants" in these programs and therefore a participant spillover survey is not the appropriate method by which to assess these effects.
  - The residential participant survey excluded programs without contact information at the residential end user level from the sample. The claims database does not contain the necessary contact information to contact participants of programs such as multifamily, school-based, and new construction programs, as well as non-lighting upstream programs. While we did not survey participants of these programs, we applied the estimated spillover rate derived from other programs to these programs, and the true spillover rate may be higher or lower than the overall rate applied.
  - In order to minimize the amount of participant contact, the nonresidential participant survey questions were added only to surveys concurrently conducted on behalf of the nonresidential impact evaluations in 2013-14. This study relied upon samples developed on behalf of these evaluations. These studies were not developed at the program level, but addressed specific end-uses (e.g. Nonresidential Downstream Custom Lighting, Deemed Lighting, and Deemed Non-Lighting Impact Evaluation) or segments of the nonresidential sector (Industrial, Agricultural, and Large Commercial Evaluation) rather than a specific program. While those impact studies encompassed a significant percentage of portfolio level nonresidential lifecycle energy savings (81%), inherently some measures and programs were not included as a result. The spillover rate generated from the population of measures and market segments studied within the context of those impact evaluations was applied to the remainder of the nonresidential portfolio not studied. Spillover savings from these non-studied measures and market segments may not be similar in structure to those studied which could result in a larger or smaller overall spillover rate had the entire population of nonresidential measures and programs been evaluated as part of those impact evaluations.
  - This was also true for the nonresidential nonparticipant study. While having access to the data from the CSS/CMST was unprecedented in terms of the quality of data available, the spillover study was limited to the specific end-uses and market segments studied in the CSS/CMST. Similar to the nonresidential participant spillover study, the spillover savings generated from nonparticipant spillover were compared to program-level savings excluding the specific end-uses and market segments mentioned above, but the spillover rate was ultimately applied to the whole population of nonresidential portfolio savings. If the magnitude of spillover within those segments is less than that of those studied, the overall spillover rate for nonparticipants would be less than what was developed for this study (and vice versa).

- The application of the spillover rates determined through this research is most pertinent to future program portfolios that have similar characteristics to the portfolio of programs studied here. As with any prospective research, if the mix of measures/programs included in future portfolios and their relative contribution to overall portfolio savings should shift significantly, this research may become less pertinent and less applicable.
- The study leveraged existing baseline research (i.e., the CLASS and CSS/CSMT studies) for the nonparticipant spillover research because using data collected onsite by trained auditors decreased the uncertainty around characteristics of the installed equipment and, therefore, the spillover savings (i.e., it reduced measurement error). However, utilizing these studies constrained our sample sizes for nonparticipant research, which, coupled with the low incidence of NPSO, led to lower levels of precision due to sampling error.
- This study explores the savings from equipment installed outside of IOU programs (i.e., the benefits), but the scope did not include researching the impact of the costs of this equipment on the customer or the portfolio's cost effectiveness. Under the total resource cost (TRC) test, the cost of a spillover measure must be accounted for as well as its benefits. Because the mix of spillover measures differs from the mix of measures in the portfolio (along with their respective benefit/cost ratios), it is not correct to apply the same multiplier to the portfolio's costs and benefits. Further, if the benefit/cost ratio of the spillover measures is significantly different than the portfolio's, then applying the actual costs of the spillover measures could have significant effects on portfolio's TRC results.

3.7 Considerations for Future Research

Given the variability in spillover observed among programs and measures, this study recommends that program-specific spillover research be completed in the future and that the global participant spillover values found here be refined with program-specific values. This study recommends the prioritization of future research for programs with high contributions to portfolio savings and for programs with high propensity for spillover (i.e., programs with high levels of customer contact and large customer investment). Additional findings that are worthy of future research include:

- **Complete spillover research as part of future program-specific impact evaluations.** While the statewide research approach provides reliable estimates of participant and nonparticipant spillover at the portfolio level, a number of study findings in the residential sector point toward the need to conduct participant spillover research on a program-by-program basis. For example, residential customers who participated in programs requiring a large customer investment and high customer contact had a higher propensity to take spillover actions than did customers who participated in programs that did not have these characteristics.
- **Conduct further research on cross-fuel effects resulting from the coexistence of small residential natural gas programs with relatively large residential electric programs.** High residential natural gas spillover rates occur when large electric programs, in tandem with few incentives with natural gas measures, create cross-fuel effects. This typically occurs when a household participates in an electric program but is induced to purchase a natural gas measure outside of a program. Therefore, future spillover research should address electric and natural gas fuel types as well as interactive effects.
- **Continue market effects research.** Market effects are a subset of spillover savings that reflect meaningful changes in the structure or functioning of energy efficiency markets. In order to form a complete picture of spillover, additional research on market effects is needed. Such research has to

be tailored to a specific market which cannot be easily accommodated as part of an overarching global spillover study.

- **Complete cross-cutting non-participant research on a two- or three-year cycle.** Since nonparticipant research is global in nature, such research should be repeated on a frequent basis at a global level.

Given these findings and the global nature of this research, the unique issues associated with individual programs may not have been fully captured. Future research conducted at a program-specific level can address these issues and provide program-level spillover rates with greater precision.

4. Residential Spillover

4.1 Research and Analysis Methodology

4.1.1 Nonparticipant Spillover (NPSO)

Data Sources

The residential nonparticipant spillover research leverages data from the 2010-2012 California Lighting and Appliance Efficiency Saturation Study (CLASS) conducted by DNV GL.[41] This study conducted site visits in 2012 on a stratified sample of 1,987 single family, multifamily, and mobile home residences with individually metered electric accounts in the PG&E, SCE, and SDG&E service territories. The CLASS data includes stratum weights to expand the sample to represent the electric population of the participating IOUs. DNV GL based the weights on electric utility, climate zone, low-income program participation, and average daily energy consumption.

The site visits collected information on home characteristics and energy-using equipment, such as lighting, HVAC equipment, appliances, and electronics, as well as building envelope measures. Trained auditors collected relevant equipment characteristics, including quantity, fuel type, efficiency rating, and age.

Opinion Dynamics used information from the CLASS data to develop the sample of households with potential nonparticipant spillover savings. Whereas spillover studies commonly depend on respondents' self-report of the presence of energy efficient equipment, by basing the sample on information gathered through the CLASS site visits we knew the equipment present in each home at the time of the site visit. Because the site visits were conducted by trained auditors, the CLASS data also provides information on equipment characteristics from which energy savings can be calculated.

Sample Development

Eligibility for Nonparticipant Spillover

As described above, DNV GL designed the CLASS sample to represent the entire population of residential IOU electric customers. As such, the CLASS data contained some households that are not eligible for nonparticipant spillover. We developed the NPSO sample eligible for our study, at the site level, by removing the following groups:

- **Low-Income Households.** We removed all low-income households from our eligible CLASS population, as savings for measures installed in these homes will not be included in the extrapolation to the energy

[41] Final Report: WO21: Residential On-site Study: California Lighting and Appliance Saturation Study (CLASS 2012). KEMA, Inc. May 21, 2014

efficiency portfolio of savings.[42] We identified 649 homes in the CLASS database as low-income.[43] We used two criteria to identify low-income households:

  - **CARE/FERA Participation.** The CLASS database contains a flag identifying homes that participated in the California Alternate Rates for Energy (CARE) or Family Electric Rate Assistance (FERA) programs. We removed all homes participating in these programs from our NPSO study sample.
  - **ESAP Participation.** DNV GL provided flags mapped to the CLASS database identifying homes that participated in the Energy Savings Assistance Program (ESAP). We removed all homes participating in this program from our population of interest.

- **Households Participating in IOU Programs.** We also removed all households from our population of interest who participated in an IOU program between 2010-2012. DNV GL provided flags mapped to the CLASS database identifying homes that participated in IOU programs (including Opower) in this time period.[44] We identified 442 homes in the CLASS database as program participants.

After applying these criteria, we identified a population of interest including 992 homes in the CLASS database. Figure 2, below, provides a visual representation of the CLASS sample and the NPSO study sample.

[42] Utilities typically assign a net-to-gross ratio of 1.0 to low-income programs because they assume that the participants lack the disposable income to purchase energy efficient measures without program incentives, meaning that there is no free-ridership or spillover associated with these programs.

[43] 589 homes in the database participated in the CARE/FERA programs, 230 participated in ESAP, and 170 households participated in both programs.

[44] This participation flag excludes upstream programs (for which IOUs do not claim savings associated with specific households), AC curtailment programs, and programs offered by publicly owned utilities.

Figure 2. CLASS Sample (*n* = 1,987)

Identification of Potential Spillover Measures

As part of our detailed review of the CLASS database, we identified 10 categories of measures with sufficient information to estimate energy savings (see Table 13).[45] For each of these measure types, we assessed their eligibility/potential to produce spillover using two criteria:

- **Installation date.** We used equipment age as a proxy for installation date. We determined the equipment age using information from the CLASS database and, where applicable, the self-reported

[45] We selected these 10 measures primarily based on availability of efficiency data through the CLASS database. CLASS also tracked presence of additional measures (e.g., pool pumps, consumer electronics, and other appliances), but not information about their efficiency level required to estimate energy savings. Additionally, we chose to exclude lighting measures from the nonparticipant survey for two reasons: 1) the difficulty of determining whether individual lighting measures received program rebates given the nature of upstream lighting programs; and 2) the length of time since the lighting purchase combined with a) inability to determine the installation timeframe from CLASS and b) the relatively low cost (and therefore unmemorable) nature of lighting purchases would reduce the accuracy of respondents' recollection. Finally, we did not estimate energy savings from windows due to the lack of sufficient information in CLASS to accurately estimate savings.

installation date. We only considered measures installed in the 2010-2012 time period (i.e., covered by the CLASS effort) to be eligible to produce spillover.

- **Efficiency level.** We considered only measures that meet energy efficiency requirements as potential candidates for spillover. These include measures that are ENERGY STAR certified or equivalent. Appendix A provides more information on efficiency levels and savings assumptions.

For some measures, the CLASS database did not contain one or both of these pieces of information. Our primary analysis approach addresses missing information in the following ways:

- **Known inefficient measure with missing age.** Ineligible for spillover.
- **Known efficient measure with missing age.** We utilized the phone survey to gather information on measure installation date when possible. These measures are considered potential spillover measures.[46]
- **Known ineligible age with missing efficiency**. Ineligible for spillover.
- **Known eligible age with missing efficiency**. Ineligible for spillover. Because efficiency information was missing from the CLASS database for these measures, we were unable to calculate potential energy savings associated with them.[47]
- **Missing age and efficiency.** Ineligible for spillover. Because efficiency information was missing from the CLASS database for these measures, we were unable to calculate potential energy savings associated with them.

The 10 measure types, their frequency of occurrence in the eligible CLASS sample, and frequency of occurrence of eligible/potential spillover measures are detailed in Table 13.

[46] An important note is that age information was missing for all building envelope measures, as well as duct sealing, given inability of auditors to collect verifiable information on age for these measures as part of CLASS. Therefore, we asked survey respondents to provide age information for all building envelope measures as well as duct sealing.

[47] The study team decided that it would be very unlikely to get accurate information about the efficiency of a measure installed between 2010 and 2012 using phone surveys or site visits in 2015/2016 if it was not possible to gather this information during site visits in 2012.

Table 13. CLASS Measures

Measures		Ineligible Spillover Measures				Potential Spillover Measures		
		Ineligible Due To:						
Measure Type	**Measure Count**	***Ineligible Age***	***Ineligible Efficiency***	***Unknown Efficiency***	**Total Ineligible Measures**	***Unknown Age & Eligible Efficiency***	***Eligible Age & Eligible Efficiency***	**Total Potential Measures**
Clothes washers	889	*719*	*79*	*0*	798	*2*	*89*	91
Cooling	893	*232*	*328*	*316*	876	*11*	*6*	17
DHW	1,027	*718*	*144*	*165*	1,027	*0*	*0*	0
Dishwashers	857	*632*	*156*	*0*	788	*9*	*60*	69
Freezers	210	*176*	*22*	*0*	198	*1*	*11*	12
Heating	1,655	*336*	*944*	*340*	1,620	*33*	*2*	35
Refrigerators	1,486	*1,250*	*186*	*2*	1,438	*3*	*45*	48
Duct sealing[a]	525	*0*	*0*	*0*	0	*525*	*0*	525
Roof insulation[b]	37	*0*	*0*	*0*	0	*37*	*0*	37
Wall insulation[b]	50	*0*	*0*	*0*	0	*50*	*0*	50

Note: This table does not include an "ineligible due to known ineligible age **and** efficiency category. As part of the initial CLASS data screening, if a measure was found to be disqualified based on age (i.e., it was installed outside of the 2010-12 time period), we did not assess its efficiency.
[a] We considered any occurrence of duct sealing as efficient. We did not attempt to estimate the number of homes that had ductwork – instead, we counted the number of homes in which duct sealing was present.
[b] We did estimate the number of homes for which any insulation was present – instead, we counted the number of homes for which efficient levels of insulation were present, as defined by DEER.

After conducting this analysis, we identified 724 homes in our population of interest with at least one potential spillover measure. We "ruled out" the remaining 268 homes where no potential spillover savings exist. In this report, we refer to this group as "ruleouts."[48]

Data Collection

We fielded a mixed-mode survey (i.e., internet and phone) with the 724 households where potential spillover measures exist and completed 197 interviews. For each eligible measure, we asked respondents questions about two concepts:

- **Measure verification.** The survey included questions to verify that the measures in the CLASS database were installed between 2010 and 2012 at the address on record. Although we knew the year of installation for many measures, we verified the installation date for all eligible measures.
- **Attribution.** We asked questions to determine whether the installation of potential spillover measures was due to IOU rebates and information (i.e., energy efficiency programming). We provide additional detail on attribution below.

We also included eligibility verification questions at the start of the survey to confirm that we were speaking to the correct contact. Due to the types of measures under study as well as the time elapsed from the CLASS site visits, we did not interview renters as part of this survey. Instead, we asked the respondents we identified as renters for the contact information of their landlord. We attempted to interview the identified 15 landlords but were unable to complete any interviews with landlords.

Survey Dispositions and Response Rate

Table 14 provides the final survey dispositions for the nonparticipant survey.

Table 14. Nonparticipant Survey Disposition Summary

Disposition	Count
Completed Interviews (I)	**197**
Internet complete	117
Phone complete	80
Non Contact (NC)	**215**
Answering machine	80
Respondent never available	135

[48] Note that our initial sampling strategy included low-e windows as a potential spillover measure. The 724 homes in the population of interest include 340 homes with low-e windows (of unknown age). Of these, 78 homes only had low-e windows and no other potential spillover measures. We conducted surveys with these households because spillover savings potentially exist for these low-e windows. However, we ultimately did not estimate the savings for these measures due to lack of the necessary information in CLASS.

Disposition	Count
Not Eligible (NE)	**143**
Business, government office, etc.	14
Duplicate number	4
Fax/data line	5
No eligible respondent	24
Non-working/disconnect	74
Wrong number	22
Refusal (R)	**127**
Break off	13
Initial refusal	114
Other (O)	**7**
Language problem	7
Unknown Eligibility, Non-Interview (UH)	**35**
Always busy	1
Call blocking	1
No answer	32
Total Participants in Sample	**724**

Table 15 provides the survey response rate and cooperation rates.

Table 15. Nonparticipant Survey Response and Cooperation Rates

AAPOR Rate	Rate
Response rate (RR3)	34.3%
Cooperation rate (COOP3)	60.8%

Weighting

The study team developed stratum-level weights to apply to our results based on the sampling conducted for CLASS, the number of interviews we completed by stratum, and the number of survey completes and ruleouts by stratum.[49] We adjusted the weights for ruleouts to account for the fact that we had information for all 268 ruleouts in our sample, but only completed interviews with a portion of the remaining sites (197 out of 724).

This weighting methodology achieves two important outcomes. First, it ensures that the number of cases (i.e., survey completions plus ruleouts) within a given stratum is representative of the proportion of households in

[49] We applied these weights to all sites for which we have information on total spillover. This includes the 197 sites for which we completed interviews, *as well as* the 268 sites for which we ruled out spillover as a possibility based on review of CLASS, which were assigned spillover savings of zero.

the population that fall within that stratum. Second, it ensures that the relationship between survey completions and ruleouts is properly represented.[50]

Table 16. NPSO Survey Weights

CLASS Stratum[a]	Survey Completes	Ruleouts	Weight (Completes)	Weight (Ruleouts)
1	10	29	1.225	0.400
2	14	11	1.027	0.336
3	9	5	1.003	0.328
7	11	43	1.602	0.524
8	11	19	1.262	0.413
9	13	27	0.503	0.165
13	1	2	1.375	0.450
14	1	0	0.238	–
15	1	0	0.696	–
19	21	25	1.385	0.453
20	13	14	1.139	0.373
21	15	9	0.690	0.225
25	6	15	1.416	0.463
26	7	8	0.966	0.316
27	5	4	0.720	0.235
31	5	9	0.705	0.231
32	11	4	0.323	0.106
33	2	4	0.438	0.143
37	9	28	0.781	0.255
38	18	8	0.509	0.166
39	14	4	0.374	0.122
Total	**197**	**268**		

[a] DNV GL developed these CLASS strata based on electric utility, climate zone, and average daily energy consumption. This table does not include the low-income CLASS strata, which are not covered in this study.

Determination of Influence and Calculation of Savings

Determination of Program Influence on Measure Installation

The study team determined, for each potential spillover measure, the influence of the IOU programs on the respondent's decision to purchase and install that measure. To do this, we relied on self-reported program attribution. Specifically, we asked if the respondent's awareness of IOU rebates and information had *any* influence on their decision to purchase or install the measure. If the respondent answered that the program

[50] This effectively means that across all strata, the ruleouts and survey completions combine to represent the starting sample of 992 cases, with ruleouts representing 268 of those cases and the 197 survey completions representing the remaining 724 of those cases.

influenced their decision, we then asked them to rate the level of influence using a scale of 0 to 10, where 0 is no influence and 10 is a great deal of influence.[51]

We considered a measure installation to be "attributable" to IOU rebates and information if respondents scored program influence greater than four on the above scale.[52] This means that we assigned attribution and the spillover savings to any measure for which the respondent provided an IOU influence score of five or greater. Note that this threshold differs from the primary participant spillover threshold of seven or greater. Whereas we awarded participant spillover to respondents providing a rating of seven or greater in cases of prompted attribution and five or greater in cases of unprompted attribution, we awarded nonparticipant spillover to respondents who gave a rating of five or greater in the cases of either prompted or unprompted attribution.[53] We used the lower threshold of five or greater for nonparticipant spillover because nonparticipants may have less knowledge of utility programs and propensity to seek out energy efficient products than participants. Additionally, the study team conducted a sensitivity analysis on the responses to assess the impact of the program influence threshold on nonparticipant spillover savings and found that nearly all respondents who indicated at least some program influence gave an influence rating of greater than four.[54]

If a measure installation met the IOU-influence threshold, we considered all energy savings resulting from that measure to be spillover. In other words, we did not vary a given measure's spillover savings by the level of program influence on that measure once it met the threshold.

Estimation of Savings for Energy Efficient Measures

The study team estimated savings associated with each attributable measure. To determine savings, we applied impacts from the Database for Energy Efficient Resources (DEER)[55] wherever possible.

The DEER database includes both whole-house impacts, which include interactive effects, and end-use impacts, which only account for savings from the individual piece of equipment. We applied whole-house impacts because this approach, incorporating interactive effects, is consistent with how program savings are calculated. Within each impact type, DEER provides savings for two baseline cases: 1) pre-existing, and 2) code/standard. We applied DEER savings values using the code/standard baseline, where possible, for the following reasons:

- Since most installed measures replaced failed or failing equipment (i.e., they are not early replacements), the customer would have purchased and installed equipment anyway and this equipment would have to at least meet code requirements or minimum standards.

[51] Survey question S09.

[52] If respondents indicated before they reached this question that the program had no influence on their decisions, we did not consider the associated savings attributable to the program.

[53] Unprompted attribution refers to when a respondent identifies the program, unprompted, as a response to the question "Why did you make this energy efficient purchase or improvement." Prompted attribution refers to when a respondent does not identify the program in the response to that question but then answers yes to the question "Did your experience participating in the utility program encourage you in ANY WAY to make this energy efficient purchase or improvement." Note that 97% of residential cases used the prompted PSO threshold of 7 or greater.

[54] See Appendix B for the NPSO program influence sensitivity analysis.

[55] The study team used measure savings from the DEER2011 as this version more closely aligns with the data available to us from the time of this study (i.e. 2010 to 2012).

- The DEER database updates code/standard requirements for each revised version of the database while the pre-existing values are not regularly updated.

For insulation, the above code/standard baseline is not appropriate because the act of installing insulation, by default, is considered to be an improvement in energy efficiency. Therefore, we used “pre-existing” insulation levels as the baseline. Our analysis choices are both informed by discussions with the DEER team and consistent with the participant spillover analysis.

We used DEER assumptions to estimate potential savings for all attributable measures for which we estimate savings. Appendix A provides more information on the engineering approaches used to calculate NPSO savings.

We calculated both first-year and lifecycle energy savings. To calculate lifecycle energy savings, we applied effective useful life (EUL) estimates from DEER to our first-year savings estimates.

4.1.2 Participant Spillover (PSO)

Data Sources

The participant spillover research used the PY2013-2014 statewide program claims database to contact households that installed energy efficient program measures in PY2013-2014.

The PY2013-2014 statewide claims database includes 2.9 million records, encompassing 195 residential and non-residential energy efficiency programs that claimed savings in PY2013-2014. The database contains, but is not limited to, participant information, savings amounts, program information, and limited information on the measures producing those savings. While the database contains a great deal of information, the level of information varies by program. It was necessary to conduct extensive data cleaning to develop a final sample frame from which we could draw a sample for fielding the participant survey. The section below provides an overview of the sample development conducted as part of this study.

Sample Development

The team’s overarching goal was to draw a sample that represented the varied programs and participants in the 65 programs in the residential portfolio and to do so in a cost-effective manner. Notably, we did not include the following program types in our sample:

- Codes and Standards programs - The study team believes there is no direct causal effect for spillover from residential codes and standards programs because these target builders and code officials and the residential end-user would likely be unaware of the programs’ interventions. While some additional savings could result from these programs, residential customers are not direct “participants” in these programs and therefore a participant spillover survey is not the appropriate method by which to assess these effects.

- Programs that already claim spillover - Because spillover savings will be in addition to any savings already associated within residential programs, it is inappropriate to include a program if the program already claims spillover in its net savings. We therefore removed the Energy Advisor programs and the Upstream Lighting Programs (ULP) from the sample. Because these programs estimate savings with market-based or billing analysis approaches, adding spillover savings from this study to claimed savings would result in double counting.

  - Energy Advisor Programs. The total savings associated with Energy Advisor programs are estimated through a billing analysis used to produce deemed savings figures for future application. Given the nature of the billing analysis, net savings attributable to the program are part of that deemed number.
  - Upstream Lighting Programs. To provide insight into the degree to which the current ULP net-to-gross ratio (NTGR) may already include spillover, the study team completed a sensitivity analysis[56] around the completed PY2010–2012 and PY2013–2014 ULP impact evaluations.[57] The results of the sensitivity analysis indicate that the spillover credit already awarded through both ULP impact evaluations NTGRs: 1) goes well beyond any spillover credit that would have been awarded by following the working definition of spillover used in this study (i.e., that which is perceivable by the end-user) and 2) includes significant elements of spillover, such as market effects, that would not have been credited in the absence of the market-based evaluation approach necessitated by ULP. Specifically, both ULP impact evaluations include impacts related to program-influenced change in stocking practices (i.e., what was made available to consumers at retail locations) as reported by retailers and lighting manufacturers, as well as impacts captured in broad market-based assessments, gathered through manufacturer interviews, of the impact of ULP on overall energy efficiency lighting sales in California.
- **Programs without contact information at the residential end user level needed for a participant telephone survey** – The claims database does not contain the necessary contact information to contact participants of programs such as multifamily, school-based, and new construction programs, as well as non-lighting upstream programs.

Ideally, we would include all programs that do not already claim spillover in our final sample frame. Out of the 65 programs in the residential portfolio, four already claim spillover due to their market-based approach to estimate savings. An additional 24 programs do not have contact information at the residential end user level. This left 37 programs in the final sample frame. Among the 61 programs that do not already claim spillover, these 37 programs account for 66% of kWh savings and 44% of therm savings. Appendix C provides more detail about the sample frame development.

Programs vary in their number of participants and we hypothesized that they also vary in their propensity to induce spillover. We chose a stratified random sample design to ensure that our sample included participants from both large and small programs and who had varied program experiences, as well as to maximize the precision of our spillover estimates. As described in Appendix D, we constructed an indicator of programs' hypothesized propensity for spillover through a systematic program review and rating process, which we used to classify programs into two groups: those with high hypothesized propensity for spillover and those with low hypothesized propensity for spillover. We further stratified these two groups by the number of participants per program, resulting in the six strata shown in Table 17.

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[56] Please refer to Appendix B for more information on this analysis.

[57] 2010–12 Report: California Upstream and Residential Lighting Impact Evaluation, Work Order 28 (WO28) Final Report. California Public Utilities Commission, Energy Division. Prepared by KEMA, Inc. 8/4/2014; 2013–14 Report: Impact Evaluation of 2013–14 Upstream and Residential Downstream Lighting Programs. California Public Utilities Commission. Prepared by DNV GL. 4/1/2016. CALMAC Study ID CPU0122.01.

Table 17. Final Residential PSO Sample Frame by Stratum

Stratum Number	Stratum	Number of Programs	Number of Participants[a]
	High Propensity for Spillover		
1	Large Programs	2	20,233
2	Medium Programs	4	8,598
3	Small Programs	5	2,393
	Low Propensity for Spillover		
4	Large Programs	5	613,768
5	Medium Programs	7	28,918
6	Small Programs	14	3,945
	Total	**37**	**677,856**

[a] The statewide claims database is organized by records and there can be multiple records per participant as well as missing contact information. Therefore, this count is an **estimate** developed from the PY2013-2014 tracking data.

Data Collection

We conducted phone interviews with PY2013-14 IOU program participants to estimate participant spillover. We conducted the surveys in two waves between January 15th and March 23rd, 2016. In total, we completed 1,604 interviews distributed across the six strata described in Table 17.

The phone interviews collected data to accomplish the following:

- Establish past program participation
- Establish installation of self-reported energy efficient measures after program participation
- Establish that these measures were installed outside of the program
- Determine program influence on measure installations
- Collect information to support savings calculations for program-influenced measures

Using the stratified final sample frame described above, we aimed to complete 1,600 interviews. We oversampled programs with a small number of participants to ensure that the study represents a variety of programs. Table 18 shows how the 1,604 completed interviews are distributed across the six strata.

Table 18. Sample Size and Total Completes by Stratum

Stratum Number	Stratum	Number of Participants[a]	Completes
	High Propensity for Spillover		
1	Large Programs	20,233	260
2	Medium Programs	8,598	189
3	Small Programs	2,393	149
	Low Propensity for Spillover		
4	Large Programs	613,768	535
5	Medium Programs	28,918	313
6	Small Programs	3,945	158
	Total	**677,856**	**1,604**

[a] The savings claim database is organized by records and there can be multiple records per participant as well as missing contact information. Therefore, this count is an estimate developed from the PY2013-2014 tracking data.

We fielded the participant spillover survey in two stages to maximize precision[58], to limit survey fielding costs, and to test our hypotheses about which programs are high or low in spillover propensity and refine our strategy as needed. Specifically, this approach provided us the option to reallocate our resources in strata with the highest incidence of spillover to maximize the number of non-zero observations. Upon review of results from the first survey wave, we decided to complete 800 additional interviews (for a total of 1,600) in order to achieve an acceptable level of absolute precision. We allocated these additional completes using a hybrid approach that balanced the relative contribution of participants from each stratum with the desire to oversample the strata with lower participation numbers so that we could compare between groups in the future.

[58] We report our results in terms of absolute precision instead of relative precision. The substantive difference between absolute and relative precision is that absolute precision allows us to estimate the population parameter within defined boundaries of the true value whereas relative precision estimates the population parameter within a defined percentage of the population parameter itself. This distinction is relevant for this study, since the purpose of estimating uncertainty for spillover is to provide a reasonable upper and lower bound of our spillover value.

Survey Dispositions and Response Rate

Table 19 provides the final survey dispositions for the participant survey.

Table 19. Participant Survey Disposition Summary

Disposition	Count
Completed Interviews (I)	**1,604**
Non Contact (NC)	**3,457**
Answering machine	1,677
Respondent never available	1,780
Not Eligible (NE)	**2,691**
Business, government office, etc.	205
Duplicate number	15
Fax/data line	60
No eligible respondent	482
Non-working/disconnect	1,321
Wrong number	608
Refusal (R)	**1,268**
Break off	96
Initial refusal	1,172
Other (O)	**384**
Language problem	384
Unknown Eligibility, Non-Interview (UH)	**1,346**
Always busy	47
Call blocking	38
No answer	954
Not attempted or worked	307
Total Participants in Sample	**10,750**

Table 20 provides the survey response rate and cooperation rates.

Table 20. Participant Survey Response and Cooperation Rates

AAPOR Rate	Rate
Response rate (RR3)	21.5%
Cooperation rate (COOP3)	55.8%

Weighting

Based on the number of completed interviews by stratum, we developed stratum-level weights to be applied to our results. These weights are presented in Table 21.

Table 21. Participant Spillover Survey Respondent Weights by Stratum

Stratum	Participant Count	% of Participants	Completes	% of Completes	Weight
Large Program - High Propensity	20,233	3%	260	16%	0.18
Medium Program - High Propensity	8,598	1%	189	12%	0.11
Small Program - High Propensity	2,393	0%	149	9%	0.04
Large Program - Low Propensity	613,768	91%	535	33%	2.71
Medium Program - Low Propensity	28,918	4%	313	20%	0.22
Small Program - Low Propensity	3,945	1%	158	10%	0.06
Total	**677,856**	**100%**	**1,604**	**100%**	—

Determination of Influence and Calculation of Savings

To determine spillover savings attributable to each respondent, we employed a four-step process:

- **Assessed presence of energy efficient measures.** We collected data via phone interviews to determine if respondents self-reported installing energy efficient measures outside of IOU programs after program participation.
- **Determined program influence on measure installation.** We collected data via phone interviews to determine if the installation of the energy efficient measure(s) was influenced by past program participation.
- **Verified measure efficiency.** We reviewed survey responses to detailed equipment specific questions to either confirm or refute that reported measures were, indeed, energy efficient.
- **Estimated spillover savings.** We estimated energy savings resulting from program-influenced measures verified as energy efficient through engineering analysis.

We describe these steps in the sections below.

Assess Presence of Energy Efficient Measures

We began by asking respondents a series of questions to determine the presence of energy efficient measures installed outside of the program. These questions did the following:

1. Confirmed participation in a PY2013-2014 IOU residential energy efficiency program;
2. Determined if the respondent made an energy efficient purchase or energy efficient home improvement following their participation in an IOU energy efficiency program; and
3. Determined if the energy efficient purchase or energy efficient home improvement decision occurred outside of an IOU energy efficiency program.

Determine Program Influence on Measure Installation

If a respondent reported installing a self-reported energy efficient measure without program assistance after participating in an IOU energy efficiency program, we then asked questions designed to determine if the energy efficient purchase or energy efficient home improvement could qualify as spillover. To assess this, the evaluation team established rules for determining if an energy efficient purchase or energy efficient home improvement was influenced by past utility program participation. Below we outline the primary decision rule and the associated questions we used to determine if a given measure qualifies as spillover eligible. Note that we applied the decision rule after we had already determined that a past program participant indicated they made an energy efficient purchase or energy efficient home improvement outside of a utility program.

We asked all respondents the following open-ended question: "Why did you make this energy efficient purchase or energy efficient home improvement?" Respondents who did not explicitly mention IOU program influence in the open-ended question were then asked if their experience with the IOU program encouraged them "in any way" to make the energy efficient purchase or energy efficient home improvement. If the response was yes (or if they previously explicitly mentioned program influence), they were asked to rate the IOU program influence on a scale of 0 to 10, where 0 is no influence and 10 is a great deal of influence. Measures for which a respondent gave an influence rating of seven or higher were considered to be program-influenced.[59]

Note that this threshold differs from the spillover threshold for nonparticipants, in which we awarded nonparticipant spillover to respondents who gave a rating of five or greater. We used the higher threshold of seven or greater because participants, by virtue of their past participation, are already inclined to seek out energy efficient products and are aware of utility programs and therefore require a higher attribution threshold.

Verification of Measure Efficiency

After conducting our phone interviews, the study team reviewed survey responses to confirm that participant-reported measures were energy efficient and could be assigned savings. We used one of the following two criteria to do this:

- **ENERGY STAR status.** We asked survey respondents who reported installing energy efficient appliances, water heating, or HVAC measures, whether or not the given measure was an ENERGY STAR model. If the respondent reported that the measure was an ENERGY STAR model, we calculated

[59] This decision rule covers 97% of cases. In the remaining 3%, we applied one of two other decision rules to identify cases of spillover: 1) participants who mentioned the utility program, unprompted, in the initial open ended question were considered influenced if they provided a score of five (5) or higher on the influence scale question; and 2) Participants who initially said that their participation in the utility program did not encourage them "in any way" to make the energy efficient purchase or energy efficient home improvement, but later reversed course by indicating they were highly unlikely (3 or less on a likelihood scale of 0 to 10) to have made the additional energy efficient purchase or energy efficient home improvement had they not participated in the utility program, were also considered influenced.

spillover savings.[60] If ENERGY STAR status was not confirmed[61], we did not calculate spillover savings for the measure.

- **Engineering review of measure information.** For other reported measures, we were unable to ask a single qualifying question similar to ENERGY STAR status. For these measures, we reviewed all available information and applied professional judgement to determine whether the measure should be considered energy efficient. We categorized these measures into three categories:
  - **All installations considered energy efficient.** For measures such as insulation the act of installing the measure, by default, is considered to an improvement in energy efficiency and we considered the measure to be energy efficient.
  - **Some installations considered energy efficient.** For measures such as pool pumps, measure energy efficiency depends on certain measure characteristics. We assigned spillover if we had evidence that the measure was energy efficient (e.g., a respondent reported that they installed a *variable speed* pool pump).
  - **No installations considered energy efficient.** Respondents also provided information that they installed a number of measures due to program influence that we do not consider energy efficient for the purposes of this study (e.g., solar panels).[62]

Estimate Savings for Energy Efficient Measures

If we established that the measure was energy efficient and influenced by the IOU program, we then calculated savings using measure-specific information from the phone interviews. To determine savings, we applied impacts from the Database for Energy Efficient Resources (DEER). DEER included most measures under study, but where this information was not available, we performed custom engineering calculations, using site- and California- specific inputs wherever possible. Detailed information on savings calculations is provided in Appendix A. Table 22 presents the methods used to calculate energy savings for each measure type present as spillover in our sample.

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[60] A qualitative note is that the literature generally finds that respondents over-report rate of ENERGY STAR status for equipment. Opinion Dynamics' past research, such as the 2012 *ComEd Residential Saturation/End-Use, Market Penetration & Behavioral Study* and the *Cape Light Compact 2014 Penetration, Potential and Program Opportunity Study*, shows that respondents may over-report ENERGY STAR status by extreme margins. Because of the research design of this study, we have no ability to verify responses to address this issue. As such, it is reasonable to believe that this study may include some false positives for measure efficiency (e.g., a measure reported by the respondent as being energy efficient when it is not), and therefore that our spillover estimates may include a slight upward bias.

[61] Across these measures (appliances, water heating, HVAC), 78% were reported by the respondent to be ENERGY STAR models. This means that 22% of appliances, water heating, and HVAC equipment that respondents said were energy efficient, installed after program participation, and utility influenced were not ultimately considered to be spillover (since they were not ENERGY STAR models). The study relies on respondents' self-reported efficiency level and, to minimize error, we must use objective thresholds such as ENERGY STAR when possible. Without an objective threshold, respondents may use different thresholds of efficiency or think of energy efficiency relative to the replaced equipment.

[62] We provide qualitative information on installations of measures in this category that might be of interest in Appendix A.

Table 22. Participant Attributable Spillover Savings Methodology

Savings Methodology	Measure Type
DEER Measures	Cooling
	Heating (Furnaces)
	DHW
	Refrigerators
	Freezers
	Clothes Washers
	Insulation
Algorithmic Approach	Showerheads
	Air Sealing
	Heating (Boilers)
	Programmable Thermostats
	Clothes Dryers
ENERGY STAR Calculator	Pool Pumps

4.2 Residential Spillover Results

This section presents the results of the residential nonparticipant and participant research based on the methodology described above.

4.2.1 Nonparticipant Spillover

The study team completed surveys with 197 customers that were part of the 2010-2012 CLASS and did not participate in an IOU program between 2010 and 2012. Please refer to Section 4.1.1 for more information on the methodology behind this research.

Incidence of Nonparticipant Spillover

In total, 8 out of 197 households in our nonparticipant spillover sample installed at least one energy efficient measure determined to be attributable to the program.[63] Additionally, based on the CLASS site visits, we know that an additional 268 households in the CLASS sample had no spillover. This results in a weighted spillover incidence of 3% in the nonparticipant population.

Table 23 presents a summary of the 465 households we analyzed as part of our study.

[63] While we found evidence of nonparticipants installing low-e windows attributable to the program, these are not included in the count of spillover measures reported here because the CLASS data did not include enough information to accurately estimate savings.

Table 23. Residential NPSO Spillover Incidence (n=465 households)[64]

Indicator	Number of Households
Installed energy efficient equipment outside of program	90
Met spillover influence criteria (≥5)	8
Incidence of Spillover (weighted)	3%

Note: Unless indicated, counts are presented unweighted

Table 24 shows the counts and incidence of non-participant spillover by measure category.

Table 24. Residential NPSO Spillover Measures

Measure Type	Spillover Measures	Incidence of Spillover (Weighted)
Clothes washers	4	1%
Duct insulation	1	<1%
Heating system	2	<1%
Refrigerators	3	1%

Note: Unless indicated, counts are presented unweighted.

Nonparticipant Spillover Savings

Calculation of Spillover Savings

The study team calculated nonparticipant spillover savings in a two-step process in order to account for the spillover savings from both the households in our sample and the households ruled out of the sample due to evidence in the CLASS data that no spillover occurred.

- First, after determining which measures met the study's spillover criteria (i.e., were installed in the proper time period, were efficient, and exceeded the required threshold of program influence), we aggregated the savings of these measures for each household responding to the survey. We then aggregated the attributable savings of all 197 households that responded to the survey and divided by the number of responding households (197) to produce a per-household average attributable savings for our survey completes. We weighted all data to ensure that survey completions appropriately represent the population of program nonparticipants. We used this per-household average attributable savings value to represent the 724 households in the CLASS sample where spillover possibly occurred.
- Next, we used a per-household savings value of zero for the remaining 268 homes where the CLASS data showed that no spillover occurred.

[64] Note that the 465 households represented in this sample are not equally represented in the spillover incidence rate. Of the 992 households in our non-participant spillover study sample, review of the CLASS data showed that 268 did not qualify for spillover. The 197 completed surveys represent the remaining 724 households in the sample. Please see the Methodology section for more detail on our non-participant sampling approach.

After establishing the per-household attributable savings for the survey sample and rule-outs, we computed a weighted average to attain per-household attributable savings for the entire non-participant spillover study sample. As shown in Table 25, we found average first-year spillover savings of 0.72 kWh, 0.001 kW, and 0.75 therms for households in the study sample.

Table 25. Attributable Residential NPSO Spillover Savings

Metric	*n*	N	First-Year Savings			Lifecycle Savings	
			kWh	kW	Therms	kWh	Therms
Per-household attributable savings (survey sample)	197	724	1.09	0.002	1.15	20.15	20.25
Per-household attributable savings (rule-outs)	268	268	0	0	0	0	0
Per-household attributable savings (population of interest)	**N/A**	**992**	**0.72**	**0.001**	**0.75**	**13.22**	**13.28**
Confidence Interval at 90%[a]			±1.13	±0.001	±0.98	±16.67	±19.09

[a] This equates to a relative precision of 158% for first-year kWh, 98% for kW, 130% for first-year therms, 126% for lifecycle kWh and 144% for lifecycle therms.

Total Nonparticipant Spillover Savings in the Population

After determining the per-household average attributable spillover savings, we calculated the total attributable savings in the population by multiplying the average per-household attributable savings (shown in the bottom rows of Table 25 and Table 26) by the number of households in California that did not participate in an IOU program in PY2010-2012.[65]

Table 26. Expansion of Residential NPSO Savings to the Population

Metric	First-Year Savings			Lifecycle Savings	
	kWh	**kW**	**Therms**	**kWh**	**Therms**
Per nonparticipant household attributable savings	0.72	0.001	0.75	13.22	13.28
Nonparticipant households in population of interest	5,060,898				
Total population attributable savings	3,622,094	5,182	3,813,129	66,890,270	67,207,812

Nonparticipant Spillover Rate

Finally, we computed a nonparticipant spillover rate for kWh, kW, and therms using the following equation:

Equation 2. Nonparticipant Spillover Rate

$$Nonparticipant\ Spillover\ Rate = \frac{Total\ NPSO\ Savings}{Total\ 2010-2012\ IOU\ Residential\ Program\ Savings}$$

As shown in Table 27, the first-year NPSO rate is 0.1% for kWh, 0.8% for kW, and 51.9% for therms. The lifecycle NPSO rate (shown in the same table) is 0.2% for kWh and 21.7% for therms.

[65] Appendix E describes the development of this number.

Table 27. Calculation of Nonparticipant Spillover Rate

Metric	First-Year Savings			Lifecycle Savings	
	kWh	kW	Therms	kWh	Therms
Total population attributable savings	3,622,094	5,182	3,813,129	66,890,270	67,207,812
2010-2012 IOU program savings	4,140,600,320	679,332	7,352,897	28,039,300,000	309,361,549
Nonparticipant spillover rate	**0.1%**	**0.8%**	**51.9%**	**0.2%**	**21.7%**
Confidence Interval at 90% Confidence[a]	±0.1%	±1.0%	±67.3%	±0.3%	±31.2%

[a]This equates to a relative precision of 158% for first-year kWh, 98% for kW, 130% for first-year therms, 126% for lifecycle kWh and 144% for lifecycle therms.

4.2.2 Participant Spillover

The study team completed surveys with 1,604 households that participated in an IOU program in 2013-2014 program cycle. This section includes the results from that research effort. Please refer to Section 4.1.2 for more information on the methodology behind this research. Additionally, Appendix C presents the residential participant spillover survey sampling strategy and Appendix D describes the how the study team stratified the sample.

Incidence of Participant Spillover

Our analysis of completed surveys found evidence of IOU program attributable spillover among 4.1% of program participants. Table 28 presents a summary of the 1,604 households we analyzed as part of our study.

Table 28. Residential PSO Spillover Incidence (n=1,604 households)[66]

Indicator	Number of Households
Installed energy efficient equipment outside of program	573
Did not receive rebate from utility program	565
Met spillover influence criteria (≥7)	87
Incidence of Spillover (weighted)	4.1%

Note: Unless indicated, counts are presented unweighted

As described in Appendix D, we stratified the participant spillover sample by programs' hypothesized propensity for spillover as well as the programs' number of participants. Table 29 presents the participant spillover incidence by hypothesized spillover propensity and overall. Analysis of these results confirmed our hypothesis that the incidence of spillover among the high propensity strata (6.5%) is significantly higher than

[66] Due to the structure of the participant survey, this table only includes households that installed high efficiency equipment outside of the program (question SO2) for which savings could be estimated. We did not include some of the 179 measures in the incidence of spillover that otherwise met all of the study's spillover criteria because they had spillover savings of zero (e.g., dishwashers installed at three sites). Please see Appendix A for further discussion of these measures. Additionally, we did not include low-e windows because we were unable to collect from participants the type of information needed (e.g., fenestration percentage, window orientation, u-value, solar heat gain coefficient, etc.) to accurately estimate savings.

the incidence of spillover in the low propensity strata (4.4%). See Appendix D for more detail on stratification by propensity.

Table 29. Incidence of Attributable Residential Participant Spillover by Hypothesized Spillover Propensity (Weighted)

Stratum Level	Sample Size	Number of Participants with Spillover	Incidence of Spillover
High Propensity	74	4	5.4%
Low Propensity	1,530	62	4.1%
Total	**1,604**	**66**	**4.1%**

Table 30 summarizes the counts and incidence of spillover by measure category.

Table 30. Incidence of Attributable Residential Participant Spillover by Measure Type

Measure Type	Spillover Measures	Incidence of Spillover (Weighted)
Cooling	6	1%
Heating	4	<1%
Domestic Hot Water	21	1%
Appliances[a]	54	3%
Pool Pumps	2	<1%
Showerheads	4	<1%
Thermostats	2	<1%
Weatherization[b]	26	1%

[a] Includes refrigerators, freezers, clothes washers, and clothes dryers.
[b] Includes insulation, and air sealing.

Participant Spillover Savings

The study team calculated total residential participant spillover savings by first aggregating the measure-level attributable savings for each completed interview. We then summed spillover savings at the stratum level to determine total attributable spillover savings for each stratum. We then developed a weighted sum of savings, as shown in Table 31.

Table 31. Residential Sample PSO Savings

Stratum	Sample First-Year SO Savings			Sample Lifecycle SO Savings	
	kWh	kWh	Therms	kWh	Therms
Large Program - High Propensity	2,765	1.88	429	41,939	6,978
Medium Program - High Propensity	4,811	3.61	737	62,803	13,606
Small Program - High Propensity	1,110	0.66	920	17,605	16,881
Large Program - Low Propensity	3,492	1.96	464	56,907	8,152
Medium Program - Low Propensity	2,664	1.18	467	40,772	6,873
Small Program - Low Propensity	1,070	0.19	89	13,986	1,311
Weighted Total	**11,193**	**6.36**	**1,560**	**179,377**	**27,101**

Note: Stratum-level results are presented unweighted.

Using these savings shown above, we then calculated per-participant participant spillover (Table 32).

Table 32. Participant Spillover per Household

	Sample First-Year SO Savings			Sample Lifecycle SO Savings	
	kWh	kW	Therms	kWh	Therms
PSO Savings	11,193	6.36	1,560	179,377	27,101
N	1,604				
Per participant household attributable savings	**6.98**	**0.004**	**0.97**	**111.83**	**16.90**
Confidence Interval at 90%[a]	±4.52	±0.003	±0.90	±87.56	±17.74

[a]This equates to a relative precision of 65% for first-year kWh, 76% for kW, 93% for first-year therms, 78% for lifecycle kWh, and 105% for lifecycle therms.

We also calculated per-participant program savings (Table 33) using the information from the program database. As these savings are a sample of all actual program savings, we express sampling error around our estimates.

Table 33. Participant Program Savings per Household

	Sample First-Year Program Savings			Sample Lifecycle Program Savings	
	kWh	kW	Therms	kWh	Therms
Program Savings	668,243	10.14	7,881	5,180,264	160,092
n	1,604				
Per participant household program savings	**416.61**	**0.12**	**4.91**	**3,229.59**	**99.81**
Confidence Interval at 90%[a]	22.76	0.01	0.90	185.20	10.81

[a]This equates to a relative precision of 5% for first-year kWh, 1% for kW, 18% for first-year therms, 6% for lifecycle kWh, and 11% for lifecycle therms.

Preliminary Participant Spillover Rates

Using the data shown in Table 32 and Table 33, we computed a preliminary participant spillover rate representative of our sample frame for kWh, kW, and therms using the following equation:

Equation 3. Participant Spillover Rate

$$Participant\ Spillover\ Rate = \frac{Sample\ PSO\ Savings}{Sample\ Program\ Savings}$$

Table 34 displays preliminary participant spillover rates and their associated confidence intervals.

Table 34. Preliminary Participant Spillover Rates

	Sample First-Year Program Savings			Sample Lifecycle Program Savings	
	kWh	kW	Therms	kWh	Therms
Per participant household attributable savings	6.98	0.00	0.97	111.83	16.90
Per participant household program savings	416.61	0.12	4.91	3,229.59	99.81
Preliminary participant spillover rate	**1.7%**	**3.3%**	**19.8%**	**3.5%**	**16.9%**
Confidence Interval at 90%[a]	±1.1%	±2.9%	±18.6%	±2.7%	±17.9%

[a]This equates to a relative precision of 66% for first-year kWh, 87% for kW, 94% for first-year therms, 78% for lifecycle kWh, and 106% for lifecycle therms.

Expanding Participant Spillover to the Full Population

As detailed in our methodology, the preliminary participant spillover rates detailed above are representative only of the programs we included in our participant spillover survey sample. To determine a statewide spillover rate, we also need to take into account the savings not included in our sample. Table 35 displays total program savings by category. We display savings included in our survey sample, savings not included in our survey sample from programs we deemed comparable to sampled programs (Category 2b), savings not included in our sample from programs we deemed *non*-comparable to sampled programs (Category 2a), and savings not included in our sample from programs already claiming spillover (ULP and Energy Advisor). Table 35 also includes assignment of spillover rates to each program for purposes of this analysis.

Table 35. Program Savings by Category

Program Category	Spillover Rate Assigned	First-Year Program Savings			Lifecycle Program Savings	
		kWh	kW	Therms	kWh	Therms
Included in survey sample	Researched	261,349,708	61,193	4,357,899	2,041,187,945	70,640,771
Category 2a	Researched	76,001,956	33,787	6,016,836	978,604,597	87,200,829
Category 2b	Researched	56,406,235	11,827	667,958	619,875,477	9,215,431
Already claiming spillover	0%	825,069,641	118,666	-3,518,938	5,263,253,147	-83,437,699
Total		**1,218,827,540**	**225,472**	**7,523,754**	**8,902,921,166**	**83,619,332**

We then apply the researched spillover rates from Table 34 to the appropriate program savings base from Table 35 to calculate overall spillover savings in California, presented in Table 36.

Table 36. Extrapolated Spillover Savings by Category

Program Category	Spillover Rate Assigned	First-Year SO Savings			Lifecycle SO Savings	
		kWh	kW	Therms	kWh	Therms
Included in survey sample	Researched	4,377,654	2,047	862,562	70,680,140	11,958,454
Category 2a	Researched	1,273,046	1,130	1,190,916	33,886,105	14,761,831
Category 2b	Researched	944,814	396	132,209	21,464,405	1,560,038
Already claiming spillover	0%	0	0	0	0	0
Total		**6,595,514**	**3,573**	**2,185,688**	**126,030,650**	**28,280,323**

Using the values in Table 35 and Table 36, we are then able to derive an overall participant spillover rate representative of the population using the following equation:

Equation 4. Participant Spillover Rate

$$Participant\ Spillover\ Rate = \frac{Population\ PSO\ Savings}{Population\ Program\ Savings}$$

Table 37 presents the overall participant spillover rates.

Table 37. Calculation of Participant Spillover Rate

Metric	First-Year Savings			Lifecycle Savings	
	kWh	kW	Therms	kWh	Therms
Total population attributable savings	6,595,514	3,573	2,185,688	126,030,650	28,280,323
Total 2013-14 program savings	1,218,827,540	225,473	7,523,755	8,902,921,166	83,619,332
Participant spillover rate	**0.5%**	**1.6%**	**29.1%**	**1.4%**	**33.8%**
Confidence Interval at 90% Confidence[a]	±0.4%	±1.5%	±30.3%	±1.2%	±39.6%

[a]This equates to a relative precision of 74% for first-year kWh, 95% for kW, 104% for first-year therms, 85% for lifecycle kWh, and 117% for lifecycle therms.

Analysis of Drivers of Non-Program Installations

As part of the participant spillover survey, we gathered information on respondents' motivations for purchasing and/or installing efficient equipment outside of energy efficiency programs. Note that we gathered information on all installations, regardless of the level of program influence. Therefore, only a portion of these installations result in spillover savings.

We coded respondent answers to open ended questions into 15 categories covering a number of motivators, presented in Table 38. Individual respondents gave responses that we coded into as many as four categories each.

Table 38. Categories of Potential Drivers of Non-Program Installations

Broad Category	Key Drivers
Critical timing	Replaced old or failing equipment
	Replaced multiple pieces of old or failing equipment
	Conducting renovation
Experience with program products	Product quality
	Previously noticed savings from EE products
Experience with the program	Information provided by vendor or representative
	Attitude of vendor or representative
Internal motivators	Money
	Save energy
	Environment
	Comfort
	Other self interest
	Other altruistic motive (e.g. “feel responsible to the world”)
Other	Received other rebate
	Other

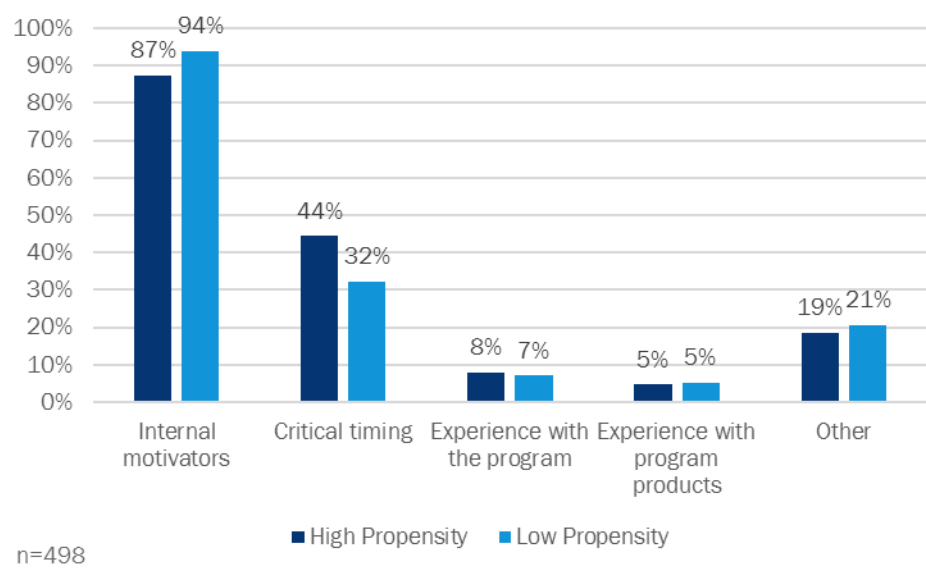
We categorized these drivers into five broad categories:

- **Critical timing.** The respondent had a time-sensitive need for new equipment and cited this as a major reason they purchased new energy efficient equipment. For example, the respondent’s air conditioner failed and needed to be replaced immediately.
- **Experience with program products.** The respondent’s experience with the energy efficient equipment they installed through the energy efficiency program in which they participated directly motivated them to install additional energy efficient equipment outside of a program. For example, the respondent had a positive experience with an energy efficient central air conditioning system they installed through a program, which led them to install energy efficient insulation outside of a program.
- **Experience with the program.** The respondent’s direct experiences with the program led them to install additional energy efficient equipment outside of a program. For example, information provided by a program representative during the respondent’s participation in a program led them to later install energy efficient insulation outside of a program.
- **Internal motivators.** The respondent had a personal, internally-motivated reason for wanting to install additional energy efficient equipment. For example, the respondent wanted to save money on their energy bills, and installed new energy efficient equipment outside of a program to accomplish this goal.

- **Other motivators.** Includes receipt of a non-energy efficiency program rebate (for example, manufacturer rebate), and other responses that do not easily fit into the above categories.

Figure 3 provides a high-level summary of the incidence of key drivers to these installations, by the hypothesized spillover propensity of the program in which the respondent. Unsurprisingly, internal motivators, especially "save money" and "save energy," are the primary drivers cited by respondents, motivating 87% of high propensity program participants and 94% of low propensity program participants (91% of all participants). Respondents in both propensity categories report similar drivers in most cases. However, we observed a statistically significant difference in the "critical timing" category, with high propensity program participants more likely to cite these factors as a motivator. This may be due to two factors: 1) HVAC programs are included in the high propensity group and these measures are typically replaced quickly after failure, and 2) whole-home programs are also included in this category and respondents participating in these programs may considering upgrades to their home outside of the program-covered items at the time of participation. Only a small share of respondents directly cited experience with energy efficiency programs or products delivered through energy efficiency programs as a motivator to their installations of equipment (7% and 5%, respectively).

Figure 3. Key Drivers to Participants' Non-Program Installations by Program Propensity for Spillover



Note: These results are unweighted.

5. Nonresidential

5.1 Research and Analysis Methodology

This section presents the research approach, methodology, data collection and results associated with developing nonresidential spillover estimates for IOU program participants and nonparticipants. The approach leverages data that was collected as part of the 2010-12 Commercial Saturation Survey (CSS) and the Commercial Market Share Tracking Survey (CMST), as well as data collected as part of the 2013-14 nonresidential impact evaluations – the nonresidential downstream impact evaluations (COM) and the custom impact evaluations (IALC). These studies have been leveraged using different approaches to determine:

1) 2010-2012 participant and nonparticipant spillover; and
2) 2013-2014 participant spillover[67]

While the study of 2010-12 participant spillover was initially a secondary objective of the nonresidential evaluation, the inclusion of 2010-12 participant spillover in this study was decided based on the fact that: a) the data were readily available; b) the same methodology was being used to assess potential spillover from 2010-12 nonparticipants; c) it allowed for a comparison and frame of reference to the 2013-14 participant spillover study.

5.1.1 Nonparticipant and Participant Spillover Methodology (2010-2012)

The approach used in developing nonresidential spillover estimates for 2010-2012 program participants and nonparticipants leveraged the comprehensive on-site equipment inventories of over 1,500 commercial premises in California that were conducted as part of the 2010-2012 Commercial Saturation Survey[68] (CSS) and the Commercial Market Share Tracking Survey[69] (CMST). The main goal of the CSS study was to capture the baseline of equipment in buildings, whereas the main goal of the CMST study was to track the market share of select energy-efficiency measures.

The CSS/CMST surveys drew upon overlapping samples to collect data regarding the year of installation, quantity installed, and the make/model information from many end uses within the facility. The CSS study analyzed the baseline of electric equipment of food stores, liquor stores, medical clinics, offices, restaurants, retail, schools, warehouses and other miscellaneous businesses. The CSS did not include hotels, hospitals, industrial businesses, agriculture or colleges and universities. The on-site data collected on behalf of the CMST study included the same businesses types surveyed for the CSS but also included a limited number of hotels, hospitals, industrial businesses, and colleges/universities. Agriculture was not included in the CMST data collection effort.

The methodology used in the study of 2010-12 nonparticipant and participant spillover consists of three distinct evaluation activities: existing data sources, additional data collection, and analysis. Each of these

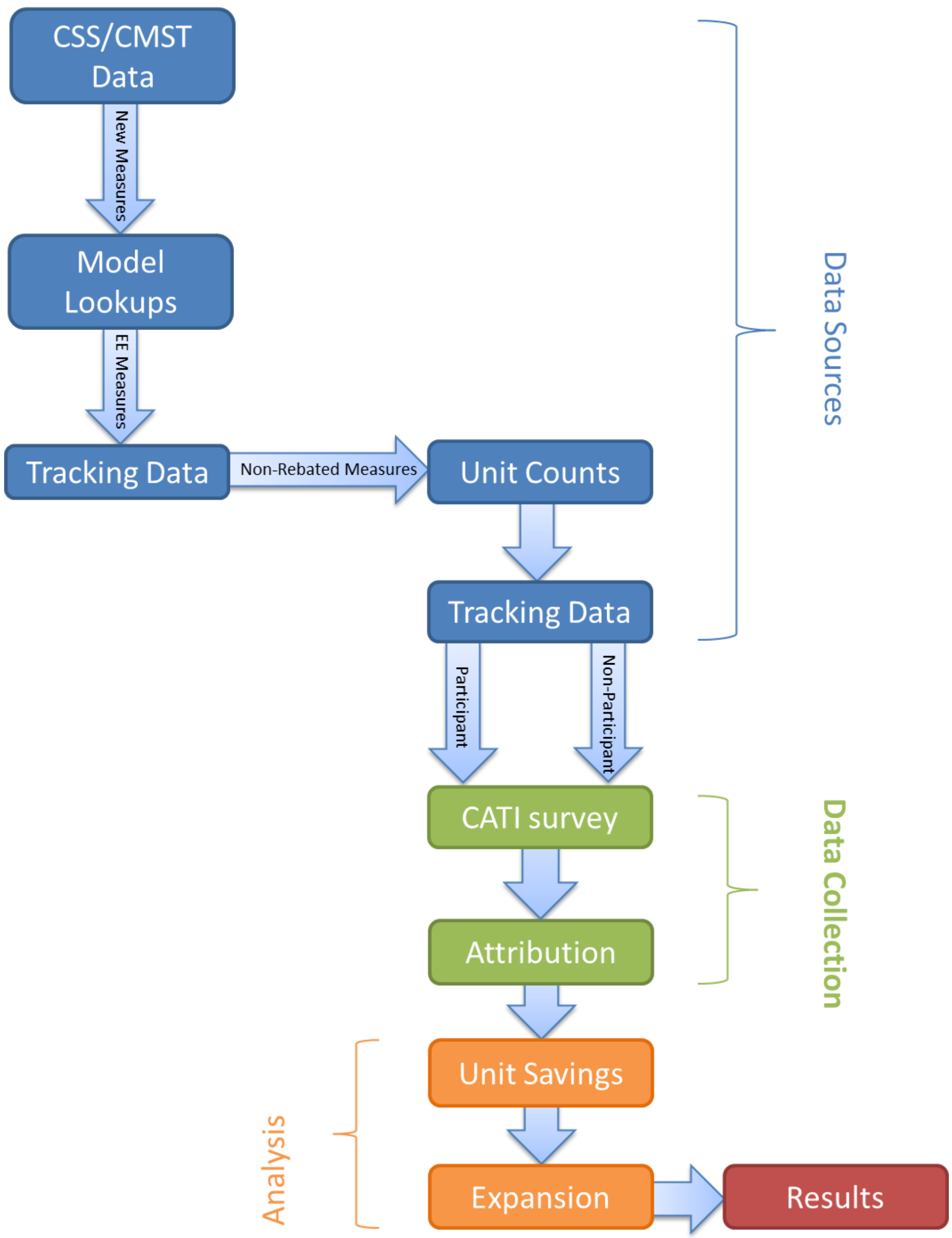
[67] 2013-2014 nonparticipant spillover is not part of the study scope.

[68] *California Commercial Saturation Survey*, Prepared for the California Public Utilities Commission, Itron, August 2014.

[69] *California Commercial Market Share Tracking Study*, Prepared for the California Public Utilities Commission, Itron, November 2014

activity groups consist of individual evaluation activities. Figure 4 shows each evaluation activity in a step-by-step diagram and the following subsections describe each of these steps in greater detail.

Figure 4. Overview of Methodology for 2010-2012 Nonparticipant and Participant Spillover



Sample Development: Nonparticipant and Participant Spillover (2010-2012)

CSS/CMST Data: Identification of (Newly Installed) Potential Spillover Measures

The CSS/CMST on-site data provided a unique opportunity to identify customers who had installed high efficiency equipment without the assistance of IOU energy-efficiency programs while not relying on self-reported installation information or requiring additional engineering review or on-site inspection of self-reported claims. Thus, the CSS/CMST data eliminated the uncertainty surrounding customer self-reports of measure installation and the efficiency level of newly purchased equipment.

This spillover study first used the CSS/CMST studies to identify sites with new measures (i.e. purchased during the 2010-2012 period). The CSS/CMST on-site data were analyzed to identify any customers who had installed new measures, regardless of efficiency level. This analysis focused on four end-uses: lighting, HVAC, refrigeration measures and energy management systems (EMS). The following measures were analyzed to determine if the newly installed measure was high-efficiency:

- **Lighting:** linear fluorescents, LEDs, compact fluorescents, lighting controls
- **HVAC:** chillers, furnaces, package single zone systems, split-system single zone systems, package terminal units, evaporative coolers, central plant
- **Refrigeration:** auto-closers, case lighting, condensers, refrigerators, freezers, strip curtains, night covers, refrigeration motors, controllers
- **EMS:** any applicable EMS measures

Model Lookups: Identification of Energy-Efficient Measures

After identifying newly installed measures, equipment efficiency levels were determined by using the make and model numbers collected from the CSS/CMST studies to search in energy-efficiency databases. The new equipment was then classified as high efficiency based on information gathered on site in combination with a make and model number lookup to determine measure efficiency. The CSS/CMST make and model lookup database was leveraged for the analysis of linear fluorescent and HVAC measures included in the development of the sites for the spillover analysis. The refrigeration analyses, however, required additional lookups as part of the effort to identify high efficiency equipment recently installed in CSS/CMST businesses. All new EMS, LEDs and CFLs were counted as high-efficiency measures.

IOU Program Tracking Data: Determination of Program Participation (Eligibility of Nonparticipant Spillover)

After identifying the CSS/CMST sites that purchased high-efficiency measures during the 2010-2012 period, the evaluation team referenced IOU program tracking data to determine whether these sites participated in an IOU energy-efficiency program.

First, IOU program tracking data was used to confirm that the high-efficiency measures purchased during the 2010-2012 period did <u>not</u> receive a rebate from an IOU energy-efficiency program. Second, if the customer did not receive a rebate for the installed high-efficiency measure, the tracking data was referenced to determine if the customer received *any* IOU energy-efficiency rebate or service during the PY 2010-2012 period. Customers that received rebates for other measures or services were flagged as participant spillover candidates while customers that did not receive any rebates were flagged as nonparticipant spillover candidates.[70] Therefore, CSS/CMST sites that participated in an IOU program during the 2010-2012 timeframe were flagged as participant spillover sites; CSS/CMST sites that did not participate in IOU programs during this timeframe were flagged as nonparticipant spillover.

The analysis of the CSS/CMST data, in combination with the review of all IOU 2010-2012 nonresidential program tracking data led to the identification of 253 sites where new high efficiency measures were installed without the receipt of an IOU program incentive during 2010-2012 (i.e. potential nonparticipant spillover sites). This analysis also identified 282 sites where high efficiency measures were installed without the receipt of an IOU incentive but the sites were found to have received an incentive for other high efficiency measures during 2010-2012 (i.e. "potential" participant spillover sites).[71]

Table 39 conveys these total site counts along with the distribution of newly installed energy efficiency equipment by end use. For both participants and nonparticipants, linear fluorescent lighting and rooftop HVAC systems represent the most significant share of site-measure installations throughout the 2010-12 timeframe.

Table 39. CSS/CMST Sites with Newly Installed Non-Incentivized High Efficiency Equipment by Participant Status

Measure	Participants	Nonparticipants
EMS	22	21
Lighting	201	160
HVAC	81	92
Refrigeration	24	21
All Measures	**282**	**253**

Data Collection

CATI Survey: Program Attribution

To determine program attribution, a self-report telephone survey was administered to the CSS/CMST sites that had installed high efficiency measures outside of IOU energy-efficiency programs. The main goal of the survey was to determine whether the installation of potential spillover measures was due to IOU program influence or, in the case of nonparticipants, due to IOU program knowledge. Eligibility questions were included at the start of the survey to ensure that the appropriate contact was reached.

CATI Survey Disposition and Response Rate

Table 40 shows the survey disposition for the CATI surveys. As mentioned above, of the approximately 1,500 commercial sites that were inventoried on behalf of the CSS/CMST study, 253 nonparticipant and 282 participant sites were identified as having installed energy-efficient equipment without an incentive. Phone surveys were completed with roughly half of these sites and the majority of these respondents were able to recall the installation of the energy-efficiency measures in question. Incomplete surveys represented those we were unable to connect with after several attempts or we were unable to connect with the individual most

[70] The development of the list of sites installing high efficiency measures outside the program and the distribution of these sites between those with the potential for participant versus nonparticipant spillover was funding by the 2010-2012 EM&V cycle.

[71] The analysis of the CSS/CMST data to determine potential participant and nonparticipant spillover sites is described in Appendix I.

familiar with the CSS/CMST data collection effort (This was determined through a series of screening questions at the begin of the phone survey). Overall, 44% of the nonparticipant spillover candidates and 27% of the participant spillover candidates completed the survey and were able to recall installation. Given the fact that the evaluation team was unable to complete phone interviews for 128 nonparticipants and 170 participants that had installed energy efficient measures throughout the 2010-12 program period, the evaluation results from the completed phone surveys will be weighted up to represent the total number of sites that installed energy efficiency measures.

Table 40. Nonparticipant and Participant (2010-12) Survey Disposition and Response Rate by Site

Disposition	Nonparticipant	Participant
Total Sites with EE Measure Installation	253	282
Phone Surveys Completed	125	112
Respondent Recalls Installation	112	76
Contact Did Not Recall Installation	13	36
Response Rate - Recalls Installation / Total Sites	44%	27%

Expansion Weights

There was a total of 237 phone surveys completed for nonresidential participants and nonparticipants. These sites were drawn from the CSS/CMST on-site based on evidence that the site had installed high efficiency (HE) equipment throughout the 2010-12 period. The CSS/CMST on-site sample was randomly drawn to represent 954,733 sites within the whole nonresidential frame. The objective was to develop a set of weights for the spillover survey sample, so that the weighted sample would represent the whole nonresidential frame.

The weights were developed in several steps:

- **Step 1** weights up the CSS/CMST on-site sample to the whole nonresidential frame.
- **Step 2** weights up the spillover survey sample to the CSS/CMST on-site sample.
- **Step 3** weights up the completed spillover surveys to the total spillover survey sample.

The strata were defined by building type, kWh size and EE participant flag

- Building type – facility's business type
- kWh size – Large (L), Medium (M), Small (S), Very Small (V) and Unknown (U) which is based on the site's annual kWh consumption
- EE participant flag – This equals 1 if a site participated in any IOU energy efficiency programs throughout 2010-12 and equals 0 for all other nonparticipants in the nonresidential frame.

Determination of Influence and Calculation of Savings

Determination of Program Influence on Measure Installation

For each potential spillover measure, the evaluation team determined the influence of IOU programs on the respondent's decision to purchase and install the given measure. To achieve this, the evaluation team relied upon self-reported program attribution. Through a series of questions, the spillover battery determined to what extent IOU energy efficiency programs influenced the customer decision to install high-efficiency equipment outside of the program.

- For nonparticipants, the survey determined the extent to which their knowledge of IOU programs influenced the customer decision. A given measure was classified as spillover or not as spillover (i.e. no partial attribution).
- For participants, the survey determined the extent to which participation in the IOU rebate program influenced the decision to install high-efficiency equipment outside of the program.

More specifically, in order to determine attribution, the survey addressed the following topics:

- **Recall**: Respondents were first asked if they recalled installing the energy-efficiency measure in question;
- **No incentive received**: Respondents were asked to confirm that they did not receive an incentive for the installed equipment;
- **Unprompted attribution**: Respondents were asked in an open-end manner why they installed the measure without applying for an incentive (to determine "unprompted attribution");
- **Prompted attribution**: Respondents were specifically asked whether their experience with the program (in the case of participants) or their knowledge of incentive programs (in the case of nonparticipants) influenced their decision (to determine "prompted attribution")
- **Program influence**: Respondents were asked to rate on a 0-to-10-point-scale how influential their experience (for participants) or their knowledge (for nonparticipants) of the program was in the decision to install the equipment;
- **Likelihood of installation (counterfactual):** Respondents were asked to rate on a 0-to-10-point-scale the likelihood that they would have installed the EE measure had they not participated in the program (for participants) or not known of the program (for nonparticipants)

Spillover was awarded based on the responses to the program influence and likelihood of installation questions. For each measure associated with spillover, attribution was either awarded fully or not at all. In other words, partial spillover was not awarded, as is done in net-to-gross studies of partial free ridership. Also, these spillover attribution questions and thresholds were developed in coordination with the residential spillover evaluation team to facilitate the comparison of results across the residential and nonresidential spillover studies. The thresholds for awarding spillover are presented below for participants and nonparticipants.

For nonparticipants:

- In the case of prompted or unprompted attribution, an influence score of 5 or higher was required to award spillover.
- In cases where there was no prompted or unprompted attribution and the program influence threshold was not met, spillover was awarded if the likelihood of installation was 5 or less.

For participants:

- In the case of unprompted attribution, an influence score of 5 or higher is required to award spillover.
- In the case of prompted attribution, an influence score of 7 or higher is required to award spillover.
- If neither prompted nor unprompted attribution is given, then a program influence score of 7 or higher is required to award spillover.
- If the program influence threshold is not met, spillover is awarded if the likelihood of installation is 4 or less.
- The evaluation team also considered awarding spillover in cases where there is prompted attribution and the program influence score is 5 or greater.

As mentioned above, spillover was attributed to customer sites by one of the three means: prompted attribution, unprompted attribution, and counterfactual attribution (i.e. low likelihood of installation without the program). For program participants, spillover attribution was awarded to 46 site-measures.

Table 41 displays attribution scoring results for each of the participants who recollected installing the energy efficient equipment outside the program along with those participants that were not awarded spillover. Overall, unprompted program influence was the most prevalent means by which a participant was awarded spillover. As discussed above, a program influence score of 5 was used as a threshold to support unprompted program influence, while a score of 7 was utilized when the participant was prompted by the interviewer. These scoring ranges are reflected in the minimum and maximum scores from the sample. Each of these inquiry routes yielded mean program influence scores of 8.4 and 8.8. For the four site measures that were awarded attribution through likelihood, the minimum score was 0 and the maximum was 1.

For the site-measures that were not awarded spillover, the most significant driver was low program influence scores or higher likelihood scores. While there were a few program influence scores in the 5-6 range for program influence, the mean score of 0.8 confirms that the vast majority of scores were in the lower range.

Table 41. Attribution of Spillover by Site-Measure: Participant Spillover (2010-12)

Inquiry Route	Program Influence				Likelihood		
	n	Mean	Min	Max	Mean	Min	Max
Unprompted	25	8.4	5.0	10.0			
Prompted	17	8.8	7.0	10.0			
Counterfactual	4				0.8	0.0	1.0
No Spillover	**67**	**0.8**	**0.0**	**6.0**	**8.9**	**5.0**	**10.0**

At the time of the phone survey implementation, no specific thresholds were administered to assess attribution for nonparticipants. Rather, each of the phone survey respondents were asked why they decided to implement the measure installation in an unprompted manner and they were also asked to state whether or not their knowledge of utility programs and services encouraged them in any way to implement the measure installation. Of the 112 nonparticipants that recollected installing the energy efficient measures in 2010-12 (135 site-measures), 29 nonparticipants, representing 41 site-measures, stated that their knowledge of utility programs or services encouraged them to install the measure. The other 83 sites self-reported that utility programs or services did not encourage them in any way to install their measures.

Table 42 displays attribution scoring results for each of the 41 site-measures where the nonparticipant stated that their knowledge of utility programs influenced their decision to install the measure along with those nonparticipants that were not awarded spillover. A program influence threshold of 5 was ultimately chosen for nonparticipants. Of the 6 site-measures that were not awarded spillover the mean program influence score was 0.3 with a maximum of 1.0.

Table 42. Attribution of Spillover by Site-Measure: Nonparticipant Spillover (2010-12)

Inquiry Route	Program Influence				Likelihood		
	n	Mean	Min	Max	Mean	Min	Max
Program Influence	31	8.1	5.0	10.0			
Counterfactual	4				1.0	0.0	3.0
No Spillover	**6**	**0.3**	**0.0**	**1.0**	**9.2**	**8.0**	**10.0**

Estimate Savings for Energy Efficient Measures

The evaluation team developed measure-specific savings estimates for the high efficiency measures associated with spillover. For measures associated with the CSS/CMST participant and nonparticipant spillover analysis, the spillover savings values were calculated based on the ex-ante values found in DEER. If the measures attributed to spillover within the CSS/CMST study were evaluated during the PY 2010-2012 evaluations, ex-post savings values from the 2010-2012 evaluations were incorporated into savings assumptions.

The evaluation team calculated both first-year and lifecycle energy savings for the measures that were determined to represent spillover savings. Each measure that was evaluated was considered replacement on burn-out (ROB) or natural replacement (NR) so no dual baselines were considered. In other words, the evaluation team assumed that there was no remaining useful life (RUL) for the replaced equipment. As such, the baseline for each measure took into account any code requirements or industry standard practice.[72]

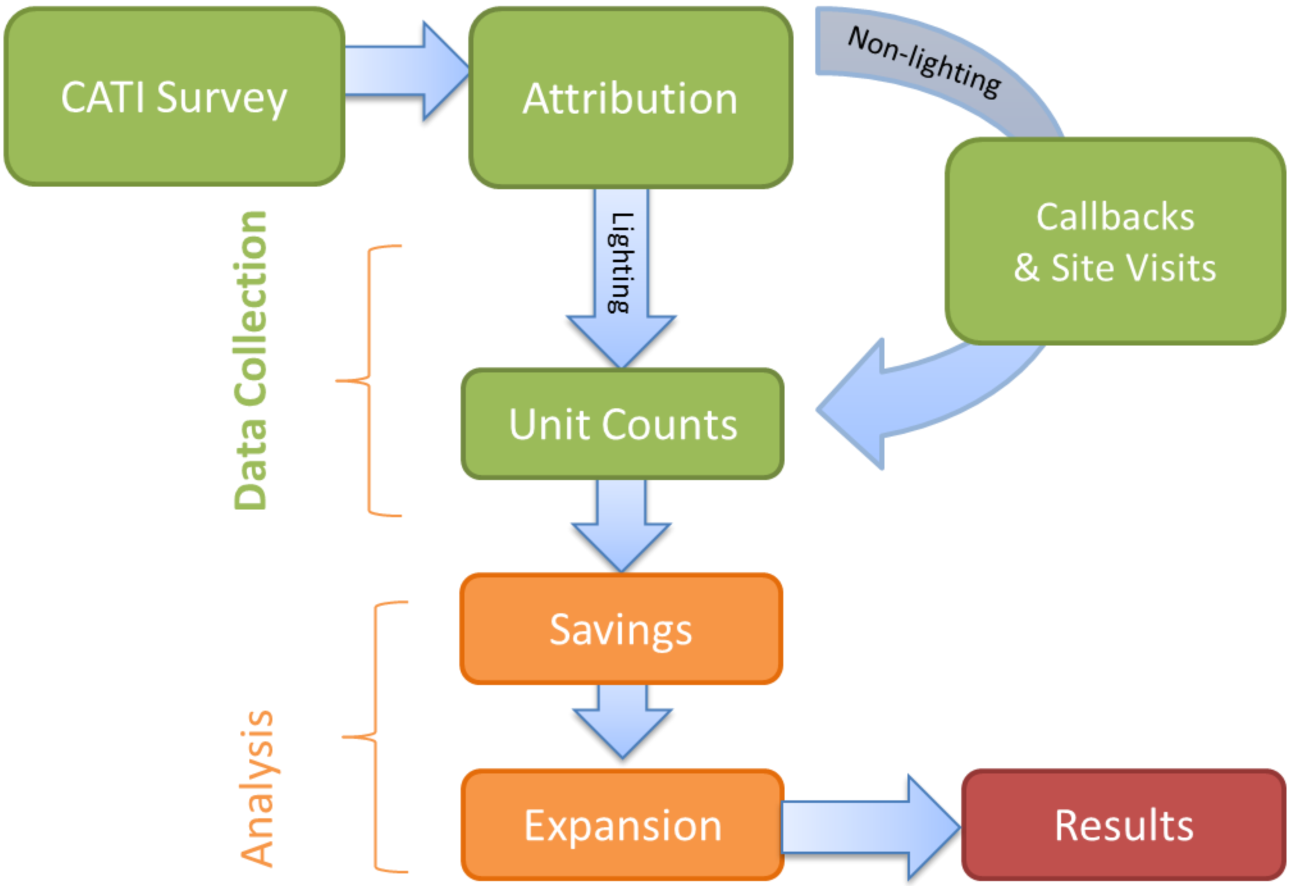
5.1.2 Participant Spillover Methodology (2013-14)

The approach used in developing nonresidential spillover estimates for 2013-14 program participants leveraged data that was collected from the 2013-14 nonresidential impact evaluations – the nonresidential downstream impact evaluations (COM) and the custom impact evaluations (IALC).

[72] Appendix K provides a more detailed description regarding the specific algorithms and impact approach.

The methodology used in the study of 2013-14 participant spillover consists of two evaluation activities: data collection and analysis. Each of these activity groups consist of individual steps, which are presented in the Figure 5 below, and are described in the following subsections.

Figure 5. Overview of 2013-2014 Participant Spillover Research Approach



Data Sources: Participant Spillover (2013-2014)

The methodology for 2013-14 participant spillover leveraged phone survey data that was collected on behalf of four impact evaluations: 1) the 2013 and 2014 Nonresidential Downstream Impact Evaluation (conducted under the Commercial Roadmap) and 2) the 2013 and 2014 Custom Impact Evaluations (conducted under the Industrial, Agricultural and Large Commercial Roadmap).[73] The following paragraphs present a brief description of each evaluation.

[73] The following studies are collectively referred as the "nonresidential impact evaluations:" The Industrial, Agricultural, and Large Commercial Impact Evaluation, and the Nonresidential Downstream Custom Lighting, Deemed Lighting, and Deemed Non-Lighting Impact Evaluation.

Nonresidential Downstream Impact Evaluation (Commercial Study)

The main goal of Nonresidential Downstream Impact Evaluation[74] was to perform impact evaluations on specific nonresidential deemed/custom lighting and deemed non-lighting measures and/or measure-parameters that were identified in Efficiency Savings and Performance Incentive (ESPI) decision.[75] The ESPI decision listed a number of measures that were subject to some level of ex post evaluation for the 2013-14 program years. These measures included:

- T5 fluorescent lamps and fixtures replacing metal halides
- Indoor LED lighting
- Occupancy Sensor lighting controls (integrated and wall/ceiling mount)
- Delamping of T12 lamps in existing fixtures
- Agricultural Sprinklers
- Pipe Insulation
- All components of custom lighting projects

Custom Impact Evaluation (IALC Study)

The custom project impact evaluation[76] is one of multiple CPUC evaluations of the PAs' efficiency programs and was conducted under the Industrial, Agricultural and Large Commercial (IALC) Roadmap as part of an overarching contract for PY2013-2014 evaluation services. The evaluation addressed custom, non-deemed measure installations and involved an array of projects that received incentives via more than 100 utility programs. The PA programs evaluated span all offerings where custom incentives are provided for non-deemed measure installations. The scope of work for the evaluation of custom measures includes an independent estimation of gross impacts and net impacts, and a Project Practices Assessments (PPA) activity to discern possible changes in ex-ante savings development practices. Findings and recommendations to improve program performance were also provided. Three main evaluation activities support the findings and recommendations: (1) M&V activities for estimating gross impacts (2) telephone survey data collection supporting net to gross (NTG) estimation, and (3) engineering reviews supporting PPA results.

Sample Development: Participant Spillover (2013-2014)

In order to minimize the amount of customer contact, spillover survey questions were added to the surveys concurrently conducted on behalf of the nonresidential impact evaluations. These spillover questions

[74] *2014 Nonresidential Downstream Custom ESPI Lighting Impact Evaluation Report*. Submitted to CPUC, March 29 2016, Itron, Inc.

[75] D.13.09.023, Decision Adopting Efficiency Savings and Performance Incentive Mechanism.

[76] *2014 Custom Impact Evaluation: Industrial, Agricultural, and Large Commercial*. Submitted to CPUC, March 15, 2016, Itron, Inc.

identified potential spillover candidates among participants in 2013-2014 energy-efficiency programs. The spillover study relied upon the samples developed on behalf of the nonresidential impact evaluations.

The programs and measures that were identified under the commercial and IALC roadmaps represent roughly 53% of portfolio level ex post lifecycle kW savings and 59% of total portfolio level ex post lifecycle kWh savings in 2013-14. Table 43 provides a break out of savings for each of these roadmaps. The commercial population represents nonresidential downstream custom lighting and deemed measures and IALC represents all custom non-lighting projects. The commercial roadmap is further disaggregated into custom lighting and commercial deemed measures which represents 13% and 21% of ex post lifecycle kWh, respectively. The IALC roadmap represents 26%.

Table 43. 2013-14 Portfolio Level Ex Post Lifecycle Savings

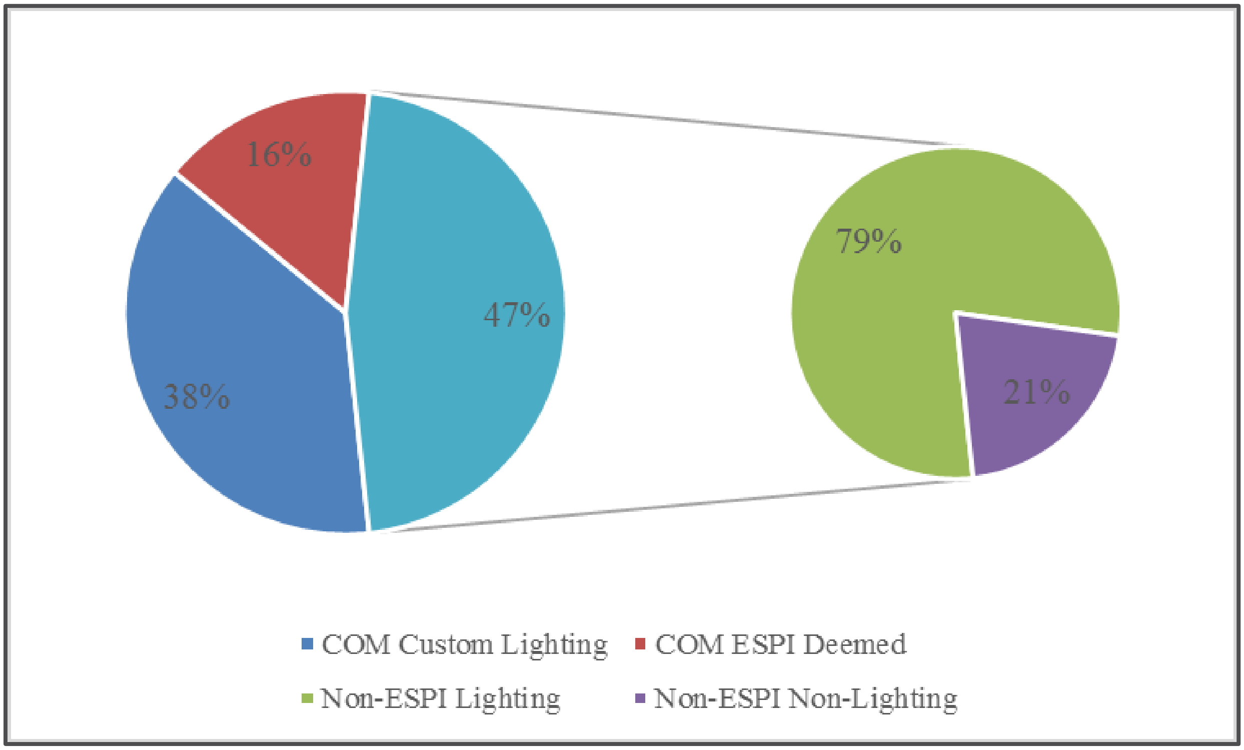
RoadMap	Ex Post Lifecycle MW	Ex Post Lifecycle GWh	% Lifecycle MW	% Lifecycle GWh
COM Custom Lighting	567	4,341,295	9%	13%
COM Deemed	1,406	7,178,937	22%	21%
IALC	1,430	9,076,143	22%	26%
All Others	3,029	13,859,408	47%	40%
Total Portfolio	**6,432**	**34,455,783**	**100%**	**100%**

Note: These savings don't take into account the savings associated with Codes and Standards.

While all IALC projects and commercial custom lighting were subject to ex post evaluation in the 2013-14 program periods, not all measures associated with the IALC and commercial roadmap were considered part of the sample frame for the nonresidential downstream ESPI impact evaluations. Given the scope and objectives of the ESPI decision and the availability of existing data sources, several measures were not explicitly evaluated within the context of those studies.

Figure 6 provides an example breakdown of the percentage of lifecycle ex post kWh savings that were represented in the commercial evaluations. Of the roughly 11.5 million GWh lifecycle ex post savings associated with the commercial roadmap, 53% was represented in the sample frame for the commercial impact evaluations. 79% of the remaining savings from non-evaluated measures represent lighting and 21% represent non-lighting. The majority of ex post savings from the non-evaluated lighting measures were linear fluorescent and LED fixture retrofits. The non-lighting savings generally reflected refrigeration and food service equipment.

Figure 6. 2013-14 Commercial Roadmap Ex Post Lifecycle Savings



Data Collection

Measure-level unit counts and savings were collected through several evaluation activities:

CATI Survey. For sites self-reporting the installation of potential spillover measures, the telephone survey solicited detailed information on the installed spillover measures, including the specific types, efficiency-levels and counts of the equipment purchased outside of programs during the 2013-2014 period. Follow-up interviews or on-site surveys were not required for most lighting measures; as self-reported unit counts were deemed sufficient. The evaluation team believes that there is minimal bias associated with self-reported lighting specifications as technologies (e.g. T8s, T5s, CFLs, LEDs) and their characteristics (e.g. lamp length) are readily observable. In the event that a phone survey respondent could not recollect the quantity of equipment they installed or if their self-reported quantity seemed questionable, then they were moved onto the callback list.

Follow-up Interviews (Callbacks). The main goal of these callbacks is to address possible sources of self-report error by confirming that no rebate was received. Verification activities include the collection of measure information such as make, model, baseline information, and other site-specific parameters. For lighting measures, these callbacks served to confirm measure quantity, configuration and baseline. In some cases, where exact quantities and measurements were not available, the evaluation team calculated savings figures based on estimates. For non-lighting equipment and select custom lighting installations, the specific technologies, capacities, and efficiencies are not readily observable without specific make and model information. For such spillover measures, engineers from the evaluation team conducted follow-up interviews with the customer to verify the reported efficiency-levels and operating characteristics needed to develop engineering estimates of savings for the installed measures.

Onsite Surveys. If the follow-up interview provided corroborating but insufficient evidence of the self-reported installation, the evaluation team conducted a limited number of onsite visits to verify measure installation and performance levels. The facilities chosen for on-site verification were selected based on spillover measures with large savings potential. For example, a chain of stores may report spillover measures being installed across all stores in the chain. Such a claim would justify a site visit at a subsample of stores to verify the installed measures, establish attribution back to the program (if needed) and obtain other data needed to compute savings.

Rejection of Potential Spillover Measures. In some cases, measures that were awarded attribution through the CATI survey were rejected after review. The rejections of sites based on information gained from callbacks may reduce the amount of sample, but ultimately increases the quality of the sample provided by minimizing measurement error. Spillover measures were rejected after a callback and a possible onsite visit for several reasons, including:

- the customer decision-makers had planned to install the equipment at that time of the CATI interview, but the project was ultimately never brought to completion;
- the customer ultimately received an incentive for the measure;
- survey error in which the interviewer was mistaken about the installation of equipment outside of the program; and
- propane was identified as the fuel source for the spillover measure.

However, in cases where the original contact was no longer available or the evaluation team was unable to make contact with the customer, the sample point was not dropped and remained in the spillover analysis. In these cases, the evaluation team developed spillover rates for the sample of measures that had sufficient information and applied that rate to the program savings of the sites where spillover savings could not be estimated.

CATI Survey: Program Attribution

To determine program attribution, a self-report telephone survey was administered to the customer sites that were contacted on behalf of the nonresidential impact evaluations. The spillover portion of the survey was designed to determine whether the installation of potential spillover measures was due to IOU rebates and incentives.

CATI Survey: Disposition and Response Rate

Table 44 shows the survey disposition for the 1,831 nonparticipant customers that were surveyed. In total 1,487 nonresidential downstream phone interviews were conducted for 2013-14 program participants and 344 IALC interviews were completed. In total, 275 phone survey respondents self-reported that they had installed additional measures outside IOU programs and did not receive a rebate for the measure installation. This represents roughly 14% of commercial participants and 19% of IALC participants.

Table 44. Participant Survey Dispositions and Response Rates (2013-14)

Disposition	Site Counts		
	COM	IALC	Total
Surveys Completed	1,487	344	**1,831**
Additional Measures Installed Without Rebate	208	67	**275**

Expansion Weights: Participant Spillover (2013-14)

The weights developed on behalf of the nonresidential impact studies were used to expand survey results to the population of program participants, but were modified to account for program level savings that were not explicitly evaluated throughout the 2013-14 program period. Note that the scope of the nonresidential impact studies was not at the program level, but addressed specific end-uses (e.g. Nonresidential Downstream Custom Lighting, Deemed Lighting, and Deemed Non-Lighting Impact Evaluation) or segments of the nonresidential sector (Industrial, Agricultural, and Large Commercial Evaluation) rather than a specific program. In order to develop spillover savings for the commercial and industrial program population, the evaluation team needed to include not only savings associated with measures that were explicitly evaluated, but any other program measures that the participants installed. For example, a customer could have installed LED A-lamps through an IOU program, which were evaluated as part of the downstream deemed lighting impact evaluation, but that customer may have also installed other measures through an IOU program; 1) another measure that the evaluation team was already evaluating like T5 linears or 2) lighting or non-lighting measures like non-high bay linear fluorescents or refrigeration equipment that were not explicitly evaluated. If that individual also installed a high efficiency HVAC system *outside* the program and met the evaluation team's criteria for attribution, then the total program savings needed to be accounted for in order to properly weight up the savings associated with spillover to the population of interest.

The measures that were explicitly evaluated as part of the COM and IALC studies represent roughly 62%, 69% and 81% of the total ex post lifecycle kW, kWh and therms savings associated with the two roadmaps. The associated measures, measures that were not explicitly evaluated as part of either study but were also installed by program participants that were included within each respective study's sample frame, represent 26%, 22% and 6% of total ex post lifecycle kW, kWh and therms savings. In total, the spillover savings that were estimated from the 2013-14 COM and IALC populations represent roughly 77%, 81% and 84% of total ex post lifecycle kW, kWh and therms savings, respectively.

Table 45. Total Ex Post Lifecycle Savings from Commercial and IALC Populations by Evaluation Type (2013-14)

	Ex Post Lifecycle		
	kW	kWh	Therms
Not Evaluated	784,073	3,829,069,142	118,968,938
Associated COM	405,703	2,138,255,864	17,142,708
Associated IALC	94,012	481,190,780	6,804,833
Evaluated COM	1,030,740	6,565,092,312	9,553,859
Evaluated IALC	1,087,733	7,574,419,199	598,458,794
Total	**3,402,262**	**20,588,027,296**	**750,929,132**

Determination of Influence and Calculation of Savings

Determine Program Influence on Measure Installation

For each potential spillover measure, the evaluation team determined the influence of IOU programs on the respondent's decision to purchase and install the given measure. To achieve this, the evaluation team relied upon self-reported program attribution.

Verify Measure Efficiency

Through a series of questions, the spillover battery determined to what extent IOU energy efficiency programs influenced the customer decision to install high-efficiency equipment outside of the program. The series of questions is as follows:

- Indication of measure installation: Respondents were asked if they installed a measure.
- Indication of high-efficiency level: Respondents were asked if the installed measure is high-efficiency.
- No incentive received: Respondents were asked whether they received an incentive for the installed equipment.
- Unprompted attribution: Respondents were asked in an open-ended manner why they installed the measure without applying for an incentive.
- Prompted attribution: Respondents were specifically asked whether their experience with the program influenced their decision.
- Program influence: Respondents were asked to rate on 10-point-scale how influential their experience with the program was in the decision to install the equipment;
- Likelihood of installation: Respondents were asked to rate on a 10-point-scale the likelihood that they would have installed the EE measure had they not participated in the program.

Spillover is ultimately awarded based on the responses to the program influence and likelihood of installation questions. The thresholds for awarding spillover are as follows:

- In the case of unprompted attribution, a program influence score of 5 or higher is required to award spillover.
- In the case of prompted attribution, a program influence score of 7 or higher is required to award spillover OR
- In the case of prompted attribution but the program influence threshold is not met, spillover is awarded if the likelihood of installation without the program is 4 or less.

These thresholds were chosen based on the expectation that scores would be distributed in a polarized manner and that relatively few responses would occur in the middle range. The survey results confirmed this expectation. However, a few program influence responses fell in the mid-range of scoring possibilities. To illustrate this point, Table 46 presents the minimum, maximum, and mean scores for program influence and program likelihood according to whether spillover was awarded or not. Notice that the minimum program influence score for prompted spillover sites was 5 while the mean score for prompted spillover sites was 8.0.

To ensure the inclusion of all potential spillover sites, regardless of threshold, this evaluation deviated from the original methodology in which prompted attribution required a program score of 7 or higher. For the few customer sites that reported a mid-range program influence score of 5 or 6, the open-end responses were reviewed to establish program causality. These sites were awarded spillover despite not meeting the prompted spillover threshold of 7 or greater.

Table 46. Distribution of Program Influence Score (2013-14)

	Max	Min	Mean
Prompted Spillover (n=93)	10	5	8.0
Unprompted Spillover (n = 20)	10	5	8.2
No Spillover (n = 196)	6	0	0.8

The likelihood without program score was also used to establish causality between IOU programs and the installation of energy-efficiency measures. These findings presented in Table 47 below confirm the expectations stated in the evaluation methodology. For example, the 16 site-measures that were awarded spillover based on the likelihood score (counterfactual spillover), all received a low likelihood of being installed without the program (4 and below). Site-measures that were not awarded spillover mostly received a high likelihood of being installed without the program, as evidenced by a mean score of 9.5. On the other hand, some customers failed the consistency check on the basis of their response to the prompted attribution questions and their responses to the program influence and likelihood. For example, some individuals said that the program encouraged them to implement the measure installation, but when asked to rate the program influence on a scale of 0-10, scored 0. They were then asked to explain the contradictory claims and they confirmed that the program had no influence. Similarly, individuals also stated that the program did not encourage them in any way to install the measure, but they scored zero on the likelihood of installation without the program. When asked to explain the seemingly divergent claims, these individuals confirmed that the program had no influence on their decision to install the equipment.

Table 47. Distribution of Likelihood Score (2013-14)

	Max	Min	Mean
Counterfactual Spillover (n = 16)	4	0	0.8
No Spillover (n = 196)	10	5	9.5
Failed Consistency Check (n = 9)	4	0	0.9

Estimate Savings for Energy-Efficient Measures

After determining counts of spillover measures, the evaluation team used the Database for Energy Efficient Resources (DEER) and IOU work papers as primary sources for determining ex ante unit energy savings. Ex-post savings values from the 2013-14 impact evaluations were incorporated into the analysis of participant spillover for most of the lighting measures.

The evaluation team calculated both first-year and lifecycle energy savings. To calculate lifecycle energy savings, the evaluation team applied effective useful life (EUL) estimates from DEER to first-year savings estimates along with updated EULs that utilized ex post data from the 2013-14 impact evaluations.[77]

5.2 Nonresidential Spillover Results

This section presents the results of the non-residential nonparticipant and participant research based on the methodology described above.

5.2.1 Nonparticipant and Participant Spillover Results (2010-2012)

Incidence of Nonparticipant and Participant Spillover

Table 48 describes how spillover was ultimately attributed through the spillover battery of the survey instrument. For the 253 nonparticipant sites that were identified as having non-rebated energy-efficiency equipment, 125 surveys were completed. Incomplete surveys represented those we were unable to connect with after several attempts or we were unable to connect with the individual most familiar with the CSS/CMST data collection effort (This was determined through a series of screening questions at the begin of the phone survey). Of these 125 completed surveys, 112 respondents recalled the installation of energy-efficiency measures, and 29 sites met the scoring threshold necessary to attribute spillover, thus resulting in a spillover incidence rate of 26%.

For the 282 participant sites that were identified as having non-rebated energy-efficiency equipment, 112 surveys were completed. Of these 112 completed surveys, 76 respondents recalled the installation of energy-efficiency measures, and 39 sites met the scoring threshold necessary to attribute spillover, thus resulting in a spillover incidence rate of 51%.

Table 48. Summary of Survey Results by Site: Nonparticipant and Participant Spillover (2010-12)

Disposition	Nonparticipant	Participant
Sites with EE Equipment	253	282
Phone Surveys Completed	125	112
Respondent Recalled EE Installation	112	76
Met Spillover Criteria	29	39
Spillover Incidence Rate (unweighted)	26%	51%

Table 49 presents the same results as presented above, but in terms of site-measures[78] rather than sites. Analysis of the CSS/CMST data identified 386 non-rebated energy-efficiency site-measures at nonparticipant sites and 450 such measures at participant sites. Phone surveys were conducted on behalf of 179 non-rebated energy-efficiency site-measures installed at nonparticipant sites and 184 such measures at participant sites. Surveyed nonparticipants were able to recall 135 non-rebated energy-efficiency site-measures; participants were able to recall 113 non-rebated participant site-measures. Ultimately, 35 site-

[77] Appendix I provides a more detailed description regarding the specific algorithms and impact approach.

[78] The term “site-measure” refers to each measure end-use identified at a given site, rather than individual measure count.

measures were identified among nonparticipants and 46 site-measures were identified among participants, thus providing a spillover site-measure incidence rate of 26% and 41% among nonparticipants and participants, respectively.

Table 49. Summary of Survey Results by Site-Measure: Nonparticipant and Participant Spillover (2010-12)

Disposition	Nonparticipant	Participant
EE Site-Measures Identified On-site	386	450
Surveyed EE Site-Measures	179	184
EE Site-Measures Recalled by Respondent	135	113
Met Spillover Criteria	35	46
Spillover Incidence Rate (unweighted)	26%	41%

Table 50 provides a breakdown of site measures that were ultimately awarded spillover for both participants and nonparticipants along with the total number of site-measures where the respondent recalled installing the measure. Lighting represents the most prevalent end use attributable to spillover for both participants and nonparticipants.

Table 50. Summary of Measure Specific Spillover: Nonparticipant and Participant Spillover (2010-12)

Measure	Nonparticipant		Participant	
	n Measures	**n Spillover**	**n Measures**	**n Spillover**
EMS	8	4	5	2
Lighting	79	27	77	35
HVAC	44	4	27	6
Refrigeration	4	-	4	3
Total	**135**	**35**	**113**	**46**

Calculation of Nonparticipant Spillover Savings (2010-12)

Calculation of Spillover Savings

Each of the site-measure specific savings estimates were summed up to the site level and weighted back up to the population of participants and nonparticipants. For nonparticipants, these data represent the weighted average spillover savings associated with sites that did not participant in an IOU program. For participants, this represents the weighted average savings associated with program participants who installed IOU program measures in 2010-12. Overall, the average first year kWh savings for nonparticipants is roughly 276 kWh and 314 kWh for participants. While there is significant variability around each of these values, which is evidenced by the precision estimates, there were some differences between the participant and nonparticipant samples that led to discernible differences in lifecycle savings. There was a higher incidence of nonparticipants installing high efficiency measures with shorter effective useful lives (EUL) like CFLs and LEDs than participants. The average therms savings is negative due to the much higher incidence of lighting measures being installed by both participants and nonparticipants. Table 51 below conveys those results.

Table 51. Attributable Nonresidential Participant and Nonparticipant Spillover Savings (2010-12)

<table>
<tr><th rowspan="2"></th><th rowspan="2">n</th><th colspan="3">First Year Savings</th><th colspan="3">Lifecycle Savings</th></tr>
<tr><th>kW</th><th>kWh</th><th>Therms</th><th>kW</th><th>kWh</th><th>Therms</th></tr>
<tr><td>Nonparticipant</td><td>125</td><td>0.07</td><td>276.19</td><td>-0.78</td><td>0.46</td><td>1,900.85</td><td>-5.04</td></tr>
<tr><td colspan="2">CI at 90%</td><td>± 0.05</td><td>±205.69</td><td>±.65</td><td>±0.30</td><td>±1,237.83</td><td>±4.96</td></tr>
<tr><td>Participant</td><td>112</td><td>0.07</td><td>314.40</td><td>-0.35</td><td>0.75</td><td>3,430.09</td><td>-2.95</td></tr>
<tr><td colspan="2">CI at 90%</td><td>±0.04</td><td>±179.23</td><td>±0.21</td><td>±0.54</td><td>±2459.47</td><td>±2.49</td></tr>
</table>

For nonparticipants this equates to a relative precision of 81%, 74% and 83% for first year kW, kWh and therms and 98% and 65% for lifecycle kWh and therms.
For participants this equates to a relative precision of 57%, 57% and 61% for first year kW, kWh and therms and 72% and 85% for lifecycle kWh and therms.

Total Nonparticipant and Participant Spillover Savings in the Population

After determining the per site average attributable spillover savings for nonparticipants and participants, the evaluation team estimated to the total attributable commercial population spillover savings for 2010-12. This was accomplished by multiplying the average per site spillover savings by the number of commercial sites in California that did not participate in an IOU program in 2010-12 for nonparticipant spillover and the total number of commercial sites that participated in IOU programs in the 2010-12 program period for participant spillover. Table 52 below conveys those results.

Table 52. Population Level Attributable Nonresidential Participant and Nonparticipant Spillover Savings (2010-12)

<table>
<tr><th rowspan="2" colspan="2"></th><th colspan="3">First Year Savings</th><th colspan="2">Lifecycle Savings</th></tr>
<tr><th>kW</th><th>kWh</th><th>Therms</th><th>kWh</th><th>Therms</th></tr>
<tr><td rowspan="3">Non participant</td><td>By Site Savings</td><td>0.07</td><td>276.19</td><td>-0.78</td><td>1,900.85</td><td>-5.04</td></tr>
<tr><td>Total Sites</td><td colspan="5">813,433</td></tr>
<tr><td>Total Savings</td><td>54,216</td><td>224,665,024</td><td>-636,232</td><td>1,546,218,078</td><td>-4,097,735</td></tr>
<tr><td rowspan="3">Participant</td><td>By Site Savings</td><td>0.07</td><td>314.40</td><td>-0.35</td><td>3,430.09</td><td>-2.95</td></tr>
<tr><td>Total Sites</td><td colspan="5">141,300</td></tr>
<tr><td>Total Savings</td><td>9,325</td><td>44,424,410</td><td>-49,119</td><td>484,671,812</td><td>-416,367</td></tr>
</table>

The combined CSS/CMST evaluations did not include agriculture and had limited on-site data from industrial businesses. Likewise, the studies did not include specific end-uses like plug loads, food service, water heating, building envelop and process equipment. In order to more accurately reflect the potential spillover rate associated with 2010-12 nonresidential participants, the evaluation team had to first exclude not only savings from the residential sector, but from these different end-uses as well. The total portfolio level lifecycle kWh savings associated with 2010-12 programs equaled roughly 67,106 GWh. The total lifecycle kWh savings associated with only the nonresidential sector was roughly 35,536 GWh. The total savings after further excluding the types of end-uses discussed above, left roughly 25,948 GWh of savings.

As presented in Table 53 and Table 54, there is significant variability in the overall spillover rate for nonparticipants relative to participants. The lifecycle kWh spillover rate for nonparticipants is 6.0% compared to 1.9% for participants. There is a marginal change in the spillover rate for participants from first year to lifecycle, whereas, there is a significant reduction in the rate for nonparticipants from first year to lifecycle. Again, this is best explained by the prevalence of installed measures with shorter EULs.

As mentioned above, the nonparticipant spillover savings (the numerator) are weighted up to the whole nonresidential frame whereas as the program savings (the denominator) represent the total nonresidential program savings minus several different end-uses (or 71% of ex post lifecycle GWh). Given the fact that the evaluation team has included 70% of program savings in the denominator and the numerator represents more than 70% of nonparticipants, the estimate of nonparticipant spillover rate may be overstated.

Table 53. First Year and Lifecycle Spillover Rate for 2010-12 Nonparticipants

	First Year Savings			Lifecycle Savings	
	kW	kWh	Therms	kWh	Therms
Spillover Savings	54,216	224,665,024	(636,232)	1,546,218,078	(4,097,735)
C&I Portfolio Savings	410,052	2,395,353,159	40,093,837	25,947,598,059	628,224,960
Spillover Rate	**13.2%**	**9.4%**	**-1.6%**	**6.0%**	**-0.7%**

Table 54. First Year and Lifecycle Spillover Rate for 2010-12 Participants

	First Year Savings			Lifecycle Savings	
	kW	kWh	Therms	kWh	Therms
Spillover Savings	9,325	44,424,410	(49,119)	484,671,812	(416,367)
C&I Portfolio Savings	410,052	2,395,353,159	40,093,837	25,947,598,059	628,224,960
Spillover Rate	**2.3%**	**1.9%**	**-0.1%**	**1.9%**	**-0.1%**

5.2.2 Participant Spillover Analysis (2013-14)

Incidence of Participant Spillover

Table 55 describes how spillover was ultimately attributed through the spillover battery of the survey instrument for 2013-14 participants. Of the 1,831 unique surveys administered to participants in the nonresidential studies, 116 customer sites met the scoring threshold necessary to attribute spillover, thus resulting in an initial spillover incidence rate of 6%. However, this initial spillover incidence was attributed before conducting follow-up interviews and onsite surveys. As discussed in Section 3.1.2.3, several measures that had initially passed the attribution algorithm were ultimately not awarded spillover based on information that was garnered from the engineering callbacks.

Table 55. Summary of Survey Results by Site: Participant Spillover (2013-14)

Disposition	Com	IALC	Total (2013-14)
Sites Surveyed	1,487	344	1,831
Reported the Non-rebated Installation of EE Measures	208	67	275
Met Spillover Criteria	90	26	116
Initial Spillover Incidence Rate (unweighted)	6%	8%	6%
Verified Spillover Sites (Confirmed by Callbacks)	62	11	73
Final Spillover Incidence Rate (unweighted)	4%	3%	4%

The 73 sites that were ultimately awarded spillover represent 81 unique site measures – 69 from commercial participants and 12 from IALC participants. Table 56 details the different end uses that were ultimately evaluated for spillover.

Table 56. Summary of Spillover Site Measures by End Use (2013-14)

Study	End use	n Measures
COM	Appliances	2
	Food Service	2
	HVAC	8
	Lighting	37
	Other	7
	Process	5
	Refrigeration	6
	Water Heater	2
IALC	EMS	3
	HVAC	4
	Lighting	1
	Other Equipment	1
	Process	3
	Total	**81**

Participant Spillover Savings (2013-14)

Participant Spillover Savings

Each of the site-measure specific savings were summed up to the site level and weighted back up to the population of 2013-14 commercial and IALC program participants. The following tables present the overall weighted spillover savings from each of the evaluation studies along with the margin of error.

The kW and kWh spillover rate for participants in the commercial roadmap are statistically difference from the spillover rates for IALC participants. Take for example, the lifecycle kWh spillover rate. The lower bound of spillover for commercial participants is 0.56% whereas the upper bound for IALC participants is 0.35%.

Overall, the first year and lifecycle spillover rate is greater for participants in the commercial roadmap than it is for IALC participants.

Table 57. First Year and Lifecycle Spillover Savings for 2013-14 Commercial Roadmap Participants

	First Year Savings			Lifecycle Savings		
	kW	kWh	Therms	kW	kWh	Therms
Spillover Savings	1,576	8,373,902	36,675	17,360	98,908,960	222,538
Portfolio Savings	135,819	751,912,704	3,238,534	1,362,856	8,231,274,765	42,686,195
Spillover Rate	**1.16%**	**1.11%**	**1.13%**	**1.27%**	**1.20%**	**0.52%**
CI at 90%	±0.54%	±0.55%	±1.51%	±0.68%	±0.64%	±0.63%

Table 58. First Year and Lifecycle Spillover Savings for 2013-14 IALC Roadmap Participants

	First Year Savings			Lifecycle Savings		
	kW	kWh	Therms	kW	kWh	Therms
Spillover Savings	293	1,317,355	68,570	4,353	19,063,306	1,106,003
Portfolio Savings	93,329	651,210,660	42,695,716	1,255,333	8,527,683,390	588,265,421
Spillover Rate	**0.31%**	**0.20%**	**0.16%**	**0.35%**	**0.22%**	**0.19%**
CI at 90%	±0.16%	±0.12%	±0.13%	±0.18%	±0.13%	±0.14%

Total Participant Spillover Savings (in the Population)

Table 59 presents the overall first year and lifecycle kW, kWh and therms spillover rates for the total evaluated nonresidential sector (including both the commercial and IALC population). The rates are also very similar when comparing first year savings to lifecycle savings. Overall, the average lifecycle kW, kWh and therms spillover rates are 0.83%, 0.70% and 0.21%, respectively.

Table 59. First Year and Lifecycle Spillover Savings for Combined 2013-14 IALC and Commercial Roadmap Participants

	First Year Savings			Lifecycle Savings		
	kW	kWh	Therms	kW	kWh	Therms
Spillover Savings	1,869	9,691,257	105,244	21,712	117,972,266	1,328,541
Portfolio Savings	229,148	1,403,123,363	45,934,250	2,618,188	16,758,958,154	630,951,616
Spillover Rate	**0.82%**	**0.69%**	**0.23%**	**0.83%**	**0.70%**	**0.21%**
CI at 90%	±0.32%	±0.29%	±0.20%	±0.36%	±0.32%	±0.21%

Additional 2013-14 Participant Research

As energy efficiency projects often have lead times of several years, not all projects may have been captured within the timeframe of the 2013-14 nonresidential participant spillover study. To address this potential gap, the evaluation team included an additional objective mid-study to assess whether or not customers were planning to complete additional energy efficiency projects within the next several years. The battery of questions included:

- Are you planning to implement any new energy efficiency measures in the future?
- If so, what measures do you plan to implement?
- When do you plan to implement this measure installation?
- Will you apply for a rebate for this measure installation?

As mentioned above, these questions were included in the survey instrument during the second phase of the 2013-14 nonresidential downstream evaluations. Of the 758 phone surveys that were completed during that phase, 312 customers stated that they had planned on installing new energy efficiency measures (41% of respondents).

These self-reported projects include a variety of end-uses. Table 60 conveys those results. Lighting technologies, which include both interior and exterior applications, represent the greatest share of upcoming project installations (35%), followed by HVAC (25%). Other, which includes a variety of measures – water heating, food service equipment, water conservation efforts, etc. – represents 15% and solar photovoltaics represent 10%.

Table 60. Self-Reported Energy Efficiency Measures Planned for Installation in the Future (2013-14 Nonresidential Downstream Participants)

Measures	n Sites	% of Upcoming Projects
Boiler	13	4%
Chiller	5	2%
EMS	6	2%
HVAC	79	25%
Lighting	109	35%
Other	47	15%
PV	31	10%
Process	17	5%
Refrigeration	5	2%
Total	**312**	**100%**

* These data are unweighted.

Customers were also asked about the timeframe in which they plan to install the additional energy efficiency measures. This question was asked in an open-ended manner and the responses were post-coded by the evaluation team into time periods. As presented below in Table 61, 33% and 36% of respondents self-reported that they would install additional energy efficient equipment within the next year and within one to two years, respectively. Note the total number of sites in Table 61 is 235 whereas the total above in Table 60 is 312. Both the question about timing and whether or not the customer would apply for a rebate were asked only about the first measure listed by the respondent. Several participants self-reported future installations of multiple end-uses.

Table 61. Self-Reported Timing of EE Installation (2013-14 Nonresidential Downstream Participants)

Measures	When do you plan to implement this measure installation?							
	ASAP	<1 yr	1-2 yrs	3-5 yrs	> 5 yrs	Ongoing	Don't Know	Didn't Answer
Boiler		6	3					
Chiller		1	3					
EMS		2	1					
HVAC	5	19	11	8		1	3	2
Lighting	6	36	27	5	2	6	14	
Other		12	15	2			4	1
PV	1	6	9	3	1		4	1
Process		3	7	1				
Refrigeration		1	1	1				1
Total	**12**	**86**	**77**	**20**	**3**	**7**	**25**	**5**
Percent	***5%***	***37%***	***33%***	***9%***	***1%***	***3%***	***11%***	***2%***

* These data are unweighted.

Finally, respondents were asked whether or not they would apply for a rebate when considering to implement the additional energy efficiency installation. Out of the 235 sites, 83% self-reported that they would apply for a rebate when considering installation of the additional energy efficient equipment. 6% did not know and the remaining 11% percent said that would not apply for a rebate. Table 62 conveys those results.

Table 62. Self-Reported Application for a Rebate for EE Installation (2013-14 Nonresidential Downstream Participants)

Measures	Will you apply for a rebate for this measure installation?		
	Yes	No	Don't Know
Boiler	9		
Chiller	3	1	
EMS	3		
HVAC	42	6	1
Lighting	84	6	6
Other	23	7	4
PV	18	4	3
Process	9	1	1
Refrigeration	4		
Total	**195**	**25**	**15**
Percent	***83%***	***11%***	***6%***

* These data are unweighted.

5.2.3 Nonparticipant Spillover Findings

Nonparticipant Spillover Finding #1

The weighted average first year kWh savings for each nonparticipant site was 276 kWh (±206) and the lifecycle kWh savings was roughly 1,900 kWh (±1,238). When aggregated up to the nonresidential frame, this resulted in a first year spillover rate of 9.4% and lifecycle rate of 6.0%. The drop from first year to lifecycle is best explained by the prevalence of CFL, LED and occupancy sensors within nonparticipant sites that installed high efficiency equipment throughout the 2010-12 period. These measures generally have shorter effective useful lives (EULs) than other lighting end-uses like linear fluorescent technologies.

Nonparticipant Spillover Finding #2

Nonparticipant spillover was more significant than participant spillover. The lifecycle kWh spillover rate for 2010-12 nonparticipants was 6.0% compared to 1.9% for participants through that same time period and 1.2% for nonresidential customers in the 2013-14 program period. (*note: this 1.2% excludes the industrial, agriculture and large commercial customers studied in 2013-14 because many of the end-uses that these customers installed – like process equipment – were not included in the CSS/CMST study*).

Nonparticipant Spillover Finding #3

The nonparticipant lifecycle kWh spillover rate of 6%, however, the lifecycle gas savings associated with nonparticipants installing measures outside the program was negative overall. The majority of nonparticipant spillover savings came from lighting measures that generally have a negative HVAC interactive effect. The CSS/CMST study did not cover many gas measures like high efficiency water heating or process equipment that could potentially lead to significant therms savings.

5.2.4 Participant Spillover Findings

Participant Spillover Finding #1

The overall lifecycle kWh spillover rate for 2013-14 nonresidential program participants was 0.7%. However, these program-induced savings were not developed at the program level. Rather, they represent an end-use and segment specific population of program participants. The spillover rate that was estimated for the evaluated COM population was roughly 1.20% and 0.22% for the evaluated IALC population. Large custom projects generally involve significant planning and utility involvement throughout all phases of the project (from inception to completion). This could lead to varying degrees of depth of retrofit when compared to other sectors.

Participant Spillover Finding #2

While the estimation of spillover from 2010-12 participants was a secondary research objective, it was implemented to help compare the estimates that were generated from the 2013-14 analysis. The overall spillover rate for 2013-14 nonresidential participants was very similar to the participant spillover rate that was estimated from 2010-12 participants at 1.2% (±.6) and 1.9 (±1.3), respectively (see note above regarding the 2010-12 participant rate).

Participant Spillover Finding #3

The evaluation team found that the vast majority of 2013-14 program participants were installing program induced measures at the same facility that they installed program measures. As such, this evaluation focused more on premise-level spillover potential and not customer level spillover potential. For customers that managed or were the decision-maker for multiply facilities across the state, it was difficult to determine in the phone interview what specific facilities they were thinking about when discussing program induced installations.

6. Statewide Spillover Values

The primary objective of this study is to assess the extent to which California's Investor Owned Utilities (IOUs) energy efficiency programs have resulted in program-induced participant and nonparticipant spillover in both the residential and nonresidential sectors. The California Public Utilities Commission (CPUC), in Decision 12-11-015 (D.12-11-015, issued on November 15, 2012) set in place a global 5% market effects value for the energy efficiency portfolio, including both the residential and nonresidential sectors. This research produces statewide spillover estimates for the residential and nonresidential sectors in California and develops recommendations for values to use in future program cycles.[79]

As described in Section 3.3, this study concentrates on spillover that is due to a program intervention but is not part of a larger structural change in the market. In other words, this spillover study is primarily focused on spillover that is perceived as such by end-users (i.e., residential and nonresidential customers). As a result, the study likely excludes some market effects, as there are bound to be market effects that end-users are not well positioned to observe. As such, by generally not accounting for market effects in our calculation of spillover, the evaluation team acknowledges that our spillover estimate likely constitutes a lower bound for overall spillover.

The preceding sections (Sections 4 & 5) discussed the research approach, methodology, data collection, and resulting residential and nonresidential spillover rates for IOU program participants and nonparticipants. This section brings those results together at a statewide level and provides recommendations on both when and how to apply the results as part of future IOU program impact reporting.

6.1 Derivation of Overall Spillover Rates

As discussed in detail within the preceding sections, the general approach used to calculate spillover rates is presented in Equation 5. The same equation is used to calculate both participant and nonparticipant spillover rates, with the denominator always represented by overall program savings and the numerator represented by either participant spillover savings or nonparticipant spillover savings.[80]

Equation 5. Spillover Rate

$$Spillover\ Rate = \frac{Spillover\ Savings}{Program\ Savings}$$

The residential study focused on programs while the nonresidential study focused on specific end-uses and segments of the nonresidential sector. Sections 4 & 5 describe the calculation of the spillover savings for the

[79] As described in the evaluation plan for this study, the goal of this study is to calculate a point estimate for spillover in California. While the study team compared the results to the 5% planning assumption for context, we did not intend for the study to be a hypothesis testing exercise to assess whether we can reject the null hypothesis of a 5% spillover rate. We believe this approach was supported in Decision 12-11-015, in which the CPUC noted that the 5% "market effects adjustment" was only a placeholder value until further research could be conducted and described in several places a desire to avoid "false specificity and accuracy in this important area when the appropriate research and data does not yet exist."

[80] It is important to keep in mind, however, that the participant study spanned the 2013-14 program cycle while the nonparticipant study spanned the 2010-12 program cycle. And, therefore, the spillover savings rates were calculated using program savings from the applicable cycle (i.e., 2013-14 for participant spillover and associated program savings and 2010-12 for nonparticipant spillover and associated program savings).

residential and nonresidential sectors, respectively. As described in those sections, due to limitations in data availability, the study team included most, but not all, program savings in the residential and nonresidential spillover rate analyses. However, for both sectors, the spillover rates developed for the covered programs and end-uses can be applied to future program cycles.

Notably, as discussed in the preceding sections, these results do not include the following:

- **Residential low-income programs** – The study team removed all low-income households from the nonparticipant spillover analysis and did not include low-income programs in the participant spillover analysis. Utilities typically assign a net-to-gross ratio of 1.0 to low-income programs because they assume that the participants lack the disposable income to purchase energy efficient measures without program incentives, meaning that there is no free-ridership or spillover associated with these programs.
- **Residential and nonresidential codes and standards programs** – The study team believes there is no direct causal mechanism through which one should expect to see end-user (e.g., residential and nonresidential customer) spillover given that codes and standards programs target architects, builders, and code officials and the end-user would likely be unaware of these types of interventions. These programs are not included in the denominator of the residential participant and denominator of the nonparticipant spillover rate estimates.

6.2 Statewide Spillover Results

This section provides a summary of the statewide nonparticipant and participant spillover results, including both the previously presented (Sections 4 & 5) residential and nonresidential spillover rates, and then presents the combined statewide spillover results. Because the 5% spillover value that was detailed in CPUC Decision D.12-11-015 is applied to gross lifecycle portfolio savings, this section shows total lifecycle spillover MWh and therm savings in order to accurately compare the evaluation results to the 5% adder. Comparisons between first year and lifecycle savings can be found in Sections 4 & 5 .

6.2.1 Statewide Nonparticipant Spillover Results

Table 63 presents the lifecycle statewide nonparticipant results for MWh, including both residential and nonresidential nonparticipant spillover. The study team estimated a lifecycle nonparticipant MWh spillover rate of 0.2% for the residential sector and 6.0% for the nonresidential sector. However, these values have relatively large confidence intervals at the 90% level: ±0.3% and ±3.9%, respectively.

Table 63. Statewide Lifecycle MWh Nonparticipant Spillover Results

Lifecycle Nonparticipant Spillover (2010-2012)	Sector		
	Residential	Nonresidential	Total
Total Spillover Savings (MWh)	66,890	1,546,218	1,613,108
Total 2010-12 Program Savings (MWh)[81]	28,039,300	25,947,598	53,986,898
Rate	0.2%	6.0%	3.0%
Confidence Interval at 90% Confidence	±0.3%	±3.9%	±1.9%
Lower Bound	-0.1%	2.1%	1.1%
Upper Bound	0.5%	9.8%	4.9%

Table 64 shows the lifecycle statewide nonparticipant results for lifecycle therms. The study team estimates a lifecycle nonparticipant therm spillover rate of 21.7% for the residential sector and -0.7% for the nonresidential sector. Similar to the MWh results, both the residential and nonresidential therm spillover rate estimates have large relative confidence intervals at the 90% level.

Table 64. Statewide Lifecycle Therms Nonparticipant Spillover Results

Lifecycle Nonparticipant Spillover (2010-2012)	Sector		
	Residential	Nonresidential	Total
Total Spillover Savings (Therms)	67,207,812	-4,097,735	63,110,077
Total 2010-12 Program Savings (Therms)	309,361,549	628,224,960	937,586,509
Rate	21.7%	-0.7%	6.7%
Confidence Interval at 90% Confidence	±31.2%	±0.6%	±10.3%
Lower Bound	-9.5%	-1.3%	-3.6%
Upper Bound	53.0%	0.0%	17.1%

A challenge for estimating natural gas spillover savings for both the residential and nonresidential sectors is that spillover savings and program savings (both the numerator and the denominator in the spillover savings equation) includes the impact of interactive effects. Interactive effects for electric measures effectively decrease overall therm savings (e.g., CFLs produce less heat than regular incandescent light bulbs and, therefore, more therms are used to heat homes with natural gas heating). The end-result is expressing overall therm related spillover savings (the numerator in the spillover rate equation), for either program participants or nonparticipants, over relatively low program therm savings (the denominator in the spillover rate equation).

Additionally, the high spillover rate for the residential sector appears to be due to cross-fuel effects resulting from the coexistence of relatively small gas programs with much larger electric programs, in which a customer

[81] The 2010-12 nonresidential program savings represent the total ex post lifecycle gross MWh savings associated with nonresidential programs excluding programs savings from specific end-uses not covered under the CSS/CMST study - plug loads, food service, water heating, building envelop and process equipment.

may participate in an electric program and is induced to purchase a non-program gas measure.[82] This results in a higher than expected spillover rate because the total therm spillover savings (the numerator) is divided by relatively low program therm savings (the denominator). Interactive effects amplify the cross-fuel effects: the therm penalties from the larger electric programs have a disproportionately negative impact on the program therm savings, reducing the denominator in the spillover equation and increasing the residential sector spillover rate.

6.2.2 Statewide Participant Spillover Results

Table 65 presents the lifecycle statewide participant results for MWh, including both residential and nonresidential participant spillover. The study team estimated a residential MWh lifecycle participant spillover rate of 1.4% (±1.2%) and a 0.7% (±0.3%) rate for nonresidential participants.

Table 65. Statewide Lifecycle MWh Participant Spillover Results

Lifecycle Participant Spillover (2013-2014)	Sector		
	Residential	Nonresidential	Total
Total Spillover Savings (MWh)	126,031	117,972	244,003
Total 2013-14 Program Savings (MWh)[83]	8,902,921	16,758,958	25,661,879
Rate	1.4%	0.7%	1.0%
Confidence Interval at 90% Confidence	±1.2%	±0.3%	±0.5%
Lower Bound	0.2%	0.4%	0.5%
Upper Bound	2.6%	1.0%	1.4%

Table 25 shows these results for lifecycle therms. The study team found a lifecycle therm participant spillover rate of 33.8% (±39.6%) for the residential sector and 0.2% (±0.2%) for the nonresidential sector.

[82] We considered cross-fuel effects from two perspectives. First, analysis of cases of residential participant spillover showed that the majority of spillover savings (both kWh and therms) were from participants of either electric-only programs or dual fuel programs with heavy focus on electric measures. Second, the ratio of electric savings to gas savings is much greater for the residential sector than for the nonresidential sector, suggesting that there is more potential for cross-fuel effects in the residential sector.

[83] The 2013-14 nonresidential program savings represent the total ex post lifecycle gross MWh savings associated with nonresidential end-uses and sectors that were explicitly evaluated as part of the commercial and IALC impact evaluation along with the savings associated with any additional program measures that the sample of participants installed throughout the 2013-14 program period.

Table 66. Statewide Lifecycle Therms Participant Spillover Results

Lifecycle Participant Spillover (2013-2014)	Sector		
	Residential	Nonresidential	Total
Total Spillover Savings (Therms)	28,280,323	1,326,934	29,607,258
Total 2013-14 Program Savings (Therms)	83,619,332	630,951,616	714,570,948
Rate	33.8%	0.2%	4.1%
Confidence Interval at 90% Confidence	±39.6%	±0.2%	±4.6%
Lower Bound	-5.8%	0.0%	-0.5%
Upper Bound	73.4%	0.4%	8.8%

As discussed above, the gas spillover rate is affected by both the inclusion of therm penalties from interactive effects and cross-fuel effects resulting from the coexistence of electric and gas programs.

6.2.3 Aggregated Statewide Spillover Results

Table 67 and Table 68 combine the results that were detailed above for nonparticipant and participant spillover.[84] Notably, given the relatively low incidence of spillover and the high variability of spillover savings, the precision around these estimates is relatively low resulting in large confidence intervals.

Table 67. Statewide kWh Total Spillover Rate Summary

	Residential	Nonresidential
Nonparticipant Spillover	0.2% ± 0.3%	6.0% ±3.9%
Participant Spillover	1.4% ± 1.2%	0.7% ±0.3%
Total Spillover	1.7% ± 1.2%	6.7% ±3.9%

Table 68. Statewide Therms Total Spillover Rate Summary

	Residential	Nonresidential
Nonparticipant Spillover	21.7% ± 31.2%	-0.7% ±0.6%
Participant Spillover	33.8% ± 39.6%	0.2% ±0.2%
Total Spillover	55.5% ± 50.4%	-0.4% ±0.7%

Comparing the spillover results by fuel, sector, and participation (participants vs. nonparticipants) revealed differences in the magnitude of spillover rates. Although the MWh participant spillover rate estimates for each sector are similar, the sector level estimated nonparticipant MWh spillover rates and both participant and nonparticipant therm spillover rates are substantially different.

[84] Again, it's important to note estimates for nonparticipant spillover are derived from 2010-12 studies and participant spillover is derived from 2013-14 program participants.

6.2.4 Additional Observations

There are a number of additional observations that bear on the spillover results presented in this study. The following observations provide important context when reviewing the results of this research.

- **Differences between nonparticipant and participant spillover.** In most cases, the spillover rate estimates for participant spillover were notably higher than for nonparticipant spillover. Participants and nonparticipants may not install the same types of measures outside of utility programs, resulting in different levels of spillover savings. Additionally, differences in the program types included in the analysis, the savings associated with those programs, and the large difference in the number of participants and nonparticipants may result in disparate participant and nonparticipant spillover rates.

- **Differences in the incidence of residential participant spillover by program.** We can confirm, at a statistically significant level, that residential customers who participated in programs requiring a large customer investment and high customer contact had a higher propensity to take spillover actions than did customers who participated in programs that did not have these characteristics.

- **Differences in the nonresidential participant spillover rates by project type.** While the lifecycle MWh spillover rate for 2013-14 nonresidential participants was 0.7%, this rate was not developed at a program level. Rather, it represents a combination of rates from the commercial population (1.20%) and the industrial, agricultural and large commercial population (0.22%). The differences between these rates may be due to the fact that large custom projects (the IALC population) involve significant planning and utility involvement throughout all phases of the project (from inception to completion). The detailed planning can often lead to deeper savings when compared to prescriptive projects and may result in few potential spillover opportunities after program participation.

6.3 Recommendation to Policymakers

In this section, we recommend how to apply the spillover rates determined through this study.

This study demonstrates that spillover is real and varies across several important factors. In Decision 12-11-015 (D.12-11-015), the CPUC set in place a global 5% market effects adjustment value for the entire energy efficiency portfolio, including both residential and nonresidential sectors. Our study indicates that spillover varies significantly across program participants and nonparticipants and, within these groups, by sector and fuel type.

Given the variability in spillover observed among programs and measures, we recommend that program-specific spillover research be completed in the future and, as these studies are completed, the global participant spillover values applied by the IOUs be replaced with program-specific values. **Until program-specific research is conducted, the study team sees no basis to recommend changes to the current adopted market effects adjustment that the IOUs continue to use – the current 5% market effects adjustment value**. It is important to note that the spillover savings rates developed from this study are not dramatically different from this adjustment at the portfolio level given the wide confidence intervals. Again, this research establishes that spillover exists and can vary quite significantly at the sector, fuel type and participant/nonparticipant level. While the evaluation team recommends careful consideration of the research conducted for this study when planning for future program activity, there are several important limitations to this study that preclude any recommendation to apply the specific quantitative spillover estimates developed in this research effort:

- As described in Section 3.3, the scope of spillover studied within this evaluation was limited to spillover perceived by end-users and did not include the overall impacts of market effects and market transformation. The methodology employed within this evaluation focused on a participant's experience with or a nonparticipant's knowledge of utility programs at a specific moment in time. This study did not include other types of program participants like contractors, builders, and architects – individuals in a better position to speak to meaningful structural changes in energy efficiency markets given their presence in those markets over time.

- As with any spillover study, we may not have captured all potential spillover due to the timing of the survey. In some cases, the length of time between the spillover activity and the survey may result in respondents' lack of recollection of the project or the program's influence on it.

- In other cases, not enough time may have passed for the respondent to implement all planned spillover activities. Energy efficiency projects often have lead times of several years and not all potential spillover projects may have been captured within the timeframe of this evaluation. A participant who installed an additional energy efficient measure outside the program in 2013, may also plan to install other measures in the near or medium term. As discussed in Section 5.2.2, the evaluation team asked nonresidential program participants whether they planned to install any new high efficiency equipment in the future and, if yes, when they planned to install the equipment, what type of equipment they planned to install, and if they planned to apply for a rebate when installing the equipment. While 83% of participants self-reported they would apply for a rebate in the future, the evaluation team had no way of quantifying those prospective claims given the forward-looking nature of the decision.

- Due to methodological decisions, this study did not directly cover all programs offered by IOUs:

  - This study does not cover codes and standards programs for both the residential and nonresidential sectors. The study team believes there is no direct causal effect for spillover from codes and standards programs from the end-user perspective because these target builders and code officials and the residential or nonresidential end-user would likely be unaware of the programs' interventions. While some additional savings may result from these programs, residential and nonresidential customers are not direct "participants" in these programs and therefore a participant spillover survey is not the appropriate method by which to assess these effects.

  - The residential participant survey excluded programs without contact information at the residential end user level from the sample. The claims database does not contain the necessary contact information to contact participants of programs such as multifamily, school-based, and new construction programs, as well as non-lighting upstream programs. While we did not survey participants of these programs, we applied the estimated spillover rate derived from other programs to these programs, and the true spillover rate may be higher or lower than the overall rate applied.

  - In order to minimize the amount of participant contact, the nonresidential participant survey questions were added only to surveys concurrently conducted on behalf of the nonresidential impact evaluations in 2013-14. This study relied upon samples developed on behalf of these evaluations. These studies were not developed at the program level, but addressed specific end-uses (e.g. Nonresidential Downstream Custom Lighting, Deemed Lighting, and Deemed Non-Lighting Impact Evaluation) or segments of the nonresidential sector (Industrial, Agricultural, and Large Commercial Evaluation) rather than a specific program. While those impact studies encompassed a significant percentage of portfolio level nonresidential lifecycle energy savings (81%), inherently some measures and programs were not included as a result. The spillover rate generated from the population of measures and market segments studied within the context of those impact evaluations was applied to the remainder of the nonresidential portfolio not studied. Spillover savings from these non-studied measures and market segments may not be similar in structure to those studied which could result in a larger or smaller overall spillover rate had the entire population of nonresidential measures and programs been evaluated as part of those impact evaluations.

  - This was also true for the nonresidential nonparticipant study. While having access to the data from the CSS/CMST was unprecedented in terms of the quality of data available, the spillover study was limited to the specific end-uses and market segments studied in the CSS/CMST. Similar to the nonresidential participant spillover study, the spillover savings generated from nonparticipant spillover were compared to program-level savings excluding the specific end-uses and market segments mentioned above, but the spillover rate was ultimately applied to the whole population of nonresidential portfolio savings. If the magnitude of spillover within those segments is less than that of those studied, the overall spillover rate for nonparticipants would be less than what was developed for this study (and vice versa).

- The application of the spillover rates determined through this research is most pertinent to future program portfolios that have similar characteristics to the portfolio of programs studied here. As with any prospective research, if the mix of measures/programs included in future portfolios and their relative contribution to overall portfolio savings should shift significantly, this research may become less pertinent and less applicable.

- The study leveraged existing baseline research (i.e., the CLASS and CSS/CSMT studies) for the nonparticipant spillover research because using data collected onsite by trained auditors decreased the uncertainty around characteristics of the installed equipment and, therefore, the spillover savings (i.e., it reduced measurement error). However, utilizing these studies constrained our sample sizes for nonparticipant research, which, coupled with the low incidence of NPSO, led to lower levels of precision due to sampling error.

- This study explores the savings from equipment installed outside of IOU programs (i.e., the benefits), but the scope did not include researching the impact of the costs of this equipment on the customer or the portfolio's cost effectiveness. Under the total resource cost (TRC) test, the cost of a spillover measure must be accounted for as well as its benefits. Because the mix of spillover measures differs from the mix of measures in the portfolio (along with their respective benefit/cost ratios), it is not correct to apply the same multiplier to the portfolio's costs and benefits. Further, if the benefit/cost ratio of the spillover measures is significantly different than the portfolio's, then applying the actual costs of the spillover measures could have significant effects on portfolio's TRC results.

6.3.1 Considerations for Future Research

Given the variability in spillover observed among programs and measures, this study recommends that program-specific spillover research be completed in the future and that the global participant spillover values found here be refined with program-specific values. This study recommends the prioritization of future research for programs with high contributions to portfolio savings and for programs with high propensity for spillover (i.e., programs with high levels of customer contact and large customer investment). Additional findings that are worthy of future research include:

- **Complete spillover research as part of future program-specific impact evaluations.** While the statewide research approach provides reliable estimates of participant and nonparticipant spillover at the portfolio level, a number of study findings in the residential sector point toward the need to conduct participant spillover research on a program-by-program basis. For example, residential customers who participated in programs requiring a large customer investment and high customer contact had a higher propensity to take spillover actions than did customers who participated in programs that did not have these characteristics.

- **Conduct further research on cross-fuel effects resulting from the coexistence of small residential natural gas programs with relatively large residential electric programs.** High residential natural gas spillover rates occur when large electric programs, in tandem with few incentives with natural gas measures, create cross-fuel effects. This typically occurs when a household participates in an electric program but is induced to purchase a natural gas measure outside of a program. Therefore, future spillover research should address electric and natural gas fuel types as well as interactive effects.

- **Continue market effects research.** Market effects are a subset of spillover savings that reflect meaningful changes in the structure or functioning of energy efficiency markets. In order to form a complete picture of spillover, additional research on market effects is needed. Such research has to be tailored to a specific market which cannot be easily accommodated as part of an overarching global spillover study.

- **Complete cross-cutting non-participant research on a two- or three-year cycle.** Since nonparticipant research is global in nature, such research should be repeated on a frequent basis at a global level.

Given these findings and the global nature of this research, the unique issues associated with individual programs may not have been fully captured. Future research conducted at a program-specific level can address these issues and provide program-level spillover rates with greater precision.

Appendix A. Residential Engineering Methods

Nonparticipant Spillover

To determine nonparticipant first-year spillover savings, we applied impacts from the Database for Energy Efficient Resources (DEER) wherever possible.

Lifecycle Savings

To determine nonparticipant lifecycle spillover savings, we applied effective useful lives (EULs) from DEER to our first-year saving estimates per Equation 6 below.

Equation 6. Lifecycle Spillover Savings Calculation

$$Lifecycle\ Spillover\ Savings = First\text{-}Year\ Spillover\ Savings * EUL$$

EULs were available from DEER for all measures in our analysis. Table 69 provides the EULs used in the nonparticipant spillover (NPSO) analysis.

Table 69. NPSO EUL Assumptions

Measure	EUL (Years)	DEER EUL ID
Clothes washer	11	Appl-EffCW
Cooling	15	HV-ResAC, HV-ResHP
Dishwasher	11	Appl-EffDW
Duct insulation	18	HV-DuctSeal
Freezer	11	Appl-ESFrzr
Heating	20	HV-EffFurn
Refrigerator	14	Appl-ESRefg
Roof insulation	20	BS-CeilIns
Wall insulation	20	BS-WallIns

Impacts from DEER

The DEER database includes both whole-house impacts, which include interactive effects, and end-use impacts, which account only for savings from the individual piece of equipment. We applied whole-house impacts because this approach, incorporating interactive effects, is consistent with how program savings are calculated. Within each impact type, DEER provides savings for two baseline cases: 1) preexisting and 2) code/standard. We applied DEER savings values using the code/standard baseline, where possible, for the following reasons:

- Since most installed measures replaced failed or failing equipment (i.e., they were not early replacements), the customer would have purchased and installed equipment anyway and this equipment would have to at least meet code requirements or minimum standards.
- The DEER database updates code/standard requirements for each revised version of the database, while the preexisting values are not regularly updated.

For insulation, the above code/standard baseline is not appropriate because the act of installing insulation, by default, is considered to be an improvement in energy efficiency. Therefore, we used "preexisting" insulation levels as the baseline. Our analysis choices are both informed by discussions with the DEER team and consistent with the participant spillover (PSO) analysis.

We applied DEER database savings for the following measures that qualified as attributable spillover:

- Cooling systems
- Heating systems
- Refrigerators, freezers, and clothes washers
- Duct sealing
- Insulation

During primary data collection, we also gathered some information indicating that investor-owned utility (IOU) programs have motivated installation of dishwashers. Per DEER, we do not assign energy savings to dishwashers as the market baseline is already efficient.[85]

Depending on the type of measure installed, the DEER database provides savings based on multiple criteria. We applied DEER savings for all measures based on the specific project location (California climate zone), home type (single-family, multifamily, or mobile home), and utility. Below we provide the assumptions for each measure listed above and the criteria used to apply DEER savings.

Cooling Systems

We applied DEER savings for cooling systems based on the inputs outlined in Table 70. Please note that the DEER database does not provide savings values for packaged air conditioners (ACs); therefore, all packaged units were assigned the split AC DEER savings values. We used the actual efficiency of the installed unit to determine the appropriate DEER savings value. In some cases, these did not align with the seasonal energy efficiency ratio (SEER) values provided within DEER, and therefore savings were applied using the DEER value with the closest SEER rating (e.g., 14.2 SEER was applied DEER savings for a 14 SEER unit). Additionally, the DEER database does not include savings values for 14.5 SEER; therefore, savings for these units are the average DEER values for 14 SEER and 15 SEER.

[85] The estimated market penetration of ENERGY STAR® dishwashers was 96% in 2011 (https://www.energystar.gov/ia/partners/downloads/unit_shipment_data/2011_USD_Summary_Report.pdf?1db4-45f7). Changes to ENERGY STAR certification could result in slightly decreased ENERGY STAR penetration in future years, but generally the market has been transformed.

Table 70. DEER Inputs for Cooling Measures

Inputs	Source/Notes
Measure Type	2012 California Lighting and Appliance Saturation Study (CLASS) study
California Climate Zone	
Utility	
Building Type	
Efficiency (SEER)	
Capacity (Tons)[a]	

[a] Not a DEER input, but needed to determine individual household spillover savings (spillover savings = DEER savings per ton * total tons per household).

Table 71 summarizes the per-measure DEER savings for each combination of inputs in Table 70 where at least one case (household) was found to have attributable spillover.

Table 71. Per-Measure DEER Savings for Cooling Measures

DEER Inputs					Spillover Savings per Ton		
Measure Type	California Climate Zone	Utility	Building Type	Efficiency (SEER)	kWh	kW	Therms
Packaged AC	11	PG&E	Single Family	14.0	39.50	0.054	-0.67
Packaged AC	13	PG&E	Single Family	14.2	46.80	0.077	-0.67
Packaged AC	13	PG&E	Single Family	14.5	57.65	0.074	-0.75
Packaged Heat Pump	9	SCE	Single Family	19.0	314.00	0.160	0.00
Split AC	6	SDG&E	Single Family	16.0	22.80	0.007	-0.19
Split AC	7	SDG&E	Multi-Family	17.0	31.80	0.017	-0.20
Split AC	8	SCE	Single Family	15.0	42.40	0.086	-0.68
Split AC	8	SDG&E	Single Family	16.0	23.10	0.079	-0.22
Split AC	12	PG&E	Single Family	14.5	34.65	0.072	-0.82
Split AC	12	PG&E	Single Family	15.0	42.90	0.077	-0.94
Split AC	15	SCE	Single Family	15.0	96.20	0.078	-0.19
Split AC	15	SCE	Single Family	18.0	130.00	0.094	-0.25
Split Heat Pump	9	SCE	Multi-Family	15.0	172.00	0.077	0.02
Split Heat Pump	10	SDG&E	Single Family	17.0	178.00	0.048	0.001
Split Heat Pump	11	PG&E	Single Family	16.0	186.00	0.044	0.001
Split Heat Pump	12	PG&E	Single Family	15.0	146.00	0.081	0.001

Heating Systems

We applied DEER savings for heating systems based on the inputs outlined in Table 72. The actual efficiency of the installed unit was used to determine the appropriate DEER savings value. In some cases, these did not align with the annual fuel utilization efficiency (AFUE) values provided within DEER, and therefore savings were applied using the DEER value with the closest AFUE rating (e.g., 92.4 AFUE was applied DEER savings for a 92 AFUE unit).

Table 72. DEER Inputs for Heating Measures

Inputs	Source/Notes
Measure Type	CLASS study
California Climate Zone	
Utility	
Building Type	
Fuel Type	
Efficiency (AFUE)	
Capacity (kBTUh)[a]	

[a] Not a DEER input, but needed to determine individual household spillover savings (spillover savings = DEER savings per kBTUh * Total kBTUh per Household).

Table 73 summarizes the per-measure DEER savings for each combination of inputs in Table 72 where at least one case (household) was found to have attributable spillover.

Table 73. Per-Measure DEER Savings for Heating Measures

DEER Inputs						Spillover Savings per kBTUh
Measure Type	California Climate Zone	Utility[a]	Building Type	Fuel Type	Efficiency (AFUE)	Therms
Split Gas Furnace	2	PG&E	Single-Family	Gas	92%	0.65
Split Gas Furnace	2	PG&E	Single-Family	Gas	95%	0.81
Split Gas Furnace	2	PG&E	Single-Family	Gas	96%	0.86
Split Gas Furnace	3	PG&E	Single-Family	Gas	96%	0.89
Split Gas Furnace	3	PG&E	Single-Family	Gas	97%	0.94
Split Gas Furnace	4	PG&E	Single-Family	Gas	95%	0.69
Split Gas Furnace	6	SCG	Single-Family	Gas	91%	0.31
Split Gas Furnace	6	SCG	Single-Family	Gas	96%	0.45
Split Gas Furnace	7	SDG&E	Single-Family	Gas	95%	0.40
Split Gas Furnace	8	SCG	Multifamily	Gas	92%	0.26
Split Gas Furnace	8	SCG	Multifamily	Gas	96%	0.35
Split Gas Furnace	9	SCG	Single-Family	Gas	92%	0.36
Split Gas Furnace	9	SCG	Single-Family	Gas	92%	0.36
Split Gas Furnace	10	SCG	Single-Family	Gas	91%	0.36
Split Gas Furnace	10	SCG	Single-Family	Gas	92%	0.39
Split Gas Furnace	10	SCG	Single-Family	Gas	96%	0.52
Split Gas Furnace	11	PG&E	Single-Family	Gas	92%	0.53
Split Gas Furnace	12	PG&E	Single-Family	Gas	92%	0.54
Split Gas Furnace	12	PG&E	Single-Family	Gas	93%	0.58
Split Gas Furnace	12	PG&E	Single-Family	Gas	93%	0.59
Split Gas Furnace	12	PG&E	Single-Family	Gas	94%	0.63
Split Gas Furnace	12	PG&E	Single-Family	Gas	95%	0.67

DEER Inputs						Spillover Savings per kBTUh
Measure Type	California Climate Zone	Utility[a]	Building Type	Fuel Type	Efficiency (AFUE)	Therms
Split Gas Furnace	13	PG&E	Single-Family	Gas	91%	0.47
Split Gas Furnace	16	SCG	Single-Family	Gas	95%	1.55
Split Gas Furnace	16	SCG	Single-Family	Gas	96%	1.65

[a] PG&E = Pacific Gas and Electric Company; SCG = Southern California Gas Company; SDG&E = San Diego Gas & Electric.

Refrigerators

We applied DEER savings for refrigerators based on the inputs outlined in Table 74. The DEER database provides savings based on size bins (in cubic feet) that differ by refrigerator type (i.e., side-by-side, top freezer, bottom freezer). We used the actual refrigerator size from CLASS data, but when this information was unavailable, we applied the DEER savings value using the average size (23 cubic feet) from CLASS data.

Table 74. DEER Inputs for Refrigerators

Inputs	Source/Notes
Measure Type	CLASS study
California Climate Zone	
Utility	
Building Type	
Appliance Type	
Size Bin (Cubic Feet)	
Through Door Ice Machine	

The refrigerator savings table is extremely long, and as such, we do not include it in the text of this appendix. Details on refrigerator savings can be found in the Refrigerators tab of the spreadsheet embedded in the DEER Savings Summary Spreadsheet section below. The spreadsheet summarizes the per-measure DEER savings for each combination of inputs in Table 74 where at least one case (household) was found to have attributable spillover.

Freezers

We applied DEER savings for freezers based on the inputs outlined in Table 75. Please note that the DEER database does not provide savings for freezers based on freezer size (cubic feet) like it does for refrigerators.

Table 75. DEER Inputs for Freezers

Inputs	Source/Notes
Measure Type	CLASS study
California Climate Zone	
Utility	
Building Type	
Appliance Type	
Defrost Type	

Table 76 summarizes the per-measure DEER savings for each combination of inputs in Table 75 where at least one case (household) was found to have attributable spillover.

Table 76. Per-Measure DEER Savings for Freezers

DEER Inputs						Spillover Savings per Appliance		
Measure Type	California Climate Zone	Utility	Building Type	Appliance Type	Defrost Type	kWh	kW	Therms
Freezer	2	PG&E	Single-Family	Upright	Automatic	55.40	0.013	−1.97
Freezer	3	PG&E	Single-Family	Upright	Automatic	52.90	0.012	−2.30
Freezer	4	PG&E	Single-Family	Upright	Automatic	57.20	0.012	−1.71
Freezer	7	SDG&E	Single-Family	Chest	Manual	34.10	0.005	−0.77
Freezer	7	SDG&E	Single-Family	Upright	Automatic	59.10	0.009	−1.34
Freezer	9	SCE	Single-Family	Upright	Automatic	65.90	0.013	−1.67
Freezer	10	SCE	Single-Family	Chest	Manual	38.50	0.008	−0.94
Freezer	10	SDG&E	Single-Family	Upright	Automatic	63.20	0.012	−1.60
Freezer	12	PG&E	Single-Family	Upright	Automatic	58.80	0.012	−1.68
Freezer	14	SCE	Single-Family	Upright	Automatic	65.60	0.013	−1.67
Freezer	16	SCE	Single-Family	Upright	Automatic	51.50	0.012	−2.21

Clothes Washers

We applied DEER savings for clothes washers based on the inputs outlined in Table 77. The DEER database provides highly granular clothes washer savings that vary by water heating fuel types, dryer fuel types, and Consortium for Energy Efficiency (CEE) tier. Additionally, DEER provides savings scaled to three assumed number of cycles per year (224 cycles per year, 272 cycles per year, or 292 cycles per year). For our analysis, we applied the DEER savings values for 272 cycles per year. We felt that 272 cycles per year was reasonable as it is the value that most closely resembles the average cycles per year (260 cycles per year) for California from the Residential Energy Consumption Survey (RECS).

Table 77. DEER Inputs for Clothes Washers

Inputs	Source/Notes
Measure Type	CLASS study
California Climate Zone	
Utility	
Building Type	
Size	Assigned based on the assumption that all clothes washers are for personal use and not for community use (such as common area for multifamily properties)
Savings Tier	Assigned based on Modified Energy Factor (MEF) in CLASS study. Tier 2 < 2.2 MEF Tier 3 ≥ 2.2 MEF
Water Heater Fuel	CLASS study

Inputs	Source/Notes
Dryer Fuel	Assigned based on space heating fuel, water heating fuel, and RECS data for California: • **Electric Dryer:** Home with non-gas space heating and water heating fuels • **Electric Dryer:** Applied RECS weight (47%) to number of homes with either gas space heating or gas water heating fuels • **Gas Dryer:** Applied RECS weight (52%) to number of homes with either gas space heating or gas water heating fuels
Cycles per Year	Determined average cycles per year from RECS for California and applied the DEER value that most closely aligned with the RECS average

The clothes washer savings table is extremely long, and as such, we do not include it in the text of this appendix. Details on clothes washer savings can be found in the Clothes Washers tab of the spreadsheet embedded in the DEER Savings Summary Spreadsheet section below. The spreadsheet summarizes the per-measure DEER savings for each combination of inputs in Table 77 where at least one case (household) was found to have attributable spillover.

Duct Sealing

We applied DEER savings for duct sealing based on the inputs outlined in Table 78.

Table 78. DEER Inputs for Duct Sealing

Inputs	Source/Notes
Measure Type	CLASS study
California Climate Zone	
Utility	
Building Type	
Duct Tightness	

The duct sealing savings table is extremely long, and as such, we do not include it in the text of this appendix. Details on duct sealing savings can be found in the Duct Sealing tab of the spreadsheet embedded in the DEER Savings Summary Spreadsheet section below. The spreadsheet summarizes the per-measure DEER savings for each combination of inputs in Table 78 where at least one case (household) was found to have attributable spillover.

Insulation

We applied DEER savings for insulation measures based on the inputs outlined in Table 79. DEER savings are applied per square foot of installed insulation. The area of installed insulation was not provided in the CLASS study. We estimated the area by using the conditioned floor area and number of stories provided within the CLASS study. We then multiplied the DEER savings values by the estimated area of installed insulation. Note that the heating fuel and presence of air conditioning is not included below as a DEER input. This is because we used the DEER value that is weighted by HVAC.

Table 79. DEER Inputs for Insulation Measures

Inputs	Source/Notes
Measure Type	CLASS study
California Climate Zone	
Utility	
Building Type	
Pre- and Post-R-values	Pre-R-values vary by home age and insulation type. • Attic Insulation: Home built pre-1978: R-0 (No building codes pre-1978) Home Built 1980–1989: R-19 (Title-24) • Wall Insulation: Home Built pre-1978: R-0 (No building codes pre-1978) Home Built 1980–1989: R-11 (Title-24) Post-R-value: From CLASS study

The insulation savings table is extremely long, and as such, we do not include it in the text of this appendix. Details on insulation savings can be found in the Attic Insulation and Wall Insulation tabs of the spreadsheet embedded in the DEER Savings Summary Spreadsheet section below. The spreadsheet summarizes the per-measure DEER savings for each combination of inputs in Table 79 where at least one case (household) was found to have attributable spillover.

DEER Savings Summary Spreadsheet

The spreadsheet embedded below summarizes the per-measure DEER savings for each combination of DEER inputs where at least one case (household) was found to have attributable spillover savings for the measures listed above.

DEER Per-measure Savings Summary.xlsx

Participant Spillover

To determine participant first-year spillover savings, we applied impacts from the DEER wherever possible. When this information was not available, we performed custom engineering calculations, using site- and California-specific inputs.

Lifecycle Savings

To determine participant lifecycle spillover savings, we applied EULs to our first-year saving estimates per Equation 7 below.

Equation 7. Lifecycle Spillover Savings Calculation

$$Lifecycle\ Spillover\ Savings = First\text{-}Year\ Spillover\ Savings * EUL$$

EULs were available from DEER for most measures in our analysis. Where EULs were unavailable in DEER, we reviewed technical reference manuals (TRMs) and selected appropriate values. Table 80 provides the EULs used in the PSO analysis.

Table 80. PSO EUL Assumptions

Measure	EUL (Years)	Source	DEER EUL ID
Clothes washer	11	DEER	Appl-EffCW
Split AC	15		HV-ResAC
Gas storage water heater	11		WtrHt-CntLrgStrg-Gas
Gas instantaneous water heater	20		WtrHt-CntLrgInst-Gas
Gas furnace	20		HV-EffFurn
Variable speed pool pump	10		OutD-PoolPump
Programmable thermostat	11		HV-ProgTstat
Refrigerator	14		Appl-ESRefg
Freezer	11		Appl-ESFrzr
Low-flow shower head	10		WtrHt-WH-Shrhd
Wall insulation	20		BS-WallIns
Air sealing	15	Illinois TRM	N/A
Clothes dryer	14		
Gas boiler	25		

Impacts from DEER

The DEER database includes both whole-house impacts, which include interactive effects, and end-use impacts, which account only for savings from the individual piece of equipment. We applied whole-house impacts because this approach, incorporating interactive effects, is consistent with how program savings are calculated. Within each impact type, DEER provides savings for two baseline cases: 1) preexisting and 2) code/standard. We applied DEER savings values using the code/standard baseline, where possible, for the following reasons:

- Since most installed measures replaced failed or failing equipment (i.e., they were not early replacements), the customer would have purchased and installed equipment anyway and this equipment would have to at least meet code requirements or minimum standards.
- The DEER database updates code/standard requirements for each revised version of the database, while the preexisting values are not regularly updated.

For insulation, the above code/standard baseline is not appropriate because the act of installing insulation, by default, is considered to be an improvement in energy efficiency. Therefore, we used "preexisting" insulation levels as the baseline. Our analysis choices are both informed by discussions with the DEER team and consistent with the NPSO analysis.

We applied DEER database savings for the following measures that qualified as attributable spillover:

- Cooling systems
- Heating systems

- Domestic hot water systems
- Refrigerators, freezers, and clothes washers
- Insulation

During primary data collection, we also gathered some information indicating that IOU programs have motivated installation of some equipment that we do not assign savings to, but might nevertheless be of interest to the California Public Utilities Commission (CPUC). We summarize these results below.

- **Dishwashers.** Program-motivated installations of ENERGY STAR® dishwashers in their homes were reported by 0.6% of participants. Per DEER, we do not assign energy savings to these measures, as the market baseline for these measures is already efficient.[86]
- **Efficient cooking equipment.** Program-motivated installations of self-reported efficient ovens, ranges, or stoves in their homes were reported by 0.6% of participants. There is no ENERGY STAR certification for efficient cooking equipment and no DEER savings defined for these measures. As such, we do not assign energy savings to these measures.

We also gathered information indicating that IOU programs have motivated installation of some equipment that cannot be classified as energy efficiency measures, but might nevertheless be of interest to the CPUC. We summarize these results below.

- **Solar PV installations.** Program-motivated installation of solar photovoltaic installations at their homes were reported by 1.3% of participants.
- **Water conservation measures.** Program-motivated installation of water conservation measures,[87] including low-flow toilets and low-volume irrigation systems, at their homes were reported by 0.6% of participants.

Depending on the type of measure installed, the DEER database provides savings based on multiple criteria. We applied DEER savings for all measures based on the specific project location (California climate zone) and home type (single-family, multifamily, or mobile home). Below we provide the assumptions for each measure listed above and the criteria used to apply DEER savings.

Cooling Systems

We applied DEER savings for cooling systems based on the inputs outlined in Table 81.

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[86] The estimated market penetration of ENERGY STAR dishwashers was 96% in 2011 (https://www.energystar.gov/ia/partners/downloads/unit_shipment_data/2011_USD_Summary_Report.pdf?1db4-45f7). Changes to ENERGY STAR certification could result in slightly decreased ENERGY STAR penetration in future years, but generally the market has been transformed.

[87] Water conservation measures that do not result in energy savings, e.g., cold water conservation.

Table 81. DEER Inputs for Cooling Measures

Inputs	Source/Notes
Measure Type	Participant survey response(s)
California Climate Zone	Climate zones mapped using participant addresses from participation database
Utility	Participation database
Building Type	Participant survey response(s)
Efficiency (SEER)	ENERGY STAR V4.0 minimum efficiency (active during the evaluation time period)
Capacity (Tons)	Default capacity from DEER

Table 82 summarizes the per-measure DEER savings for each combination of inputs in Table 81 where at least one case (household) was found to have attributable spillover.

Table 82. Per-Measure DEER Savings for Cooling Measures

DEER Inputs						Spillover Savings per Ton		
Measure Type	California Climate Zone	Utility	Building Type	Efficiency (SEER)	Capacity (Tons)	kWh	kW	Therms
Split AC	8	SCE	Single-Family	14.0	3.11	16.40	0.071	−0.43
Split AC	11	PG&E	Single-Family	14.0	3.50	39.50	0.055	−0.67
Split AC	12	PG&E	Single-Family	14.0	3.33	26.40	0.067	−0.70
Split AC	12	PG&E	Multifamily	14.0	1.65	27.10	0.044	−0.70
Split AC	13	PG&E	Single-Family	14.0	3.38	46.80	0.077	−0.67

Heating Systems

We applied DEER savings for heating systems based on the inputs outlined in Table 83.

Table 83. DEER Inputs for Heating Measures

Inputs	Source/Notes
Measure Type	Participant survey response(s)
California Climate Zone	Climate zones mapped using participant addresses from participation database
Utility	Participation database
Building Type	Participant survey response(s)
Fuel Type	Participant survey response(s)
Capacity (kBTUh)	Default capacity from DEER
Efficiency (AFUE)	Minimum ENERGY STAR eligible AFUE

Table 84 summarizes the per-measure DEER savings for each combination of inputs in Table 83 where at least one case (household) was found to have attributable spillover.

Table 84. Per-Measure DEER Savings for Heating Measures

DEER Inputs							Spillover Savings per kBTUh
Measure Type	California Climate Zone	Utility	Building Type	Fuel Type	Capacity (kBTUh)	Efficiency (AFUE)	Therms
Furnace	7	SDG&E	Mobile Home	Gas	55.1	90%	0.22
Furnace	10	SDG&E	Single Family	Gas	67.8	90%	0.31
Furnace	13	PG&E	Single Family	Gas	63.2	90%	0.43

Domestic Hot Water Systems

We applied DEER savings for domestic hot water systems based on the inputs outlined in Table 85. DEER provides savings for each combination of these inputs, combined with tank size and energy factor. We did not collect tank size and energy factor in the participant survey. Therefore, to determine the appropriate DEER savings to apply, we computed a weighted average of the DEER savings for each measure type, climate zone, utility, and building type combination.

Table 85. DEER Inputs for Domestic Hot Water Measures

Inputs	Source/Notes
Measure Type	Participant survey response(s)
California Climate Zone	Climate zones mapped using participant addresses from participation database
Utility	Participation database
Building Type	Participant survey response(s)
Water Heater Type	Participant survey response(s)
Fuel Type	Participant survey response(s)

Specifically, we made two sets of assumptions. First, we chose the energy factor in DEER for each tank size that was closest to the ENERGY STAR standard. Second, we used the 2010–2012 CLASS study to determine the share of water heaters of each tank size in the population.[88] Table 86 presents these assumptions.

Table 86. Energy Factor Used by Tank Size

Tank Size	Energy Factor	Share of Installed Water Heaters
30 gallons	0.65	11.8%
40 gallons	0.67	51.1%
50 gallons	0.67	30.6%
60 gallons	0.70	1.2%
75 gallons	0.70	5.3%

[88] We rebucketed tank sizes observed in CLASS, gathered as a continuous variable, into their closest DEER category.

Using the information in Table 86, we computed a weighted average of DEER savings for each measure type, climate zone, utility, and building type combination.

Table 87 summarizes the per-measure DEER savings for each combination of inputs in Table 85 where at least one case (household) was found to have attributable spillover. Table 87 also utilizes the assumptions in Table 86.

Table 87. Per-Measure DEER Savings for Domestic Hot Water Measures

DEER Inputs						Spillover Savings per Water Heater
Measure Type	California Climate Zone	Utility	Building Type	Water Heater Type	Fuel Type	Therms
Water Heater	2	PG&E	Single-Family	Storage	Gas	29.03
Water Heater	2	PG&E	Multifamily	Storage	Gas	26.10
Water Heater	3	PG&E	Single-Family	Storage	Gas	29.27
Water Heater	5	PG&E	Single-Family	Storage	Gas	28.84
Water Heater	7	SDG&E	Single-Family	Storage	Gas	27.65
Water Heater	7	SDG&E	Mobile Home	Storage	Gas	27.79
Water Heater	8	SCE	Single-Family	Storage	Gas	27.45
Water Heater	9	SCE	Single-Family	Storage	Gas	27.21
Water Heater	10	SCE	Single-Family	Storage	Gas	26.87
Water Heater	10	SDG&E	Mobile Home	Storage	Gas	27.41
Water Heater	12	PG&E	Single-Family	Storage	Gas	28.53
Water Heater	12	PG&E	Single-Family	Tankless	Gas	63.80
Water Heater	13	PG&E	Single-Family	Storage	Gas	26.87
Water Heater	13	PG&E	Multifamily	Storage	Gas	24.47

Refrigerators and Freezers

We applied DEER savings for refrigerators and freezers based on the inputs outlined in Table 88. The DEER database provides savings based on the actual unit type (e.g., single door, side-by-side, top freezer, chest, etc.). Given that we did not collect this information through the participant survey, we computed a weighted average of DEER savings for all available refrigerator and freezer types using data from the 2010–2012 CLASS study.

Table 88. DEER Inputs for Refrigerators and Freezers

Inputs	Source/Notes
Measure Type	Participant survey response(s)
California Climate Zone	Climate zones mapped using participant addresses from participation database
Building Type	Participant survey response(s)

Table 89 summarizes the per-measure DEER savings for each combination of inputs in Table 88 where at least one case (household) was found to have attributable spillover.

Table 89. Per-Measure DEER Savings for Refrigerators and Freezers

DEER Inputs				Spillover Savings per Appliance		
Measure Type	California Climate Zone	Utility	Building Type	kWh	kW	Therms
Refrigerator	1	PG&E	Single-Family	57.30	0.010	−2.63
Refrigerator	2	PG&E	Single-Family	67.36	0.016	−2.50
Refrigerator	3	PG&E	Single-Family	63.81	0.013	−2.93
Refrigerator	3	PG&E	Multifamily	68.86	0.011	−2.93
Refrigerator	6	SCE	Multifamily	78.07	0.012	−1.71
Refrigerator	7	SDG&E	Single-Family	72.03	0.014	−1.75
Refrigerator	7	SDG&E	Mobile Home	76.92	0.016	−1.56
Refrigerator	8	SCE	Single-Family	78.06	0.014	−1.78
Refrigerator	9	SCE	Single-Family	80.99	0.016	−2.17
Refrigerator	10	SCE	Single-Family	81.52	0.017	−2.10
Refrigerator	10	SDG&E	Single-Family	77.12	0.015	−2.06
Refrigerator	10	SDG&E	Mobile Home	81.64	0.016	−1.54
Refrigerator	12	PG&E	Single-Family	70.82	0.015	−2.13
Refrigerator	13	PG&E	Single-Family	79.56	0.016	−2.04
Refrigerator	13	PG&E	Multifamily	82.60	0.014	−1.63
Refrigerator	13	SCE	Single-Family	82.51	0.016	−2.09
Freezer	3	PG&E	Single-Family	38.74	0.009	−1.69
Freezer	12	PG&E	Single-Family	43.07	0.009	−1.23
Freezer	13	PG&E	Single-Family	48.35	0.009	−1.19

Clothes Washers

We applied DEER savings for clothes washers based on the inputs outlined in Table 90. DEER provides several choices for clothes washer savings:

- **Parameter-specific savings.** When detailed information is available, DEER provides highly granular clothes washer savings by hot water heating fuel types, dryer fuel types, and CEE tier.
    - Additionally, DEER provides these savings either on a per-cycle basis or scaled to common assumptions about cycles per year (savings are available scaled to 224, 272, and 292 cycles per year).
- **Cross-weighted savings.** DEER also provides “cross-weighted” savings reflecting the typical fuel types and cycles per year observed in California. These savings are provided individually for CEE Tier II and CEE Tier III clothes washers.

We used the cross-weighted savings as cycle counts and fuel types were not available to us. Additionally, we assumed CEE Tier II, the more conservative available savings in DEER.

Table 90. DEER Inputs for Clothes Washers

Inputs	Source/Notes
Measure Type	Participant survey response(s)
California Climate Zone	Climate zones mapped using participant addresses from participation database
Utility	Participation database
Building Type	Participant survey response(s)
Savings Tier	Most conservative DEER assumption available

Table 91 summarizes the per-measure DEER savings for each combination of inputs in Table 90 where at least once case (household) was found to have attributable spillover.

Table 91. Per-Measure DEER Savings for Clothes Washers

DEER Inputs					Spillover Savings per Clothes Washer		
Measure Type	California Climate Zone	Utility	Building Type	Savings Tier	kWh	kW	Therms
Clothes Washer	1	PG&E	Single-Family	CEE Tier II	92.60	0.017	7.45
Clothes Washer	2	PG&E	Multifamily	CEE Tier II	106.00	0.019	5.66
Clothes Washer	3	PG&E	Single-Family	CEE Tier II	92.20	0.016	7.26
Clothes Washer	3	PG&E	Multifamily	CEE Tier II	106.00	0.019	5.64
Clothes Washer	7	SDG&E	Single-Family	CEE Tier II	31.50	0.009	9.89
Clothes Washer	9	SCE	Single-Family	CEE Tier II	4.45	0.005	11.10
Clothes Washer	10	SDG&E	Single-Family	CEE Tier II	31.40	0.009	9.95
Clothes Washer	10	SDG&E	Multifamily	CEE Tier II	112.00	0.020	8.09
Clothes Washer	10	SDG&E	Mobile Home	CEE Tier II	25.00	0.007	8.71
Clothes Washer	10	SCE	Mobile Home	CEE Tier II	13.30	0.005	9.24
Clothes Washer	11	PG&E	Multifamily	CEE Tier II	105.00	0.019	5.48
Clothes Washer	12	PG&E	Single-Family	CEE Tier II	91.70	0.018	7.22
Clothes Washer	12	PG&E	Multifamily	CEE Tier II	106.00	0.019	5.58
Clothes Washer	13	PG&E	Single-Family	CEE Tier II	91.20	0.018	7.01
Clothes Washer	13	PG&E	Multifamily	CEE Tier II	105.00	0.019	5.36

Insulation

We applied DEER savings for insulation measures based on the inputs outlined in Table 92. DEER savings are applied per square foot of installed insulation. We multiplied the DEER savings values by the total area of installed insulation per project from participant survey responses.

Table 92. DEER Inputs for Insulation Measures

Inputs	Source/Notes
Measure Type	Participant survey response(s)
California Climate Zone	Climate zones mapped using participant addresses from participation database
Utility	Participation database
Building Type	Participant survey response(s)
Cooling Type	Participant survey response(s)
Heating Fuel Type	Participant survey response(s)
Pre-R-value	R-values vary by home age and insulation type. • Attic Insulation: Home Built Pre-1978: R-0 (No building codes pre-1978) Home Built 1980–1989: R-19 (Title-24) • Wall/Basement Insulation: R-0 (Assumed preexisting condition of no wall or basement wall insulation)
Post-R-value	Title-24 requirement as of 2008 • Attic Insulation: R-38 • Wall Insulation: R-13 • Basement Insulation: R-13

Table 93 summarizes the per-measure DEER savings for each combination of inputs in Table 92 where at least once case (household) was found to have attributable spillover. Note that DEER savings are applied per square foot of installed insulation.

Table 93. Per-Measure DEER Savings for Insulation Measures

DEER Inputs								Spillover Savings per Square Foot		
Measure Type	California Climate Zone	Utility	Building Type	Cooling Type	Heating Fuel Type	Pre-R-value	Post-R-value	kWh	kW	Therms
Attic Insulation	2	PG&E	Single-Family	None	Gas	R-0	R-38	n/a	n/a	0.19
Attic Insulation	3	PG&E	Single-Family	None	Gas	R-0	R-38	n/a	n/a	0.18
Attic Insulation	3	PG&E	Multifamily	None	Elec	R-0	R-38	0.02	0.000008	n/a
Attic Insulation	7	SDG&E	Single-Family	None	Gas	R-0	R-38	n/a	n/a	0.10
Attic Insulation	9	SCE	Single-Family	Central AC	Gas	R-0	R-38	0.76	0.000645	0.15
Attic Insulation	10	SCE	Single-Family	Central AC	Gas	R-19	R-38	0.05	0.000073	0.01
Attic Insulation	11	PG&E	Multifamily	Central AC	Gas	R-0	R-38	0.03	0.000012	0.01
Attic Insulation	12	PG&E	Single-Family	Central AC	Gas	R-0	R-38	0.67	0.000686	0.19

DEER Inputs								Spillover Savings per Square Foot		
Measure Type	California Climate Zone	Utility	Building Type	Cooling Type	Heating Fuel Type	Pre-R-value	Post-R-value	kWh	kW	Therms
Attic Insulation	12	PG&E	Single-Family	Central AC	Gas	R-19	R-38	0.05	0.000062	0.02
Attic Insulation	13	PG&E	Single-Family	Central AC	Gas	R-0	R-38	0.88	0.000667	0.18
Wall Insulation	9	SCE	Single-Family	None	Gas	R-0	R-13	n/a	n/a	0.09
Basement Insulation	3	PG&E	Single-Family	None	Gas	R-0	R-13	n/a	n/a	0.15

Spillover Measures using Algorithmic Approach

Respondents to our survey also reported installing low-flow shower heads, air sealing, heating (boilers), programmable thermostats, clothes dryers, and pool pumps due to program influence. These measures are not present in DEER and therefore we used alternative methods to calculate the resulting savings. The methodologies for calculating savings for these measures are presented below.

Shower Heads

To estimate savings from low-flow shower heads, we performed custom calculations taking into account the pre- and post-flow rate of the devices, assumed usage, water temperature, and other parameters. We used home- and California-specific data where possible.

The following equations determine the energy and gas savings for low-flow shower heads.

Equation 8. Low-Flow Shower Head Energy Savings

$$kWh\ savings_{Showerheads}\ (Electric\ water\ heater) = \frac{S\ x\ GPD_{saved} * 365 * (T_{mix} - T_{inlet})}{3412 * EF_{electric\ WH}} * \%Elec$$

Equation 9. Low-Flow Shower Head Demand Savings

$$kW\ savings_{Showerheads}(Electric\ water\ heater) = \frac{(gpm_{base} - gpm_{lowflow}) * 60 * S * (T_{mix} - T_{inlet})}{3412 * EF_{electric\ WH}} * CF * \%Elec$$

Equation 10. Low-Flow Shower Head Gas Savings

$$Therm\ savings_{Showerheads}\ (Gas\ water\ heater) = \frac{S\ x\ GPD_{saved} * 365 * (T_{mix} - T_{inlet})}{100{,}000 * EF_{gas\ WH}} * \ \%Gas$$

Equation 11. Gallons Saved per Day

$$Gallons\ Saved\ per\ Day\ (GPD_{saved}) = (Base\ Annual\ Water\ Usage_{Showerhead} - Low\ Flow\ Annual\ Water\ Usage_{Showerhead})$$

$$Base\ Annual\ Water\ Usage_{Showerhead} = gpm_{base} * (Number\ of\ people\ in\ household) * (minutes\ per\ shower\ per\ person) * (showers\ per\ person\ per\ day)/(number\ of\ showerheads\ per\ household)$$

$$Low - Flow\ Annual\ Water\ Usage_{Showerhead} = gpm_{low\ flow} * (Number\ of\ people\ in\ household) * (minutes\ per\ shower\ per\ person) * (showers\ per\ person\ per\ day)/(number\ of\ showerheads\ per\ household)$$

Where:

- S = Constant used to convert the weight of water from gallons to pounds (8.3 lbs/gallon)
- Gallons Saved per Day (GPD_{saved}) = The amount of water saved in gallons per day (see equations below)
- T_{mix} = Temperature of the water leaving the shower head
- T_{inlet} = Temperature of the water that enters the water heater
- EF = Efficiency factor of the water heater that is in operation
- %Elec = Percentage of California residents with electric water heaters
- %Gas = Percentage of California residents with gas water heaters
- gpm_{base} = The baseline flow rate in gallons per minute of the existing shower head
- $gpm_{lowflow}$ = Low-flow rate in gallons per minute of the shower head
- Coincidence Factor (CF) = A number between 0 and 1 indicating how many shower heads are expected to be in use and saving energy during the peak summer demand period

Table 94 summarizes the savings assumptions for low-flow shower heads and identifies the source of each assumption.

Table 94. Low-Flow Shower Head Variable Values and Assumptions

Variable	Value	Source
Minutes per shower per person	7.8	Michigan Showerhead and Faucet Aerator Meter Study; 2013
Showers per day per person	0.6	Michigan Showerhead and Faucet Aerator Meter Study; 2013
Shower heads per household	2.07	Weighted average for homes in the West built between 1973 and 2012; U.S. Department of Commerce[a]
People per household	Actual	Participant phone survey
Gpm_{base}	2.5	Federal standard flow rate for shower heads[b]
$Gpm_{lowflow}$	2.0	WaterSense standard released in 2010[b]
$Temperature_{inlet}$	Varies by location Arcata, CA: 57.3 °F Carlsbad, CA: 68.4 °F Livermore, CA: 63.5 °F Riverside, CA: 69.4 °F	DHW_Event Schedule Generator developed by NREL[c]; inlet water temperature varies by participant location
$Temperature_{mix}$	101 °F	Michigan Showerhead and Faucet Aerator Meter Study; 2013

Variable	Value	Source
Efficiency Factor (Electric Water Heater)	0.98	U.S. Department of Energy (DOE) Gama Directory from "Policy Recommendations for the HERS Community to Consider regarding HERS point credit for Waste Water Heat Recovery Devices"; Chinery, Glenn, March 2004[d]
Efficiency Factor (Gas Water Heater)	0.78	
%Elec	11%	RECS 2009 for California
%Gas	84%	RECS 2009 for California
CF	0.0067	Average across eight TRMs[e]
Conversion Factor (S)	8.33	Engineering constant in units of BTU/(gal °F)

[a] http://www.census.gov/construction/chars/pdf/c25ann2015.pdf.
[b] http://www.energy.ca.gov/title24/2013standards/prerulemaking/documents/current/Reports/Residential/Water_Heating/2013_CASE_R_Shower_Heads_Sept_2011.pdf.
[c] http://www1.eere.energy.gov/buildings/residential/ba_analysis_spreadsheets.html.
[d] https://www.energystar.gov/ia/partners/bldrs_lenders_raters/downloads/Waste_Water_Heat_Recovery_Guidelines.pdf.
[e] Average across the following TRMs: Indiana TRM (V2.2), Illinois TRM (V5.0), Connecticut (2013), Maine (2014), Mid-Atlantic (V4.0), Ohio (2012), Pennsylvania (2016), Wisconsin (2014).

Savings vary based on project location and household occupancy. Therefore, Table 95 presents the *average* per-measure savings for low-flow shower heads using the algorithms and variable assumptions presented above.

Table 95. Average Per-Measure Savings for Low-Flow Shower Heads

Measure	Average kWh per Shower Head	Average kW per Shower Head	Average Therms per Shower Head
Low-Flow Shower Head[a]	59.57	0.002	20.24

[a] Assumed one shower head per household.

Air Sealing

We estimated home and window air sealing savings using an algorithmic approach that assumes pre- and post-air pressure in a home based on ENERGY STAR assumptions for air sealing windows, doors, and whole homes. We took into account home-specific values, such as square footage, weather data, and the number of windows and doors sealed.

The following equations determine the energy and gas savings for air sealing and weatherstripping.

Equation 12. Air Sealing Energy Savings

$$kWh\ Cooling\ savings_{Air\ Sealing} = \frac{\left(\dfrac{\dfrac{CFM50_{base} - CFM50_{AirSealed}}{Nfactor} * 60 * 24 * CDD * DUA * 0.018}{1000 * nCool * LM}\right)}{\left(\dfrac{CFA\!:Natural\ Light\ Ratio * SF_{home}}{SF_{Typical\ Window}}\right)} * Windows_{Sealed}$$

$$kWh\ Electric\ Heating\ savings_{Air\ Sealing} = \frac{\left(\frac{\frac{CFM50_{base} - CFM50_{AirSealed}}{Nfactor} * 60 * 24 * HDD * 0.018}{COP * 3412}\right)}{\left(\frac{CFA: Natural\ Light\ Ratio * SF_{home}}{SF_{Typical\ Window}}\right)} * Windows_{Sealed}$$

Equation 13. Air Sealing Demand Savings

$$kW\ savings_{Air\ Sealing} = \frac{kWh\ Cooling\ savings_{Air\ Sealing}}{EFLH_{Cool}} * CF$$

Equation 14. Air Sealing Gas Savings

$$Therm\ savings_{Air\ Sealing} = \frac{\left(\frac{\frac{CFM50_{base} - CFM50_{AirSealed}}{Nfactor} * 60 * 24 * HDD * 0.018}{AFUE * 100{,}000}\right)}{\left(\frac{CFA: Natural\ Light\ Ratio * SF_{home}}{SF_{Typical\ Window}}\right)} * Windows_{Sealed}$$

Where:

- $CFM50_{base}$ = Initial air flow measured in cubic feet per minute (cfm), pressurized at 50 pascal to determine the amount of leakage in the home prior to any air sealing measures
- $CFM50_{AirSealed}$ = Air flow measured in cfm, pressurized at 50 pascal to determine the amount of leakage in the home after installing air sealing measures
- Nfactor = Constant used to convert 50 pascal air flow to natural airflow, which is dependent on exposure levels
- CDD = Cooling degree days
- HDD = Heating degree days
- DUA = Discretionary use adjustment that accounts for people who do not always operate their cooling equipment when conditions may call for it
- nCool = Efficiency (in SEER) of the existing cooling equipment
- COP = COP of the existing electric heating equipment
- AFUE = AFUE of the existing gas heating equipment
- LM = Latent multiplier to account for latent cooling demand
- CFA:Natural Light Ratio = Building code requirement of natural light as a function of conditioned floor area
- SF_{home} = Conditioned floor square footage of the home
- $SF_{Typical\ Window}$ = Square footage of a typical sized window
- $Windows_{Sealed}$ = Actual quantity of windows sealed
- $EFLH_{Cool}$ = Effective full load cooling hours

- CF = A number between 0 and 1 indicating how many cooling units are expected to be in use and saving energy during the peak summer demand period

Table 96 summarizes the savings assumptions for air sealing and identifies the source of each assumption.

Table 96. Air Sealing Variable Values and Assumptions

Variable	Value	Source
$CFM50_{base}$	$CFM50_{base}$ = $ACH50_{base}$ * Home Volume/60	$ACH50_{base}$ = 18.20 for ENERGY STAR Climate Zone 3 for air sealing windows, doors, and walls.[a] Home volume varies by project; calculated by multiplying home square footage by assumed 8' ceiling.
$CFM50_{AirSealed}$	$CFM50_{AirSealed}$ = $ACH50_{AirSealed}$ * Home Volume/60	$ACH50_{AirSealed}$ = 17.70 for ENERGY STAR Climate Zone 3 for air sealing windows, doors, and walls (based on 2.5% infiltration reduction).[a] Home volume varies by project; calculated by multiplying home square footage by assumed 8' ceiling.
Nfactor	19.58	Average for Normal Exposure for Climate Zones 3 and 4.[b]
CDD	Eureka, CA = 1,888 Fresno, CA = 2,097 Oakland, CA = 155 Red Bluff, CA = 1,888 Riverside, CA = 1,606 San Diego, CA = 1,197 Stockton, CA = 1,382	ASHRAE Fundamentals (2013); varies by project location.
HDD	Eureka, CA = 2,724 Fresno, CA = 2,266 Oakland, CA = 2,637 Red Bluff, CA = 2,724 Riverside, CA = 1,567 San Diego, CA = 673 Stockton, CA = 2,448	ASHRAE Fundamentals (2013); varies by project location.
DUA	0.75	Energy Center of Wisconsin, May 2008 metering study; "Central Air Conditioning in Wisconsin, A Compilation of Recent Field Research"
nCool	13 SEER	DOE minimum efficiency standard[c].
COP	1.0	DOE minimum efficiency standard[c].
AFUE	78% AFUE	DOE minimum efficiency standard[c]
LM	3.9	LM for Las Vegas, NV (closest to California climate) from "Dehumidification and Cooling Loads from Ventilation Air" from ASHRAE Journal.
CFA:Natural Light Ratio	8%	International Code Council Section 1205.2 requires 8% of conditioned floor area of natural light[d].
SF_{home}	Actual	Varies by project; from participant survey.
$SF_{Typical\ Window}$	15	Engineering judgment; assumes 3x5 window.
$Windows_{Sealed}$	Actual	Varies by project; from participant survey.
$EFLH_{Cool}$	Beverly Hills, CA = 1,166 Palm Springs, CA = 2,092 Sacramento, CA = 871 San Diego, CA = 1,347 San Francisco, CA = 224 Stockton, CA = 1,158	EPA 2002; varies by project location; used closest city available to the project location city.
CF	0.75	Average across 12 TRMs[e].

[a] https://www.energystar.gov/ia/home_improvement/home_sealing/Measure_Upgrade_Assumptions.pdf?945a-eddc.
[b] http://www.waptac.org/data/files/Website_docs/Technical_Tools/Building%20Tightness%20Limits.pdf.

[c] http://www.ecfr.gov/cgi-bin/text-idx?SID=2942a69a6328c23266612378a0725e60&mc=true&node=se10.3.430_132&rgn=div8.
[d] http://www.ecodes.biz/ecodes_support/free_resources/2013California/13Building/PDFs/Chapter%2012%20-%20Interior%20Environment.pdf.
[e] Average across 12 TRMs: Alaska, Connecticut (2013, 8th ed.), Hawaii (PY2015, V17, Illinois (V5.0, Vol 3), Indiana (V2.2), Mid-Atlantic (V4.0), Minnesota (V1, 2014), New York (V4), Ohio (2012), Pennsylvania (2013), Rhode Island (PY2014), Texas (V2.0, PY2015).

Savings vary by project location, conditioned floor area, cooling and heating equipment, and the number of sealed windows. Therefore, Table 97 presents the *average* per-measure savings for air sealing using the algorithms and variable assumptions presented above.

Table 97. Average Per-Measure Savings for Air Sealing

Measure	Average kWh per Sealed Window	Average kW per Sealed Window	Average Therms per Sealed Window
Air Sealing	65.96	0.027	4.32

Heating (Boilers)

To estimate savings from energy-efficient gas boilers, we applied the algorithm provided in the Uniform Methods Project (UMP),[89] using home- and California-specific inputs wherever possible.

The following equation determines the gas savings for energy-efficient gas boilers.

Equation 15. Energy-Efficient Boiler Gas Savings

$$Therm\ savings_{Boilers} = EFLH_{heat} * BTUh * \left(\frac{AFUE_{eff}}{AFUE_{base}} - 1\right) * therm/MMBTU$$

Where:

- $EFLH_{heat}$ = Effective full load heating hours
- BTUh = Capacity of heating system
- $AFUE_{eff}$ = Annual fuel utilization efficiency of the installed high-efficiency boiler
- $AFUE_{base}$ = Annual fuel utilization efficiency of the baseline code compliant/standard boiler
- therm/MMBTU = Conversion factor that converts from MMBTU to therms

[89] The Uniform Methods Project (UMP): Chapter 5: Residential Furnaces and Boilers Evaluation Protocol. April 2013. http://energy.gov/sites/prod/files/2013/11/f5/53827-5.pdf.

Table 98 summarizes the savings assumptions for energy-efficient gas boilers and identifies the source of each assumption.

Table 98. Energy-Efficient Boiler Variable Values and Assumptions

Variable	Value	Source
$EFLH_{heat}$	2016	EPA 2002 for Sacramento, California
BTUh	26,160	Default capacity from DEER
$AFUE_{eff}$	0.90	Lowest qualifying ENERGY STAR efficiency rating in California
$AFUE_{base}$	0.80	DOE minimum efficiency standard[a]
therm/MMBTU	10^{-6}	Engineering constant to convert from MMBTU to therms

[a] http://www.ecfr.gov/cgi-bin/text-idx?SID=2942a69a6328c23266612378a0725e60&mc=true&node=se10.3.430_132&rgn=div8.

Table 99 presents the per-measure savings for energy-efficient boilers using the algorithms and variable assumptions presented above.

Table 99. Per-Measure Savings for Energy-Efficient Boilers

Measure	kWh per Boiler	kW per Boiler	Therms per Boiler
Energy-Efficient Boiler	N/A	N/A	66.02

Programmable Thermostats

To estimate savings from programmable thermostats, we calculated home-specific values for heating and cooling loads based on location and updated other parameters as necessary to generate a savings estimate appropriate for California homes. All participants who indicated installing programmable thermostats identified that the fuel used to heat their homes is gas. As such, we do not include electric heating savings calculations or assumptions within this section.

The following equations determine the energy and gas savings for programmable thermostats.

Equation 16. Programmable Thermostat Energy Savings

$$kWh\ savings_{Pstat}\ (Cooling) = \frac{\frac{1}{nCool} * EFLH_{Cool} * BTUH_{Cool}}{1000} * ESF_{Cool}$$

Equation 17. Programmable Thermostat Demand Savings

$$kW\ savings_{Pstat}\ (Cooling) = \frac{kWh\ savings_{Pstat}(Cooling)}{EFLH_{cool}} * CF$$

Equation 18. Programmable Thermostat Gas Savings

$$Therm\ savings_{Pstat}\ (Heating) = \frac{EFLH_{Heat} * BTUH_{Heat}}{100{,}000} * ESF_{Heat}$$

Where:

- $EFLH_{Cool}$ = Effective full load cooling hours
- $EFLH_{Heat}$ = Effective full load heating hours
- $BTUH_{Cool}$ = Capacity of cooling system
- $BTUH_{Heat}$ = Capacity of heating system
- nCool = Efficiency (in SEER) of the existing cooling equipment
- ESF_{Cool} = Energy Savings Factor for cooling
- ESF_{Heat} = Energy Savings Factor for heating
- CF = A number between 0 and 1 indicating how many cooling units are expected to be in use and saving energy during the peak summer demand period

Table 100 summarizes the savings assumptions for programmable thermostats and identifies the source of each assumption.

Table 100. Programmable Thermostat Variable Values and Assumptions

Variable	Value	Source
$EFLH_{Cool}$	Sacramento, CA: 871 Stockton, CA: 1,158	EPA 2002 specific to project location for participants who indicated installing programmable thermostats
$EFLH_{Heat}$	Sacramento, CA: 2,016 Stockton, CA: 1,834	EPA 2002 specific to project location for participants who indicated installing programmable thermostats
$BTUH_{Cool}$	42,000	Default capacity from DEER
$BTUH_{Heat}$	Multifamily (CZ3): 25,700 Single-Family (CZ11): 65,700	Default capacity from DEER
nCool	13	DOE minimum efficiency standard[a]
ESF_{Cool}	0.066	Average across four TRMs[b]
ESF_{Heat}	0.062	Average across seven TRMs[c]
CF	0.75	Average across 12 TRMs[d]

[a] http://www.ecfr.gov/cgi-bin/text-idx?SID=2942a69a6328c23266612378a0725e60&mc=true&node=se10.3.430_132&rgn=div8.
[b] Average across the following TRMs: Indiana TRM (V2.2), Pennsylvania (2016), Massachusetts (2013), New York (2014).
[c] Average across the following TRMs: Indiana TRM (V2.2), Illinois TRM (V5.0), Mid-Atlantic (V4.0), Ohio (2012), Pennsylvania (2016), Massachusetts (2013), New York (2014).
[d] Average across the following TRMs: Alaska, Connecticut (2013, 8th ed.), Hawaii (PY2015, V17, Illinois (V5.0, Vol 3), Indiana (V2.2), Mid-Atlantic (V4.0), Minnesota (V1, 2014), New York (V4), Ohio (2012), Pennsylvania (2013), Rhode Island (PY2014), Texas (V2.0, PY2015).

Savings vary per project based on each participant's utility provider, project location, and cooling and heating equipment. Therefore, Table 101 presents the *average* per-measure savings for programmable thermostats using the algorithms and variable assumptions presented above.

Table 101. Average Per-Measure Savings for Programmable Thermostats

Measure	Average kWh per Pstat	Average kW per Pstat	Average Therms per Pstat
Programmable Thermostat	92.86	0.080	55.67

Clothes Dryers

To estimate savings from clothes dryers, we applied algorithms based on the ENERGY STAR Appliance Calculator to calculate savings individually for electric and gas clothes dryers. We then calculated a weighted average by applying dryer fuel weights from 2009 RECS data, specific to California, and applied these savings uniformly to each respondent who reported installing an energy-efficient clothes dryer.

The following equations determine the energy and gas savings for energy-efficient clothes dryers.

Equation 19. Clothes Dryer Energy Savings

$$kWh\ savings_{Clothes\ Dryer}\ (Electric\ dryer) = \left[\left(\frac{Load}{CEF_{base}} - \frac{Load}{CEF_{eff}}\right) * Ncycles * \%ElecSavings_{Elec\ Dyer} * \%Elec_{Dryer}\right] + \left[\left(\frac{Load}{CEF_{base}} - \frac{Load}{CEF_{eff}}\right) * Ncycles * \%ElecSavings_{Gas\ Dryer} * \%Gas_{Dryer}\right]$$

Equation 20. Clothes Dryer Demand Savings

$$kW\ savings_{Clothes\ Dryer}(Electric\ dryer) = \frac{kWh\ savings_{Clothes\ Dryer}}{Hours} * CF$$

Equation 21. Clothes Dryer Gas Savings

$$Therm\ savings_{Clothes\ Dryer}\ (Gas\ dryer) = \left[\left(\frac{Load}{CEF_{base}} - \frac{Load}{CEF_{eff}}\right) * Ncycles * \%GasSavings_{Elec\ Dryer} * \%Elec_{Dryer}\right] + \left[\left(\frac{Load}{CEF_{base}} - \frac{Load}{CEF_{eff}}\right) * Ncycles * \%GasSavings_{Gas\ Dryer} * \%Gas_{Dryer}\right]$$

Where:

- Load = Average weight (in pounds) of clothes per drying cycle
- CEF_{base} = Combined energy factor (lbs/kWh) of a federal standard baseline clothes dryer
- CEF_{eff} = Combined energy factor (lbs/kWh) of the installed energy-efficient clothes dryer
- N_{cycles} = Number of cycles per year
- $\%ElecSavings_{Elec\ Dryer}$ = The overall percentage of electric savings for installing an electric energy-efficient clothes dryer
- $\%ElecSavings_{Gas\ Dryer}$ = The overall percentage of electric savings for installing a gas energy-efficient clothes dryer
- $\%Elec_{Dryer}$ = Percentage of California residents with electric clothes dryers

- $\%Gas_{Dryer}$ = Percentage of California residents with gas clothes dryers
- $\%GasSavings_{Elec\ Dryer}$ = The overall percentage of gas savings for installing an electric energy-efficient clothes dryer
- $\%GasSavings_{Gas\ Dryer}$ = The overall percentage of gas savings for installing a gas energy-efficient clothes dryer
- Hours = Number of hours the clothes dryer is in operation per year
- CF = A number between 0 and 1 indicating how many clothes dryers are expected to be in use and saving energy during the peak summer demand period

Table 102 summarizes the savings assumptions for energy-efficient clothes dryers and identifies the source of each assumption.

Table 102. Energy-Efficient Clothes Dryer Variable Values and Assumptions

Variable	Value	Source
Load	8.45	Based on ENERGY STAR test procedures.[a] Dryer size unknown therefore assumed standard size (not compact).
CEF_{base}	Electric Dryer: 3.11 Gas Dryer: 2.84	ENERGY STAR Draft 2 Version 1.0 Clothes Dryers Data and Analysis.
CEF_{eff}	Electric Dryer: 3.93 Gas Dryer: 3.48	DOE minimum efficiency standard; ENERGY STAR Clothes Dryers Key Product Criteria.
Ncycles	283	Uniform Test Method for Measuring the Energy Consumption of Dryers. 10 CFR Part 430 Appendix D1 to Subpart B.[b]
$\%ElecSavings_{Elec\ Dryer}$	100%	The ratio of the electric savings to total savings from gas dryers from ENERGY STAR Draft 2 Version 1.0 Clothes Dryers Data and Analysis.
$\%ElecSavings_{Gas\ Dryer}$	16%	
$\%Elec_{Dryer}$	47%	RECS 2009 for California.
$\%Gas_{Dryer}$	52%	RECS 2009 for California.
$\%GasSavings_{Elec\ Dryer}$	0%	The ratio of the gas savings to total savings from gas dryers from ENERGY STAR Draft 2 Version 1.0 Clothes Dryers Data and Analysis.
$\%GasSavings_{Gas\ Dryer}$	84%	
Hours	283	Assume each dryer cycle is 1 hour; therefore, 283 operating hours per year.
CF	0.039	Average across eight TRMs.[c]

[a] https://www.energystar.gov/index.cfm?c=clothesdry.pr_crit_clothes_dryers.
[b] https://www.gpo.gov/fdsys/pkg/CFR-2012-title10-vol3/pdf/CFR-2012-title10-vol3-part430-subpartB-appD1.pdf.
[c] Average across the following TRMs: Indiana TRM (V2.2), Illinois TRM (V5.0), Mid-Atlantic (V4.0), Ohio (2012), Pennsylvania (2016), New York (2014). Wisconsin (2014), Maine (2014).

Table 103 presents the weighted average per-measure savings for energy-efficient clothes dryers using the algorithms and variable assumptions presented above.

Table 103. Weighted Average Per-Measure Savings for Energy-Efficient Clothes Dryers

Measure	Weighted Average kWh per Clothes Dryer	Weighted Average kW per Clothes Dryer	Weighted Average Therms per Clothes Dryer
Energy-Efficient Clothes Dryer	88.29	0.012	2.31

Pool Pumps

To estimate savings from variable speed pool pumps, we calculated savings using the ENERGY STAR Certified Pool Pump Savings Calculator available from the U.S. Environmental Protection Agency, embedded below.

ENERGY STAR Pool Pump Calculator.xlsx

Table 104 presents the weighted average per-measure savings for energy-efficient pool pumps using the algorithms and variable assumptions presented above.

Table 104. Per-Measure Savings for Energy-Efficient Pool Pumps

Measure	kWh per Pool Pump	kW per Pool Pump
Energy-Efficient Pool Pump	1,365.16	1.125

Appendix B. Sensitivity Analyses

Residential

Nonparticipant Spillover

Sensitivity of Analysis to Attribution Criteria

In the nonparticipant spillover (NPSO) analysis presented in this report, the study team determined, for each potential spillover measure, the influence of the investor-owned utility (IOU) programs on a respondent's decision to purchase and install that measure. To do this, we relied on self-reported program attribution. Specifically, we asked if the respondent's awareness of IOU rebates and information had *any* influence on his or her decision to purchase or install the measure. If the respondent answered that the program influenced his or her decision, we then asked him or her to rate the level of influence using a scale of 0 to 10, where 0 is no influence and 10 is a great deal of influence.[90]

For the analysis presented in Section 4.2.1, we considered a measure installation to be "attributable" to IOU rebates and information if a respondent scored program influence greater than 4 on the 0–10 scale.[91] This means that we assigned attribution and the spillover savings to any measure for which the respondent provided an IOU influence score of 5 or greater.

Understanding that arguments for a different spillover threshold could be made, we conducted a sensitivity analysis to assess the impact of the program influence threshold on spillover savings, expressed as the spillover rate.

Table 105 presents the NPSO rates (as presented in the final line of Table 26) as they would result from changes to the definition of attribution by varying the cutoff to the program influence question (0–10) used.

[90] Survey question SO9.

[91] If a respondent indicated before reaching this question that the program had no influence on his or her decision, we did not consider the associated savings attributable to the program.

Table 105. NPSO Rates with Alternate Attribution Criteria

	First-Year NPSO Rate (%)			Lifecycle NPSO Rate %	
Attribution Criteria[a]	kWh	kW	Therms	kWh	Therms
Influence = 0	0.0%	0.8%	59.5%	0.2%	23.7%
Influence > 0	0.0%	0.8%	59.5%	0.2%	23.7%
Influence > 1	0.0%	0.8%	59.5%	0.2%	23.7%
Influence > 2	0.0%	0.8%	59.5%	0.2%	23.7%
Influence > 3	0.1%	0.8%	51.9%	0.2%	21.7%
Influence > 4[b]	0.1%	0.8%	51.9%	0.2%	21.7%
Influence > 5	0.1%	0.8%	41.5%	0.3%	19.0%
Influence > 6	0.1%	0.1%	34.0%	0.2%	15.8%
Influence > 7	0.1%	0.1%	0.9%	0.2%	0.1%
Influence > 8	0.1%	0.1%	1.9%	0.1%	0.4%
Influence > 9	0.1%	0.1%	-1.1%	0.2%	-0.4%

[a] Level of utility rebate and information influence on purchase/installation decision, varying from 0 (no influence) to 10 (a great deal of influence)
[b] Definition chosen for analysis.

Nearly all respondents who indicated at least some program influence gave an IOU influence rating of greater than 4. As can be seen in Table 105, changing the rating required for attribution from greater than 4 to greater than 0 would not meaningfully affect results. However, we see a fairly significant drop if the threshold is moved from greater than 4 to greater than 5, especially for therms. Additionally, we see a large drop when moving from a threshold of greater than 6 to greater than 7 (for both kWh and therms).

In general, increasing the attribution threshold decreases the spillover rate as the savings from projects that do not meet the increased threshold are not included in the numerator of the spillover rate. However, in some cases the spillover rate increased as the attribution threshold increases. This is due to the inclusion of penalties from interactive effects for some measures, particularly negative electric savings for efficient clothes washers and negative natural gas savings from refrigerators.

Appendix C. Residential Participant Spillover Survey Sampling Strategy

This appendix describes the sampling strategy for the residential participant spillover survey. Per the evaluation plan, the evaluation team originally proposed a data collection approach that would leverage other Energy Division (ED)/investor-owned utility (IOU) studies by adding a spillover survey battery to existing participant survey instruments. However, due to an insufficient number of participant surveys planned for fielding for the Program Year (PY) 2013–2014 (PY2013–2014), the evaluation team conducted its own primary data collection effort via a statewide residential participant spillover survey, using the telephone to reach customers.

Any phone survey must start with a list of phone numbers and, in this case, that phone number must be for a residential customer. Since the study is assessing PY2013–2014 participant spillover, our list included program participants from that period——specifically, the PY2013–2014 statewide program claims database.

This appendix outlines the procedures that we are using to develop the sampling frame, our proposed sampling strategy, and the underlying reasons for this sampling approach.

Sample Frame Development

The PY2013–2014 statewide program claims database includes 2.9 million records, representing 195 energy efficiency programs that claimed savings for PY2013–2014. The database contains, but is not limited to, participant information, savings amounts, program information, and limited information on the measures producing those savings. While the database contains a great deal of information, the level of information varies by program. It was necessary to conduct extensive data cleaning to develop a sample frame from which we could draw a sample for fielding the participant survey. Below, we provide a summary of the steps taken to develop the sample frame. The "Rationale for Removal of Records from Sample" discussion (the last major section within this appendix) contains additional details on each step.

Data Cleaning and Preliminary Sample Frame Development

To develop the sample frame, we began with 65 programs in the statewide program claims database that contain residential tracking records.[92] This group does not include residential codes and standards programs that do not produce residential spillover and that were therefore dropped from the population of programs under consideration.[93]

We then dropped programs from the sample frame because they either already included an estimate of spillover or did not contain contact information at the residential end-user level needed for a participant

[92] This group contains 21 programs that included both residential and commercial records (including 18 local government partnership programs). We included these programs in our target population but removed the commercial records.

[93] The study team believes there is no direct causal effect for spillover from residential codes and standards programs because these target builders and code officials and the residential end-user would likely be unaware of the programs' interventions. While some additional savings could result from these programs, residential customers are not direct "participants" in these programs and therefore a participant spillover survey is not the appropriate method by which to assess these effects.

telephone survey. Our sample frame comprised programs that did not fall into either of these categories, which are described in more detail below.

- **Category 1 – Programs already claiming spillover.** Because spillover savings will be in addition to any savings already associated within residential programs, it is inappropriate to include a program if the program already claims spillover in its net savings. This category includes the Energy Advisor programs and the Upstream Lighting Programs (ULP). Because these programs estimate savings with market-based or billing analysis approaches, adding spillover savings from this study to claimed savings would result in double counting.
  - **Energy Advisor Programs.** The total savings associated with Energy Advisor programs are estimated through a billing analysis used to produce deemed savings figures for future application. Given the nature of the billing analysis, net savings attributable to the program are part of that deemed number.
  - **Upstream Lighting Programs.** To provide insight into the degree to which the current ULP net-to-gross ratio (NTGR) may already include spillover, the study team completed a sensitivity analysis[94] around the completed PY2010–2012 and PY2013–2014 ULP impact evaluations.[95] The results of the sensitivity analysis indicate that the spillover credit already awarded through both ULP impact evaluations NTGRs: 1) goes well beyond any spillover credit that would have been awarded by following the working definition of spillover used in this study (i.e., that which is perceivable by the end-user) and 2) includes significant elements of spillover, such as market effects, that would not have been credited in the absence of the market-based evaluation approach necessitated by ULP. Specifically, both ULP impact evaluations include impacts related to program-influenced change in stocking practices (i.e., what was made available to consumers at retail locations) as reported by retailers and lighting manufacturers, as well as impacts captured in broad market-based assessments, gathered through manufacturer interviews, of the impact of ULP on overall energy efficiency lighting sales in California.
- **Category 2 – Programs without contact information at the residential end-user level.** Sixty-one programs remained after removing the four programs that already include spillover within existing net savings estimates. Ideally, we would include all 61 of these remaining programs in the final sample frame. However, this was not possible because we could only contact participants for the telephone survey if we had valid telephone numbers. The claims database does not contain the necessary contact information for two types of programs: programs that are not comparable to the final sample frame and programs that are comparable to the final sample frame.
  - **Category 2a – Programs <u>not</u> comparable to sample frame.** The claims database includes 21 programs with participant contact information that is not at the residential end-user level and that are not comparable to programs in the final sample frame. The programs in Category 2a include multifamily, school-based, and new construction programs.[96] Of the residential programs that do

[94] Please refer to Appendix H for more information on this analysis.

[95] 2010–12 Report: California Upstream and Residential Lighting Impact Evaluation, Work Order 28 (WO28) Final Report. California Public Utilities Commission, Energy Division. Prepared by KEMA, Inc. 8/4/2014; 2013–14 Report: Impact Evaluation of 2013–14 Upstream and Residential Downstream Lighting Programs. California Public Utilities Commission. Prepared by DNV GL. 4/1/2016. CALMAC Study ID CPU0122.01.

[96] In addition to these three program types that include 21 programs, we included three additional programs in this category because they are not comparable to programs in the sample frame: Pacific Gas and Electric Company's (PG&E) Enhanced Time Delay Relay

not already claim spillover, these program types account for 20% of kWh savings and 45% of therm savings. Because all three program types are sufficiently different from the programs that are ultimately included in the final sample frame, it would be inappropriate to extrapolate results from the participant survey to these programs.

- **Multifamily Programs.** For the multifamily programs, the program database contains contact information only for the owner or property manager.[97] While it is theoretically possible that some tenants take spillover actions based on program-supported upgrades to their units, the database does not contain data on individual residents.[98] The program theory of a multifamily program is different from any of the programs in the final sample frame. As a result, it is not appropriate to extrapolate results from the participant survey to multifamily programs.

- **School-Based Programs and New Construction Programs.** The claims database does not identify the individuals that participated in these programs. Therefore, it was not possible to follow up with them through a participant spillover survey. These programs are sufficiently different in their delivery from the programs in the final sample frame that it would be inappropriate to extrapolate results from our participant survey to them.

- **Category 2b – Programs comparable to sample frame.** We also lacked contact information for an additional three programs that were flagged as upstream programs in the claims database.[99] Of the residential programs that do not already claim spillover, these three programs account for 14% of kWh savings and 12% of therm savings. Because these upstream programs are similar to some of the downstream programs for which we have contact information (e.g., residential HVAC programs), we extrapolated our spillover estimates from our participant survey to these programs.

After removing the two categories of programs detailed above (Categories 1 and 2), the remaining 37 programs constitute our final sampling frame. These programs do not already incorporate spillover savings and contain the appropriate residential end-user contact information. Our sample frame consists of all participants from these 37 programs for whom we have complete telephone numbers.[100] We drew our participant survey sample from these 37 programs. We extrapolated the results of the participant survey to all participants in this category as well as Category 2b programs. Of the residential programs that do not already claim spillover, these 37 programs accounted for 66% of kWh savings and 44% of therm savings.

Figure 7 provides a graphical representation of our sample frame construction steps. The colored boxes distinguish between the programs that are included in our estimates of spillover based on the participant survey and programs that are excluded from the study. In particular, our participant spillover survey produced estimates of spillover for programs in the green boxes (the final sample frame and Category 2b).

Program, Southern California Edison's (SCE) Lighting Innovation Program, and the Southern California Regional Energy Network (SoCalREN) program.

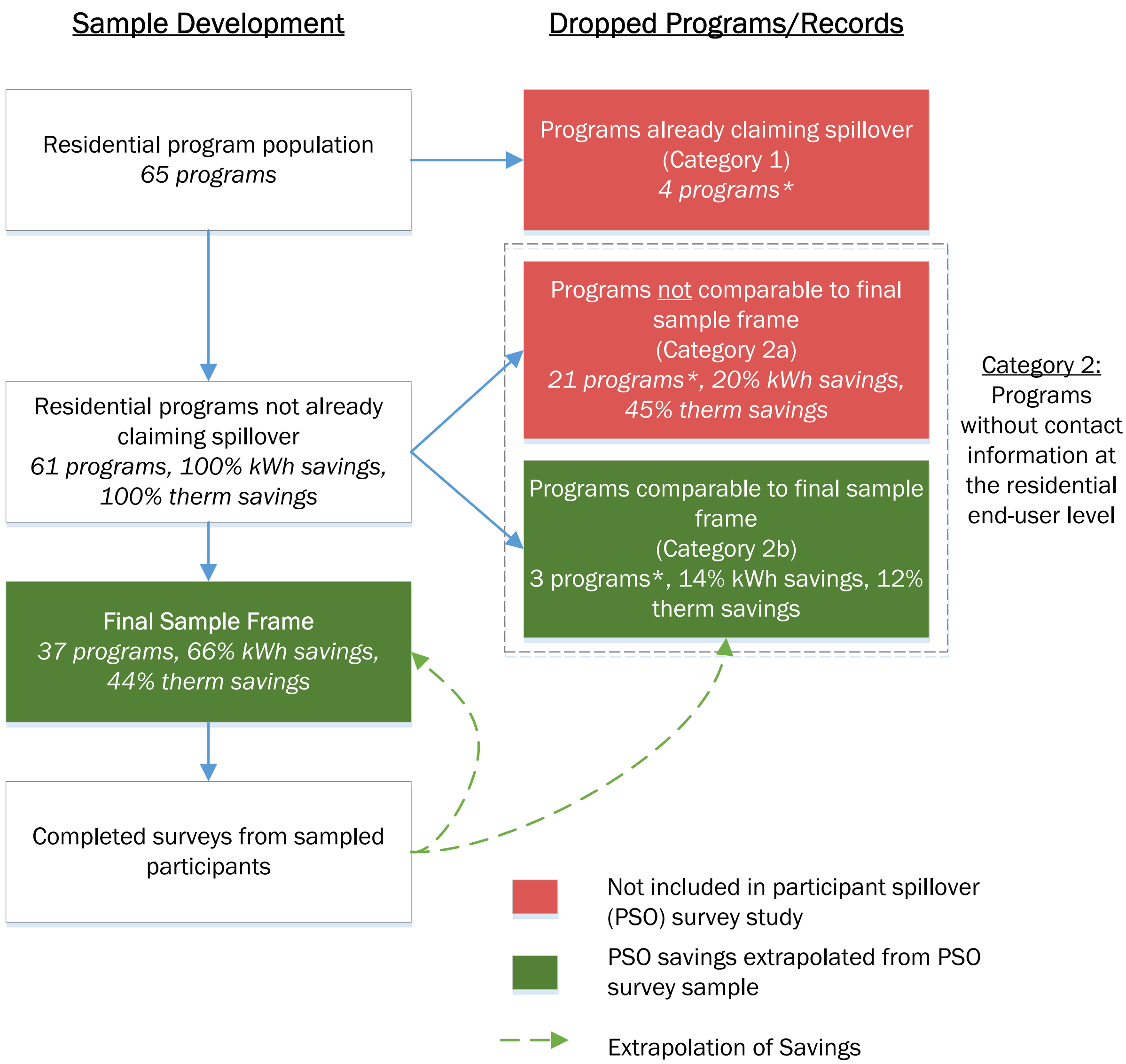
[97] The nonresidential spillover study will capture any potential spillover resulting from multifamily buildings or common area upgrades.

[98] Multifamily programs are discussed in more detail in the "Rationale for Removal of Records from Sample" section below.

[99] Unlike the ULP, there was not suitable past impact evaluation work that could be leveraged to assess spillover for these programs.

[100] The sample frame includes incomplete or missing telephone numbers for some participants (in some programs) and we were unable to include these participants in our final sample frame. The difference between missing phone numbers for the Category 2 and programs in the sample frame is that most of the Category 2 programs simply do not track participant phone numbers at the residential end-user level so that we have a systematic missing data problem. However, for programs in the sample frame, the program tracks data at the residential end-user level, but data entry mistakes were made or participants did not provide their phone numbers. We assume that these phone numbers are missing at random.

Figure 7. Residential Participant Spillover Survey Sample Frame Construction



* Entire programs dropped in this step

Table 106 presents a summary of all database records and associated savings, and delineates where and why Opinion Dynamics excluded programs from the sample frame for the participant survey.

Table 106. Participant Survey Final Sampling Frame

Stage	Reason	Records	MWh Savings	Therm Savings[a]
Residential programs	**All except codes and standards**	**2,263,016**	**1,218,828**	**19,713,927**
Drop 4 programs already claiming spillover	Spillover already included as part of deemed savings or captured in existing NTGRs.	*460,803*	*825,070*	*5,570,227*
Residential programs not already claiming spillover		**1,802,213**	**393,758**	**14,143,700**
Drop 21 programs without contact information at the residential end-user level and not comparable to sample frame (Category 2a)	Residential participant spillover could have occurred, but we cannot sample.	*506,264*	*76,002*	*6,321,052*
Savings to extrapolate to		**1,295,949**	**317,756**	**7,822,647**
Drop 3 programs without contact information at the residential end-user level and comparable to sample frame (Category 2b)	Residential participant spillover could have occurred, but we cannot easily sample.	*375,986*	*56,406*	*1,635,587*
Final Sample Frame		**919,963**	**261,350**	**6,187,061**

[a] Therm savings do not contain records with negative savings (i.e., therm penalties from interactive effects).

Table 107 contains the distribution of programs and savings in the participant survey final sample frame by IOU.[101]

Table 107. Programs and Ex Post Savings in the Final Sample Frame by IOU

IOU	Unique Programs	MWh	Therms
Bay Area Regional Energy Network (BayREN)	1	188	49,105
PG&E	22	90,585	2,863,982
SCE	5	141,970	259,087
SCG	3	4,303	2,605,873
SDG&E	6	24,303	409,014
Total	**37**	**261,350**	**6,187,061**
Percent of Residential Population Not Already Claiming Spillover	**61%**	**66%**	**44%**

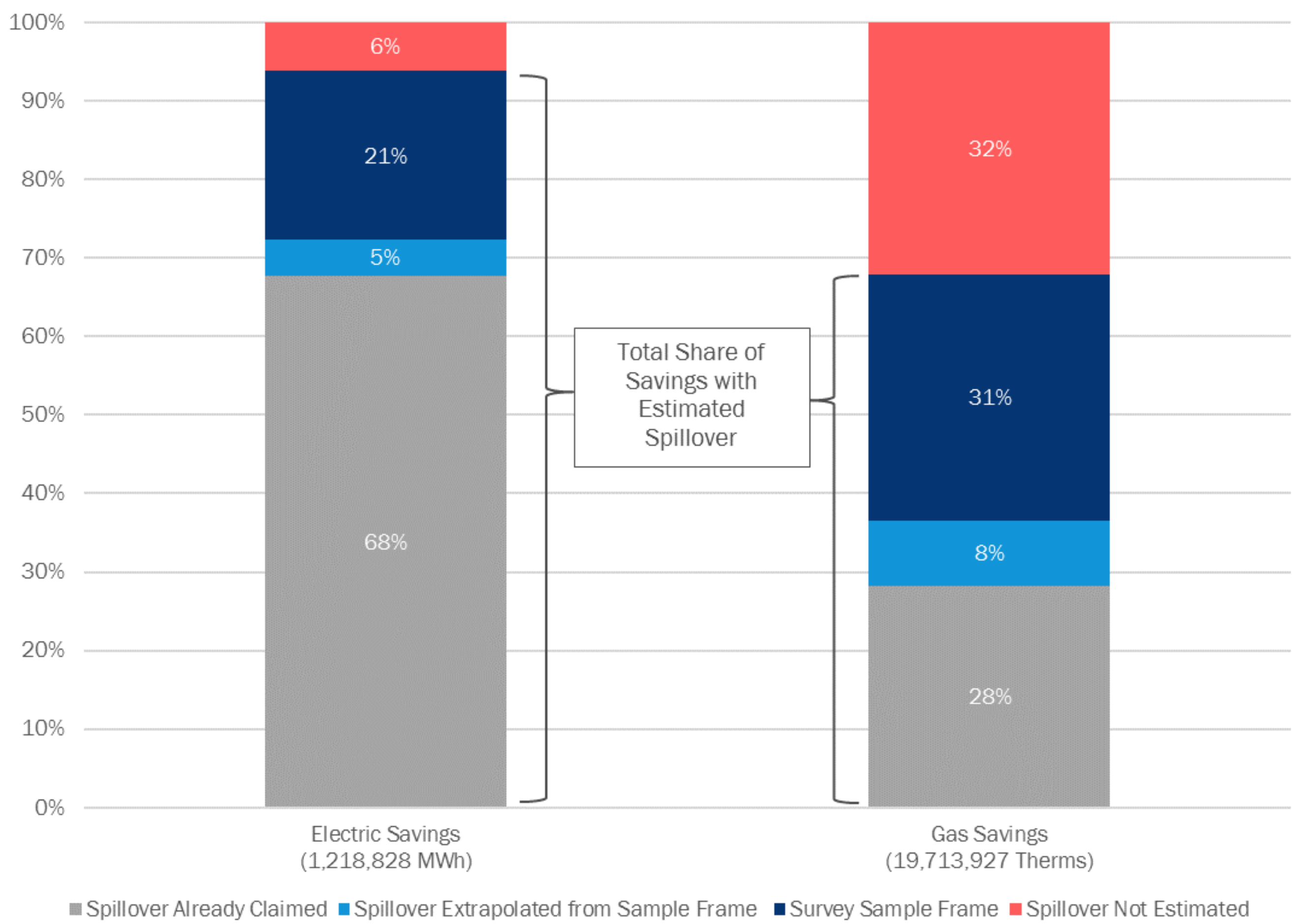
[101] Note that all SoCalREN records were dropped due to lack of contact information.

Coverage of Participant Spillover Survey

As described above, after removing those programs that do not already include spillover, the final sample frame (37 programs) and Category 2b (3 programs to which we can extrapolate the survey results) combine to account for 80% of residential kWh savings and 56% of therm savings.

Figure 8 provides context to the coverage of our final sample frame (37 programs) and extrapolation plans (3 programs). The figure provides a breakdown of savings from all residential programs (less codes and standards), including those that already include spillover. As shown in the bar on the left, 68% of residential MWh savings in the PY2013–2014 claims database (the source of our sample plan information) comes from programs that already claim spillover. More importantly, it indicates that when we add in the results of this study, the total amount of MWh savings for which spillover will be estimated includes 94% of total residential MWh savings. The bar on the right illustrates the same information for gas savings, showing that 28% of residential PY2013–2014 therm savings comes from programs that already claim spillover. It also indicates that 68% of total residential therm savings are either included in this study or already claim spillover.

Figure 8. Share of Statewide Program Savings with Estimated and Claimed Spillover[a]



[a] Residential ex post savings excluding codes and standards programs and penalties from interactive effects.

Sampling Strategy

The team's overarching goal was to draw a sample that represents the varied programs and participants in the residential portfolio and to do so in a cost-effective manner. The 37 programs in the final sample frame vary in their number of participants, and we hypothesized that they might also vary in their individual propensity to induce spillover. We decided to use a stratified sample design to ensure that our sample included participants from both large and small programs and participants who have had varied program experiences. In addition, a stratified sample can improve the precision of our spillover estimates. In the next section, we outline the factors that influenced our proposed stratified sampling approach.

Considerations for Sample Development

One of the considerations in drawing any survey sample is variability in the survey estimates. As variability increases, the precision of the estimate decreases, requiring a greater number of sample points to achieve desired precision levels. To create an optimal sample design, we considered how much variability there might be across the 37 programs. Participant spillover rates could differ for a variety of possible reasons that affect a sample design. Below, we outline three particular areas of variation we considered.

- **Variation in Number of Participants by Program.** There is considerable variation in the number of participants across the 37 programs. For example, plug load and appliance programs have a very large number of participants, while far fewer participate in whole-house programs. Seventy-seven percent of all PY2013–2014 records in our sample frame were plug load and appliance program participants. If we used a simple random sample design that does not account for program participation levels, participants of plug load programs would dominate the results and programs with relatively low levels of participation would have very few survey completions. A stratified sample design that takes into account program size ensures that programs with fewer participants are adequately represented in the sample.

- **Variation in Program "Touch."** Program participants may take additional energy-saving actions because of a number of program factors, including the marketing, education, and outreach efforts associated with a program. Programs that are "high touch" have greater contact with customers and may therefore, we hypothesized, be more likely to educate and influence participants about energy efficiency. Programs strategies that include personal interaction with customers through contractors or other representatives are high-touch programs. We hypothesized that these customers are aware that they have participated in an energy efficiency program and may be more aware of various energy efficiency opportunities as a result. An example of a high-touch program would be a whole-house retrofit program where the customer has substantial contact or sustained contacts with program representatives. An example of a "low-touch" program would be appliance or plug load rebate programs, where the customer may have minimal program contact or reason to think about additional measures, especially if the discount was at the point of purchase through an upstream program. Though upstream programs often have in-store marketing materials, customers may purchase a discounted measure simply because it is less expensive and may be unaware of the measure's energy benefits. We hypothesized that programs with higher customer touch will be more likely to cause the participants to think about their energy use and therefore be more likely to complete spillover actions.

- **Size of Customer Investment.** Embedded within the program types are the measures associated with each program.[102] We hypothesized that not all measures are equally likely to encourage participants to take additional actions. Some measures, such as central air conditioning systems, are high cost and programs typically provide a sizable rebate. Due to the considerable investment required, we hypothesized that participants may become more aware of energy efficiency and take additional actions.

We ultimately decided that our hypothesized variation in program touch and size of the investment were, in many ways, related to one another. In short, we hypothesized that both, taken together, might affect a program's propensity to cause spillover. As a result, we classified all programs by their propensity to cause spillover ("high" propensity or "low" propensity). Further description of the development of program spillover propensity rating, including the programs assigned to each category and the assessment of interrater reliability, can be found in Appendix D. We then stratified our sample by the hypothesized propensity to cause spillover and, within each propensity grouping, the number of program participants (i.e., program size).[103] This created six strata from which we sampled, shown in Table 108. We felt that this approach would allow us to identify any variation in spillover propensity by program and account for large differences in program size.

Table 108. Final Sample Frame by Stratum

Stratum Number	Stratum	Number of Programs	Number of Participants[a]
High Propensity for Spillover			
1	Large Programs	2	20,233
2	Medium Programs	4	8,598
3	Small Programs	3	2,393
Low Propensity for Spillover			
4	Large Programs	6	613,768
5	Medium Programs	7	28,918
6	Small Programs	16	3,945
	Total	**38[b]**	**677,855**

[a] The savings claim database is organized by records and there can be multiple records per participant as well as missing contact information. Therefore, this count is an **estimate** developed from the PY2013–2014 tracking data.

[b] This total differs from the final sample frame total of 37 because one program was dropped after developing the propensity ratings due to the combination of multiple drop steps described later in this appendix.

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[102] We did not sample at the measure level for two primary reasons. First, most programs target specific end uses and measure types. Second, if a measure was offered through multiple programs, the program touch as it affects a given measure could vary substantially from program to program, which may result in different levels of spillover. For example, a customer purchasing an appliance as part of a whole-house retrofit through the Energy Upgrade California program would experience a significantly different level of program "touch" than if he or she purchased the same appliance at a retailer and received a rebate through a point of purchase appliance rebate program.

[103] For high spillover propensity programs, we considered programs with 5,000 or more participants to be large programs and those with 1,000 or more to be medium. For low spillover propensity programs, the cutoffs were 10,000 and 1,000.

Rationale for Removal of Records from Sample

Below we describe the steps and rationale used for removing records from the population to develop the initial sample frame. As described above, we began with a population of more than 2.9 million records. Note that multiple records may be associated with an individual participant due to the installation of multiple measures.

Drop Nonresidential Program Records (Step 1)

Rationale: No residential participant spillover can occur

First, we removed all nonresidential programs from the database in their entirety. These programs and their associated spillover will be assessed through the ongoing commercial spillover evaluation. Nonresidential programs totaled 516,071 records. Additionally, we removed nonresidential *records* associated with programs that contained a mix of residential and nonresidential records. We removed nonresidential records using the "residentialflag" variable present in the database as an indicator of whether records were commercial or residential. These programs were primarily Local Government Partnership (LGP) programs. Nonresidential records accounted for 136,727 of 197,029 LGP program records and 96.5% of LGP gross kWh savings.[104] We also removed a handful of records in SCE's Residential HVAC, Primary Lighting, and Lighting Innovation programs. Table 109 presents the effects of Drop Step 1.

Table 109. Drop Step 1 Effects

	Programs[a]	Records	MWh Savings	Therm Savings
Starting Point	195	2,925,879	5,648,823	125,257,780
Affected	147	657,647	2,445,543	82,812,894
Remaining	69	2,268,232	3,203,280	42,444,886

[a] Please note that the "Affected" row notes programs *affected* by this step, not programs removed in their entirety. As such, the "Remaining" count of programs may not equal the starting point minus affected.

Drop Codes and Standards Programs Records (Step 2)

Rationale: No residential participant spillover can occur

We removed codes and standards programs from the sample frame. Residential customers are not direct "participants" in these programs, and, while some additional savings could result from these programs, a participant spillover survey is not the appropriate method by which to assess these effects. Table 110 presents the effects of Drop Step 2.

[104] Dropped commercial LGP records have savings of −19,246 therms and retained residential records have savings of 6,613 therms.

Table 110. Drop Step 2 Effects

	Programs[a]	Records	MWh Savings	Therm Savings
Starting Point	69	2,268,232	3,203,280	42,444,886
Affected	4	5,216	1,984,453	22,730,959
Remaining	65	2,263,016	1,218,828	19,713,927

[a] Please note that the "Affected" row notes programs *affected* by this step, not programs removed in their entirety. As such, the "Remaining" count of programs may not equal the starting point minus affected.

Drop Energy Advisor Programs Records (Step 3)

Rationale: Residential participant spillover could have occurred, but is already claimed by the program (Category 1)

In this step, we removed records associated with SCE's and PG&E's Energy Advisor programs. These programs are shown in Table 111.

Table 111. Energy Advisor Programs Removed from the Sample Frame

Program ID	Program Administrator	Program Name
SCE-13-SW-001A	SCE	ENERGY ADVISOR PROGRAM
PGE21001	PG&E	RESIDENTIAL ENERGY ADVISOR

As can be seen earlier in Table 106, dropping these records removes a sizable amount of residential claimed savings from our sample frame. However, these programs intend to cause participants to take energy-efficient actions on their own. The IOUs claim savings for these programs based on billing analyses conducted in past program cycles, which estimated the average savings resulting from all actions taken by each participant in the program. Therefore, claimed savings represent the net effect of the program (including spillover) and no additional spillover can be associated with them. Table 112 presents the effects of Drop Step 3.

Table 112. Drop Step 3 Effects

	Programs[a]	Records	MWh Savings	Therm Savings
Starting Point	65	2,263,016	1,218,828	19,713,927
Affected	2	189,132	202,337	5,570,227
Remaining	63	2,073,884	1,016,490	14,143,700

[a] Please note that the "Affected" row notes programs *affected* by this step, not programs removed in their entirety. As such, the "Remaining" count of programs may not equal the starting point minus affected.

Drop Upstream Lighting Records (Step 4)

Rationale: In the case of ULP, residential participant spillover could have occurred, but is already estimated through market-based net-to-gross (NTG) methods. (Category 1)

We then removed all records associated with ULP, as marked in the database with "upstreamflag." In the cases of these programs, upstream programs do not track the identities of program participants, so it would not be possible to include them in a participant survey effort. However, even if we could identify individual program participants, we would not have included them in the survey effort because spillover has already been included in ULP market-based NTG methodology.

Table 113 lists the two entire programs dropped as part of this step. We also removed records from the SCE Primary Lighting program as part of this step.

Table 113. Upstream Lighting Programs with All Records Removed from the Sample Frame

Program ID	Program Administrator	Program Name
PGE21041	PG&E	PRIMARY LIGHTING
SDGE3245	San Diego Gas & Electric (SDG&E)	SW-LIGHTING-PRIMARY LIGHTING

Table 114 presents the effects of Drop Step 4.

Table 114. Drop Step 4 Effects

	Programs[a]	Records	MWh Savings	Therm Savings
Starting Point	63	2,073,884	1,016,490	14,143,700
Affected	3	271,671	622,732	0
Remaining	61	1,802,213	393,758	14,143,700

[a] Please note that the "Affected" row notes programs *affected* by this step, not programs removed in their entirety. As such, the "Remaining" count of programs may not equal the starting point minus affected.

Drop Upstream Non-Lighting Records (Step 5)

Rationale: Residential participant spillover could have occurred, but we cannot sample (Category 2b)

We also removed records for non-lighting upstream programs marked in the database with "upstreamflag." These programs do not track the identities of program participants, so it would not be possible to include them in a participant survey effort. Table 115 lists the three entire programs dropped as part of this step. We also dropped records from the PG&E, SCE, and Southern California Gas Company (SCG) Plug Load and Appliances programs and the PG&E Residential HVAC program as part of this step.

Table 115. Non-Lighting Upstream Programs With All Records Removed from the Sample Frame[105]

Program ID	Program Administrator	Program Name
SCE-13-SW-001F	SCE	RESIDENTIAL NEW CONSTRUCTION PROGRAM
SDGE3302	SDG&E	SW-CALS-RESIDENTIAL HVAC UPSTREAM
SDGE3204	SDG&E	SW-CALS-PLUG LOAD AND APPLIANCES-POS REBATES

In this step, we also removed SDG&E's point-of-sale plug load and appliance program, which was not flagged as an upstream program but has similar characteristics (i.e., lack of any contact information). Table 116 presents the effects of Drop Step 5.

[105] One program dropped using the "upstreamflag" screen was SCE's Residential New Construction Program. This is a program that does not fit into the typical definition of an upstream program.

Table 116. Drop Step 5 Effects

	Programs[a]	Records	MWh Savings	Therm Savings
Starting Point	61	1,802,213	393,758	14,143,700
Affected	3	375,986	56,406	1,635,587
Remaining	58	1,426,227	337,352	12,508,113

[a] Please note that the "Affected" row notes programs *affected* by this step, not programs removed in their entirety. As such, the "Remaining" count of programs may not equal the starting point minus affected.

Drop Records of Programs with 100% Missing Contact Information (Step 6)

Rationale: Residential participant spillover could have occurred, but we cannot sample (Category 2a)

We then removed additional programs for which the claims database did not contain any usable contact information. Additionally, these programs are dissimilar to any programs within our sample frame and therefore we do not include them in Category 2b as possible programs to which we could extrapolate savings. We removed 11 programs in their entirety, presented in Table 117. Additionally, we removed some records from SCE's Lighting Innovation Program as part of this step.

Table 117. Programs Removed from the Sample Frame Due to No Associated Contact Information

Program ID	Program Administrator	Program Name
PGE21005	PG&E	RESIDENTIAL NEW CONSTRUCTION
PGE21007	PG&E	CALIFORNIA NEW HOMES MULTIFAMILY
PGE21008	PG&E	ENHANCE TIME DELAY RELAY
SCE-13-TP-001	SCE	COMPREHENSIVE MANUFACTURED HOMES
SCG3707	SCG	SW-CALS-RNC
SCG3765	SCG	3P-MANUFACTURED MOBILE HOME
SDGE3207	SCG	SW-CALS-MFEER
SDGE3213	SDG&E	SW-CALS - CAHP/ESMH-CA ADVANCED HOMES
SDGE3214	SDG&E	SW-CALS - CAHP/ESMH-E STAR MANUFACTURED HOMES
SOCALREN	SDG&E	SOCALREN
SCE-13-TP-001	SOCALREN	COMPREHENSIVE MANUFACTURED HOMES

Table 118 presents the effects of Drop Step 6.

Table 118. Drop Step 6 Effects

	Programs[a]	Records	MWh Savings	Therm Savings
Starting Point	58	1,426,227	337,352	12,508,113
Affected	12	105,502	34,521	2,797,053
Remaining	46	1,320,725	302,831	9,711,061

[a] Please note that the "Affected" row notes programs *affected* by this step, not programs removed in their entirety. As such, the "Remaining" count of programs may not equal the starting point minus affected.

Drop Records of Programs with Inappropriate Contact Level (Step 7)

Rationale: Residential participant spillover could have occurred, but we cannot sample (Category 2a)

Finally, we removed programs from our sample frame that contained contact information at an improper level (e.g., contact information for landlords rather than residents). This includes two classes of programs: multifamily programs and school-centric programs, such as SoCalGas's LivingWise program.

In the case of multifamily programs, the primary participants are the building owners or managers who made the decision to participate in the multifamily energy efficiency program. This implies that there can be spillover from property owner/manager actions, but this would be captured in the nonresidential spillover study.

While typically not the primary participants, the programs do affect residents and, as a result, there is a possible causal mechanism for spillover. However, as currently constructed, our residential participant survey is not appropriate to assess possible spillover resulting from resident actions encouraged by these programs because we do not have the appropriate contact information and cannot break out tenant space savings from common area savings to extrapolate the overall survey results to these tenants.

In addition to multifamily programs, there is potential for participant spillover resulting from *other* residential programs that will not be captured in this effort, including spillover from school-centric programs where database contact information is provided at the school level. If the California Public Utilities Commission (CPUC) wishes to identify and estimate residential participant spillover from these programs, Opinion Dynamics recommends conducting targeted research for these programs.

Table 119 presents programs dropped because of inappropriate contact level.

Table 119. Program Drops – Inappropriate Contact Level

Program ID	Program Administrator	Program Name
BAYREN_MF_2013-14	BayREN	MULTIFAMILY
MEA01	MCE	MULTIFAMILY
PGE21003	PGE	MULTIFAMILY ENERGY EFFICIENCY REBATES PROGRAM
SCE-13-SW-001C	SCE	MULTIFAMILY ENERGY EFFICIENCY REBATE PROGRAM
SCE-13-SW-010B	SCE	WE&T CONNECTIONS
SCG3759	SCG	3P-ON DEMAND EFFICIENCY
SCG3761	SCG	3P-MF HOME TUNE-UP
SCG3763	SCG	3P-MF DIRECT THERM SAVINGS
SCG3764	SCG	3P-LIVINGWISE

Table 120 presents the effects of Drop Step 7.

Table 120. Drop Step 7 Effects

	Programs[a]	Records	MWh Savings	Therm Savings
Starting Point	46	1,320,725	302,831	9,711,061
Affected	9	400,762	41,481	3,524,000
Remaining	37	919,963	261,350	6,187,061

[a] Please note that the "Affected" row notes programs *affected* by this step, not programs removed in their entirety. As such, the "Remaining" count of programs may not equal the starting point minus affected.

Program-Level Spreadsheet

The following embedded spreadsheet provides a detailed breakout of each program tracked in the CPUC database and shows if and why Opinion Dynamics dropped the program from our sample frame. One row in this spreadsheet represents each program. For programs where Opinion Dynamics dropped some records and kept others, we have split the program into two rows with one row representing records that were kept in the sample frame and one representing records that were dropped.

The spreadsheet includes the number of records and electric and gas savings associated with each program. It also shows the estimated number of participants per program, our team's rating of each program's propensity for spillover (discussed further in Appendix D), and the sampling stratum.

CPUC Programs
2013-2014 2015-10-2

Appendix D. Stratification of Residential Programs by Propensity for Participant Spillover

In this appendix, we provide additional information on the rating process we used to classify programs as having a high or low propensity for spillover. We also provide the final ratings for each program in our sample frame.

Please note that this appendix refers to 38 programs in the sample frame but the final sample frame was 37. One program was dropped after we developed the propensity ratings due to the combination of multiple drop steps described in Appendix C.

Development of Program Spillover Propensity Rating

As described in Appendix C, we hypothesized that variation in participant spillover rates may be due to three factors: the variation in the number of participants by program, the variation in program "touch," and the variation in the size of the customer investment. We can obtain the number of participants by program from the savings claim database.[106] However, we did not have information on the propensity for spillover for each program that we could use to assign programs to different sample strata. To account for this, we constructed an indicator of program propensity for spillover through a systematic program review and rating process. Four internal experts reviewed the 38 programs in our sample frame and categorized each program based on its hypothesized propensity for spillover. Based on these expert ratings, we divided the programs into a high or a low propensity for spillover stratum.

Raters based their spillover ratings on two criteria:

- **Program "touch" level (with high touch predicting high propensity).** As we discussed in Appendix C, programs with a high level of touch typically provide more information for and education of participants about the benefits of their participation and energy-saving actions more generally. Low-touch programs provide less education and tend to rely on the participant recognizing the benefits after his or her participation. For this reason, we hypothesized that high-touch programs will have a greater propensity for spillover.
- **The size of the customer investment (with high investment predicting high propensity).** This criterion refers to programs that require a relatively high financial investment to participate, specifically, that the investment for acquiring a high-efficiency version of certain products or modifications of a home are relatively high and therefore very memorable. Additionally, the higher-cost equipment tends to result in relative higher energy savings compared to lower-cost equipment. We hypothesized that customers receiving this benefit would be more likely to seek out additional energy-efficient opportunities. Finally, we expected that participants who invest more resources will have the financial ability to take additional actions.

[106] The savings claim database is organized by records, and there can be multiple records per participant. Because some records did not have contact information on which to base an aggregation to the participant, we estimated the total number of participants based on the average number of records per known participant. We did this within programs since the number of records per participant can vary by program. We performed this aggregation after constructing the sample frame, described in the previous section. This is why the total number of records in the sample frame in Table 106 does not match the number of participants that we show in Table 108.

Note that the raters considered the two criteria together. While they judged most programs to be either high touch with high investment or low touch with low investment, there are two other possible conditions (i.e., high touch with low investment and low touch with high investment). While the raters did not identify any program with low touch and high investment, the final sample frame included many programs (the most common being direct install programs) that are characterized by high program touch and low customer investment. We describe how the raters classified these programs below when we discuss disagreements between raters.

We assessed the interrater reliability of the program categorization by calculating a kappa statistic using the method suggested by Fleiss et al.[107] The evaluated kappa is 0.52, which is generally considered by the literature to indicate a moderate level of interrater reliability.

Table 121. Interrater Reliability

Raters	Programs Rated	Kappa
4	38	0.52

We then examined the interrater agreement for each of the 38 programs. All raters agreed on the appropriate category for 22 out of 38 (58%) of the programs. For another 10 programs, the majority of raters (either 3 of 4 or 2 of 3) agreed on the appropriate category. For the remaining six programs, raters split evenly (2 versus 2).

Table 122. Description of Interrater Agreement

Agreement Type	Programs
Complete agreement	22
Majority agreement (3/4 or 2/3)	10
Evenly split (2/2)	6

For those programs where there was disagreement among raters, we convened a meeting to resolve the differences and come to a consensus. In most cases, when one of the parties described his rationale, agreement was easily reached.

By far the largest category producing disagreements was the Local Government Partnership programs, especially the direct install programs. Direct install programs within these partnerships tended to be for moderate-income households. These programs caused disagreement because they split the two criteria that the raters used to code the programs as high or low propensity for spillover, i.e., direct install programs are generally very high touch programs (implying high propensity); however, there is little or no financial investment for the participant (implying low propensity). In these cases, the raters ultimately decided to categorize these programs as low propensity in spite of the high touch of the program. This decision was based on multiple factors. First, program administrators targeted these customers for direct install because they were considered unlikely to take energy efficiency actions on their own; this implies low likelihood for spillover as well, probably due to limited income. Second, if these customers do take further action to purchase efficient equipment, it is highly likely to be through another program. Thus, these actions would be considered channeling rather than spillover. The consensus was that all of the direct install programs should be placed in the low-propensity group.

[107] Fleiss, J. L., B. Levin, and M. C. Paik. 2003. Statistical Methods for Rates and Proportions. 3rd ed. New York: Wiley.

There were two mobile home retrofit programs that produced one rater disagreeing with the others. However, this turned out to be a misreading of the description on the part of that rater, who classified these as low-propensity programs, but changed to (relatively) high propensity because both touch and investment were relatively high. Thus, all raters agreed that these programs should be in the high-propensity group.

In the end, any program that involved whole-home retrofits and/or financing was placed in the high-propensity group, and any program for moderate income was placed in the low-propensity group. The most difficult agreement was on the HVAC Quality Installation/Quality Maintenance program due to different ideas about how much program involvement there would be. One rater overlooked the continuing nature of the QM part of the program, and the other questioned how much investment is required for the program. The raters eventually placed this program in the high-propensity group.

Table 123 lists the programs under study and their rated propensity for spillover. It is important to note that the designation as high propensity for spillover is relative.

Table 123. Propensity for Spillover by Program

Number	Program ID	Program Administrator	Program Name	Spillover Propensity
1	PGE21006	PG&E	RESIDENTIAL HVAC	High
2	SCE-13-SW-001E	SCE	RESIDENTIAL HVAC PROGRAM	High
3	PGE21004	PG&E	ENERGY UPGRADE CALIFORNIA	High
4	SCE-13-SW-001D	SCE	ENERGY UPGRADE CALIFORNIA	High
5	SDGE3212	SDG&E	SW-CALS - RESIDENTIAL HVAC-QI/QM	High
6	SCG3705	SCG	SW-CALS-EUC	High
7	SDGE3211	SDG&E	LOCAL-CALS - MIDDLE INCOME DIRECT INSTALL (MIDI)	High
8	BAYREN_SF_2013-2014	Bay Area Regional Energy Network (BayREN)	SINGLE-FAMILY	High
9	SDGE3209	SDG&E	SW-CALS - EUC WHRP - ADVANCED	High
10	PGE211010	PG&E	FRESNO	High
11	PGE211018	PG&E	SAN LUIS OBISPO COUNTY	High
12	SCG3702	SCG	SW-CALS-PLUG LOAD AND APPLIANCES	Low
13	PGE21002	PG&E	PLUG LOAD AND APPLIANCES	Low
14	SCE-13-SW-001B	SCE	PLUG LOAD AND APPLIANCES PROGRAM	Low
15	SDGE3206	SDG&E	SW-CALS-PLUG LOAD AND APPLIANCES-ARP	Low
16	SDGE3203	SDG&E	SW-CALS-PLUG LOAD AND APPLIANCES-HEER	Low
17	SCG3765	SCG	3P-MANUFACTURED MOBILE HOME	Low
18	SDGE3279	SDG&E	3P-RES-COMPREHENSIVE MANUFACTURED-MOBILE HOME	Low
19	PGE211009	PG&E	EAST BAY	Low
20	PGE21009	PG&E	DIRECT INSTALL FOR MANUFACTURED AND MOBILE HOMES	Low
21	SCE-13-SW-005C	SCE	PRIMARY LIGHTING PROGRAM	Low
22	SCG3703	SCG	SW-CALS-PLUG LOAD AND APPLIANCES - POS	Low

Number	Program ID	Program Administrator	Program Name	Spillover Propensity
23	PGE2110051	PG&E	LOCAL GOVERNMENT ENERGY ACTION RESOURCES (LGEAR)	Low
24	PGE211013	PG&E	MARIN COUNTY	Low
25	PGE210132	PG&E	RSG THE SMARTER WATER HEATER	Low
26	PGE211023	PG&E	SILICON VALLEY	Low
27	PGE211007	PG&E	ASSOCIATION OF MONTEREY BAY AREA GOVERNMENTS (AMBAG)	Low
28	PGE211016	PG&E	REDWOOD COAST	Low
29	PGE211019	PG&E	SAN MATEO COUNTY	Low
30	PGE211011	PG&E	KERN	Low
31	PGE211020	PG&E	SANTA BARBARA	Low
32	PGE211022	PG&E	SONOMA COUNTY	Low
33	SCE-13-L-002J	SCE	DESERT CITIES ENERGY LEADER PARTNERSHIP	Low
34	PGE211024	PG&E	SAN FRANCISCO	Low
35	PGE211012	PG&E	MADERA	Low
36	PGE211021	PG&E	SIERRA NEVADA	Low
37	PGE211015	PG&E	NAPA COUNTY	Low
38	PGE211014	PG&E	MENDOCINO COUNTY	Low

PG&E = Pacific Gas and Electric Company; SCE = Southern California Edison; SDG&E = San Diego Gas & Electric; BayREN = Bay Area Regional Energy Network.

Appendix E. Calculation of Nonparticipant Population

We determined the number of households in the population of interest using the 2012 California Lighting and Appliance Saturation Study (CLASS) sample frame, with supplemental data used to remove households outside of our scope of research. We calculated the number of households in the population of interest in a three-step process:

- Beginning with the 42 strata in the CLASS sample frame and their associated population counts, we discarded the 21 strata associated with California Alternate Rates for Energy (CARE) or Family Electric Rate Assistance (FERA) program participants to remove most of the low-income population.
- Next, we made an adjustment to remove additional low-income premises not captured in the CLASS sampling scheme by extrapolating Energy Savings Assistance Program (ESAP) participation in the CLASS sample to the population.
- Finally, we removed investor-owned utility (IOU) program participants by extrapolating program participation in the remaining CLASS sample to the population.

Further detail on these adjustments can be found in Table 124.

Table 124. Development of Population of Interest

CLASS Stratum[a]	# of Premises	Stratum Non-ESAP Rate[b]	# of Non-Low-Income Premises	Nonparticipant Rate[c]	# of Nonparticipant Premises
1	666,010	91%	609,156	85%	519,813
2	345,101	95%	328,668	85%	279,367
3	204,604	96%	197,209	77%	152,837
7	1,144,436	95%	1,084,830	87%	941,775
8	556,869	95%	529,026	78%	412,083
9	277,278	96%	266,187	82%	219,050
13	59,879	100%	59,879	75%	44,909
14	23,300	100%	23,300	11%	2,589
15	11,356	100%	11,356	67%	7,571
19	1,121,730	94%	1,053,227	66%	693,589
20	578,337	92%	534,853	63%	334,827
21	326,220	94%	306,744	59%	180,151
25	407,073	100%	407,073	79%	323,571
26	205,117	97%	199,858	79%	157,782
27	104,432	100%	104,432	68%	70,492
31	154,757	92%	141,861	76%	107,470
32	79,136	97%	77,107	68%	52,757
33	43,514	100%	43,514	66%	28,595
37	363,967	100%	363,967	86%	314,335
38	186,358	100%	186,358	77%	144,004
39	99,212	99%	97,774	75%	73,331
Total	6,958,686		6,626,377		5,060,898

[a] This table presents a subset of the 42 unique CLASS strata, which include the low-income strata discarded as part of this analysis.
[b] Determined by applying ESAP flag to CLASS participants.
[c] Determined by applying participation flag to CLASS participants less ESAP participants.

Appendix F. Survey Response Rate Methodology

Given that survey response and cooperation rates are calculated and presented for the residential participant and nonparticipant surveys, we present here a definition and explanation of how the rates are calculated.

The survey response rate is the number of completed interviews divided by the total number of potentially eligible respondents in the sample. We calculated the response rate using the standards and formulas set forth by the American Association for Public Opinion Research (AAPOR).[108] For various reasons, we were unable to determine the eligibility of all sample units through the survey process and so chose to use AAPOR Response Rate 3 (RR3). RR3 includes an estimate of eligibility for these unknown sample units. The formulas used to calculate RR3 are presented below. The definitions of the letters used in the formulas are shown in the survey disposition tables in the nonparticipant and participant "Survey Dispositions and Response Rate" sections of the report.

$$E = (I + P + R + NC) / (I + R + NC + e)$$

$$RR3 = I / ((I + P + R + NC) + (E * U))$$

We also calculated a cooperation rate, which is the number of completed interviews divided by the total number of eligible sample units actually contacted. In essence, the cooperation rate gives the percentage of participants who completed an interview out of all of the participants with whom we actually spoke. We used AAPOR Cooperation Rate 3 (COOP3), which is calculated as:

$$COOP3 = I / (I + P + R)$$

[108] *Standard Definitions: Final Dispositions of Case Codes and Outcome Rates for Surveys*, AAPOR, 2011. http://www.aapor.org/AM/Template.cfm?Section=Standard_Definitions2&Template=/CM/ContentDisplay.cfm&ContentID=3156.

Appendix G. Calculating Sampling Error for Spillover Estimates

The text below is from a memo sent from the study team to the California Public Utilities Commission (CPUC) on August 18, 2015.

Industry Standard Approach

Typically, when sampling, we choose a target level of precision and confidence around our item of interest and develop preliminary estimates of the number of completed interviews required to achieve these targets, based on an assumption about a coefficient of variation (CV)[109] and application of a finite population correction factor (when needed). We normally base the CV on past research focused on similar items of interest since we cannot know the actual CV for a particular measured quantity or proportion until research is complete. However, by using comparable research conducted in other jurisdictions as a guide, we are able to design a sampling strategy that will allow us to reach our targeted levels of precision and confidence in most cases.

In typical impact evaluations within the energy industry, evaluators treat spillover as a secondary characteristic, which is measured as part of a self-report net-to-gross survey battery. As such, general industry practice is to use a sample of convenience to assess spillover, wherein a sampling strategy (as described above) is designed to produce a free-ridership estimate that meets target levels of sampling and precision, and spillover questions are asked of those participants who are administered the free-ridership battery. As a result, evaluators typically do not report spillover-specific confidence and precision estimates.

Our Spillover Approach

Unlike most studies that assess spillover, the primary objective of this evaluation is to assess the deemed statewide California spillover estimate. Since spillover is the primary characteristic for estimation, we must design a sampling strategy that yields a population estimate of spillover and allows us to calculate the sampling error associated with our estimate.

We can break the process of estimating spillover into two parts. One component of a spillover estimate is the incidence of spillover, defined as the proportion of the population that completes spillover projects (or purchases). The second component is the spillover factor, which is the estimate of the savings associated with those spillover projects. It is possible to make an overall estimate that combines the two, but because the issues for each are somewhat different, we treat them separately. We understand that the primary objective of this study is to quantify the spillover factor and our approach will aim to meet the confidence and precision levels for this measurement. However, there is also value in understanding the incidence of spillover. In the section below, we detail our strategy to address both of these components.

Incidence of Spillover

Given our approach described above, we first use the results from our self-report survey to estimate the percentage of the population that qualifies as producing spillover savings. This presents a challenge because spillover is a rather rare event. Estimating a population percentage of an event that occurs in, say, 1%[110] of

[109] The CV is defined as the ratio of the standard deviation to the mean for a probability or frequency distribution.

[110] Please note that we choose 1% as an illustrative (and conservative) example. Our spillover rate may very well be higher than 1% after actually conducting our study.

cases within the sample and finding it to be statistically significant different from zero requires a large sample[111] and to achieve the industry standard of 90% confidence and 10% relative precision would require the sample to be even larger.

However, in the case of proportions, especially very small ones, it is more appropriate to use absolute precision as a yardstick rather than relative precision.[112] Thinking in those terms, a reasonable goal is to look for a confidence interval that is approximately a half-width of our estimate. Assuming a proportion of about .01, a half-width confidence interval would ensure that we could distinguish our estimate from zero. Therefore, our target confidence interval (a half-width) for a proportion of .01 would be 0.005. To estimate the confidence interval for this example, we use Equation 22 from Valliant, Dever, & Kreuter (2013, p. 36):

Equation 22. Estimating Sample Size from Known Proportion, Desired t, and Desired Confidence Interval

$$CI = t\sqrt{\frac{p_u q_u}{n}}$$

Where:

- $CI =$ confidence interval
- $t =$ critical *t* for desired confidence
- $p_u =$ proportion to be estimated
- $q_u = 1 - p_u$

Using this formula, a proportion of .01, a half-width of 0.005, based on a t (or z) of 1.645 (i.e., a 90% confidence level) would require a sample size of about 1,100. This sample size would provide assurance that the estimate of 1% is significantly different from zero at 90% confidence.

When the proportion being estimated is very small and we want to report a relative precision of 10% (e.g., of 1%) or less, the sample size needs become impractical. We illustrate this using the same example described above. To estimate the required sample size for 10% relative precision, we use the following equation below (Valliant, et al., 2013, p. 38). Assuming an incidence rate of 1%, we would require a sample size of about 39,000 to achieve a relative error bound of ±10%.

Equation 23.

$$n \doteq \frac{z^2}{e^2}\frac{q_u}{p_u}$$

[111] We usually think of estimating a proportion of 0.5 (50%) as requiring the largest sample. This principle is based on hitting a specific variance, which is largest at p=0.5. However, to achieve precision in a very small proportion, the appropriate metric is the CV or tolerable error (e).

[112] The Uniform Methods Project: Methods for Determining Energy Efficiency Savings for Specific Measures. Chapter 11, page 40.

Where:

- e = tolerable error
- p_u = proportion of interest
- $q_u = 1 - p_u$

Spillover Savings

Relative Precision

The second component of estimating spillover involves estimating the actual savings for the sample of customers that completed spillover-qualified projects. For this estimate, the question becomes, how many spillover-qualified customers must we sample to estimate spillover savings with the industry standard relative precision of 10%? Equation 24 from the California Framework (TecMarket Works, 2006, p. 322) provides the means of calculating sample size:

Equation 24.

$$n = \left(\frac{t * CV}{D}\right)^2$$

Where:

- n = sample size needed
- t = critical t for desired confidence
- CV = population CV
- D = desired relative precision

Using Equation 24 requires knowing or assuming a CV. Because Opinion Dynamics has conducted spillover studies in the past, we have a basis on which to assume a CV for the current study. Specifically, we were able to use spillover data from 1,990 respondents (combining two studies) to calculate the standard deviation of spillover savings of our sample.[113] The CV for that combined spillover sample was 13.4, and the CV for the two individual studies were 8 and 11. Substituting the CV of 13 into Equation 24, using a t of 1.645 for 90% confidence, and 0.1 for relative precision, we find that we would need almost 50,000 respondents to achieve 90/10 for spillover savings. Given our expected incidence of spillover-qualified participants for this survey effort, we can see that the number of outbound calls required to meet the industry standard 90/10 confidence and relative precision is not feasible.

Absolute Precision

An alternate approach is to use a sample design that optimizes absolute precision. The substantive difference between absolute and relative precision is that absolute precision allows us to estimate the population parameter within defined boundaries of the true value, whereas relative precision estimates the population parameter within a defined percentage of the population parameter itself. This distinction is relevant for this

[113] We had access to three other spillover studies as well, but those studies discovered no spillover-qualified projects.

study, since the purpose of estimating uncertainty for spillover is to provide a reasonable upper and lower bound of our spillover value and to assess, among other things, whether our estimated spillover value is statistically different from zero. In this context, we think that a narrower estimate of uncertainty using relative precision, which requires extremely large sample sizes, is not a cost-effective approach for assessing the error bound for spillover. Rather, we think a more appropriate strategy is to focus on absolute precision.

To assess the possible sample size requirements for estimating a reasonable level of absolute precision around spillover savings, the evaluation team can apply the following equation from Beri (2008):

Equation 25.

$$n = \frac{z^2 \hat{s}^2}{E^2}$$

Where:

- n = sample size needed
- z = value for desired confidence
- $\hat{s}$ = estimated population standard deviation
- E = acceptable error in absolute terms

Specifically, we applied Equation 25 to multiple scenarios that vary in CV and precision targets. We assume a 90% confidence level over all calculations. Table 125 shows the sample size requirements for each of our scenarios. Note that we based this set of calculations on a full sample of screened participants, not only those who qualified for spillover. This means that most spillover savings were zero, which is realistic. We also did calculations with only qualified participants; the results were very similar in terms of how many participants would have to be screened for a given result.

Table 125. Sample Sizes Needed under Different CV Assumptions Using a Mean Spillover Savings of 2.5[114]

	Sample *n* Needed			Absolute Precision	
Precision Level	CV=12	CV=10	CV=8	Lower Bound	Upper Bound
High	6,235	4,330	2,771	1.88	3.13
Medium	1,559	1,082	693	1.25	3.75
Low	693	481	308	0.63	4.38

Table 126 shows how these results translate into estimates of spillover savings as a percent of program savings, which is the ultimate approach for allowing investor-owned utilities (IOUs) to claim spillover savings. For ease of interpretation, we display our results assuming that our spillover savings results above (Table 125) translates into a 5% spillover rate (i.e., the deemed California statewide spillover rate). We show the same three levels of absolute precision and CVs that we included in Table 125.

[114] The mean savings is presented in the table as unit-less, and is unimportant, since the essential factor in estimating confidence, precision, and sample size is the CV. We accomplished varying the CV by varying the assumed standard deviations in each scenario. The mean spillover savings of 2.5 did come from a recent study we completed in a different territory and, in that case, it represented therms.

Table 126. Estimated Precision Levels Tying Spillover to Program Savings at 5% under Different Assumptions and Targets

	Sample *n* Needed			Absolute Precision		Cost
Precision Level	**CV=12**	**CV=10**	**CV=8**	**Lower Bound**	**Upper Bound**	**Survey Fielding Price Estimates**
High	6,235	4,330	2,771	3.75%	6.25%	$145,000–$327,000
Medium	1,559	1,082	693	2.50%	7.50%	$36,000–$81,000
Low	693	481	308	1.25%	8.75%	$16,000–$36,000

Note: These figures do not take into account sampling error in the program savings estimate.

Table 126 also provides the budget implications for the different sample size requirements estimated in our analysis. Our estimates of survey fielding costs incorporate assumptions on survey production based on previous participant telephone surveys conducted by Opinion Dynamics. By incorporating survey fielding costs, we can determine the relative cost-effectiveness of achieving different precision levels.

We see that to achieve the highest precision levels, we would need between $145,000 (n=2,771) and $327,000 (n=6,235) for survey fielding. However, if we were to relax our precision requirements slightly, we see a significant drop in survey fielding costs (between $36,000 and $81,000).

Conclusion

We cannot know what the CV for the current spillover study will be and thus we can only use data from previous studies to estimate a range of possible values. However, as Table 126 demonstrates, there is considerable variation in fielding costs depending on the ultimate value of the CV. For this reason, the evaluation team proposes a two-stage sampling process to maximize absolute precision and limit survey fielding costs. Specifically, we propose surveying a small sample of participants until we reach a limited number customers who qualify as spillover-eligible participants. At that point, we will have a much better estimate of the CV for this study and the estimated spillover savings. This information will allow the evaluation team to modify the sample size requirements to ensure that we are best utilizing our resources and that we sample the minimum number of customers needed to achieve desired precision levels. A forthcoming memo will describe in more detail our sampling strategy.

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Appendix H. Residential Upstream Lighting Program Analysis Results

Overview and Summary

The Upstream Lighting Programs (ULP) present a number of unique challenges with respect to ensuring that ULP-related spillover savings are captured as part of past impact studies or through this residential spillover study. Similar to spillover resulting from other demand-side management programs, ULP-related spillover results from program-influenced energy efficiency actions/measures taken outside of programs by either program participants or nonparticipants and can involve both lighting and non-lighting measures. The key question is how one should, given the upstream nature of ULP, go about capturing energy-efficient lighting and non-lighting actions/measures (and the associated savings) taken outside of ULP but influenced by it (i.e., ULP-related spillover). For this study, how we approach this issue varies by measure type, as outlined below.

- **Non-Lighting Measures.** For ULP, there are a couple of important and interrelated issues with respect to isolating the influence of ULP on the installation of non-lighting spillover measures. First, there is probably no study design that could isolate the extent to which ULP might influence the installation of non-lighting measures as most people are not aware of their ULP-related participation. Further, there appears to be no obvious causal mechanism that should lead us to expect ULP-influenced non-lighting spillover to exist. That is, why would we expect someone who purchases CFLs or LEDs at a subsidized price—without being aware of the subsidy—to go out and buy a non-lighting energy efficiency measure of some kind? In short, we have no reason to believe that ULP influences the installation of non-lighting energy efficiency measures and no reliable way to measure it even if we thought it exists. Therefore, while this might be (in some respects) a gap in this overarching residential spillover study, it is largely an unavoidable one.

- **Lighting Measures.** The residential spillover study does not directly address spillover for lighting measures for several reasons. First, we could not appropriately ask program participants and nonparticipants questions regarding lighting actions/measures purchased and installed outside of programs because we have no way of determining if a reported "purchase" was of a ULP-incented bulb.[115] Therefore, it follows that there is a significant opportunity to count as spillover savings bulb purchases reported by respondents that actually received ULP incentives (something that would be unknown to the respondent given ULP's upstream nature). Second, a review of the program year (PY) 2010–2012 and PY2013–2014 ULP impact studies[116] (hereinafter referred to as the "ULP Impact Studies") indicates that the market-based evaluation approach used for both studies tended to incorporate spillover to some extent, and it was unclear whether it needed to be incorporated any further. Therefore, we focused on analyzing to what extent spillover is already captured in the most recent ULP Impact Studies.

[115] Respondents simply are not in a position, nor does tracking system data exist, to identify whether or not a given bulb purchase received (upstream) a ULP incentive. This is completely understandable given the upstream nature of ULP, but it effectively means that ULP-related lighting spillover cannot be measured through traditional measurement (i.e., consumer survey) approaches.

[116] 2010–12 Report: California Upstream and Residential Lighting Impact Evaluation, Work Order 28 (WO28) Final Report. California Public Utilities Commission, Energy Division. Prepared by KEMA, Inc. 8/4/2014; 2013–14 Report: Impact Evaluation of 2013–14 Upstream and Residential Downstream Lighting Programs. California Public Utilities Commission. Prepared by DNV GL. 4/1/2016. CALMAC Study ID CPU0122.01.

To explore the possibility that the ULP Impact Studies net-to-gross ratios (NTGRs) already capture residential lighting spillover, the remainder of this memo highlights the results of a ULP sensitivity analysis. The goal of the analysis is to understand whether or not (and the extent to which) residential lighting spillover credit has already been awarded through the ULP Impact Studies.

PY2010–2012 and PY2013–2014 ULP Impact Studies and Sensitivity Analysis

To provide insight into the degree to which the most recent ULP Impact Studies already address ULP-related residential lighting spillover, we worked with the DNV GL team that completed both ULP Impact Studies to conduct a sensitivity analysis around key study parameters. The purpose of the sensitivity analysis is not to develop an estimate of spillover savings for ULP. Rather, the primary purpose is to understand whether or not (and the extent to which) residential lighting spillover credit has already been awarded through the ULP Impact Studies.

Overview of ULP Impact Studies' Evaluation (NTGR) Framework

Prior to discussing the sensitivity analysis, we provide a brief overview of the NTGR framework used in the ULP Impact Studies. Both studies estimated ULP net impacts by examining ULP's influence on:

- **Changes in consumer demand:** Specifically, the development of a Lamp Choice Model (LCM) to provide estimates, under various conditions, of changes in consumer demand (for example, market share) attributable to ULP. The LCM is based on data collected through in-store intercepts with customers purchasing lighting products at ULP participating retailers.
- **Changes in supply:** Specifically, interviews with various members of the supply chain (manufacturers, retail buyers, retail store managers) to provide estimates of changes in product availability and supply/sales as a result of ULP.

While it is not our intent to cover ground already covered in the ULP Impact Studies, it is important to point out that the LCM included both a "Price Effects Only" scenario and a "Price and Availability Effects" scenario. Since the difference between these scenarios plays an important role in our sensitivity analysis, we describe each scenario here:

- **Price Effects Only[117]:** This LCM scenario reflects the lamp prices that consumers would have seen without investor-owned utility (IOU) discounts. The ULP Impact Studies estimated price differences based on clearly labeled IOU discounts in the stores or by matching lamps to program-tracking data. This scenario results in a counterfactual estimate of market shares that would have occurred if CFL prices were not discounted by the IOUs.
- **Price and Availability Effects[118]:** In addition to Price Effects Only, this scenario reflects stocking changes that would not have occurred in the absence of ULP. When a manufacturer stated that it would not have shipped any CFLs to the California market without the program incentives, the ULP Impact Studies flagged the particular manufacturer's lighting product as "program-reliant." This

[117] The PY2013–2014 ULP Impact Study refers to this as the "No Discount" scenario.
[118] The PY2013–2014 ULP Impact Study refers to this as the "Constrained" scenario.

scenario results in a counterfactual estimate of market shares if program-reliant lamps were not in stores and if CFL prices were not discounted by the IOUs.[119]

As described more fully in the respective ULP Impact Studies, a NTGR for each bulb type (by utility and statewide) was determined through the LCM and another estimate was determined through supply-side interviews. Within each study, these two estimates were then combined to arrive at an overall NTGR per bulb type (by utility and statewide). While there are important differences between the 2010–12 and 2013–14 ULP Impact Studies, they are very similar in terms of the overall methodology. Specifically, both use in-store intercepts, retailer interviews, and manufacturer interviews. They do, however, vary somewhat in the relative weight given to the NTGR determined through the LCM versus the supply-side interviews.[120] They also differ somewhat in how the LCM was determined and applied. These differences are best understood by reviewing each of the respective ULP Impact Studies reports.

Sensitivity Analysis – Conceptual Framework

To understand the sensitivity analysis, it is necessary to understand its conceptual underpinnings. As discussed above, the ULP Impact Studies NTGR estimates are essentially an integration of two NTGR estimation methods (i.e., LCM and supply-side interviews). Within the LCM, there are two underlying scenarios, the Price Effects Only scenario and the Price and Availability Effects scenario. So, in essence, there are three somewhat distinct scenarios one could apply to estimate a NTGR for ULP (i.e., Price Effects Only, Price and Availability Effects, Supply Side) and we view these three NTGR estimation scenarios as forming a hierarchy in terms of the degree to which they incorporate spillover. We view the hierarchy as follows:

- **Price Effects Only:** The lowest in the hierarchy (of increasing emphasis on spillover) because it incorporates only price effects. This scenario provides an estimate of the NTGR if the only impact of ULP was to reduce the retail price of CFLs/LEDs. It is based entirely on in-store intercepts, and we view the resulting NTGR as analogous to the NTGR that one would get through traditional consumer telephone surveys (1 – free-ridership), with no inclusion of spillover savings.[121]

- **Price and Availability Effects:** Next in the hierarchy because it incorporates not only price effects but also stocking effects. This scenario provides an estimate of the NTGR if the impacts of ULP are to 1) reduce the retail price of CFLs/LEDs, and 2) increase the availability of some CFLs/LEDs (to reflect

[119] It is noteworthy that the impact of flagging lighting products as "program-reliant" on the NTGR was greater for some bulb type/channel combinations (e.g., Basic Spiral/Discount, A-Lamps/Grocery-Chains) than for others (e.g., Basic Spiral/Home Improvement, A-Lamps/Drug Store).

[120] In PY2010–2012, 83% of the 69,874,522 incented bulbs included in the analysis were Basic Spirals and A-Lamps. For both bulb types, the LCM was based on the Price and Availability Effects model. Further, the final NTGR for both bulb types was determined by giving the NTGR determined through the LCM approximately 90% of the weight and the NTGR determined through supply-side interviews approximately 10% of the weight. In PY2013–2014, overall program activity was more evenly distributed across four bulb types (Basic CFLs < 30 watts, A-Lamp CFLs < 30 watts, Reflector CFLs, and CFLs ≥ 30 watts). For all bulb types, the LCM was based on a combination of the Price Effects Only and the Price and Availability Effects models, varying by retail channel. The final NTGR for all bulb types was determined by giving the NTGR determined through the LCM 70% of the weight and the NTGR determined through the supply-side interviews 30% of the weight. It is notable that the supply-side interviews wielded additional influence as they are also the source of information on product availability that is central to the Price and Availability Effects LCM.

[121] In essence, the NTGR provided through the Price Effects Only scenario (based on store intercepts) is similar to asking customers (via a telephone survey) if they would have purchased a program-incented CFL/LED (at the regular retail price) in the absence of the program. The resulting adjustment would be a NTGR without any spillover adjustment (1 – free-ridership). Admittedly, in many circumstances, these same customers would have been asked if they made any additional CFL/LED purchases after their program participation (and outside the program) and how influential their program experience was in that decision, resulting in some additional spillover credit.

the fact, as identified in the supply-side interviews, that some CFLs/LEDs would not have been available for sale in California in the absence of ULP). We view the resulting NTGR as including a significant amount of spillover, as the inclusion of changes in product availability clearly include market effects (a component of spillover) that would not be perceivable to the end-user.

- Supply Side: Highest in the hierarchy because it incorporates not only price and availability effects but also some other supply-side effects, such as changes in production and overall California sales. While not technically an upper bound,[122] it would likely include most, if not all, spillover.

Sensitivity Analysis – Methodology

The ULP Impact Studies, completed in both PY2010–2012 and PY2013–2014 by DNV GL, provide NTGRs by bulb type that effectively weight LCM results (e.g., Price Effects Only, Price and Availability Effects, or a combination of both) with supply-side results. The most important outcome, for purposes of this sensitivity analysis, is that both ULP Impact Studies provide a single overall NTGR by bulb type (the "awarded" NTGR). From this, the Opinion Dynamics team took the following additional steps:

1. To make the analysis results easier to understand and compare, we computed an overall "awarded" NTGR for each of the ULP Impact Studies (one for PY2010–2012 and another for PY2013–2014). We did this by weighting the NTGR results for each bulb type by its respective contribution to overall ULP incented sales for the given time period. The statewide "awarded" NTGR for PY2010–2012 and PY2013–2014 are .65 and .39, respectively.

2. For each ULP impact study, we asked DNV GL to provide a NTGR by bulb type by applying each of the three scenarios independently. The result is three NTGRs for each bulb type and study period. The first NTGR (for each bulb type and study period) is based exclusively on the application of the Price Effects Only LCM, the second is based exclusively on the application of the Price and Availability Effects LCM, and the third is based exclusively on the supply-side results. As previously stated, we view these three NTGR estimation scenarios as forming a hierarchy in terms of the degree to which they incorporate spillover. Because this approach differs from the way the results were analyzed and broken down in the original ULP Impact Studies, additional reanalysis was required.

3. Since DNV GL provided the sensitivity analysis at a bulb level and separately for PY2010–2012 and PY2013–2014, we computed an overall NTGR for each of the ULP Impact Studies (one for PY2010–2012 and another for PY2013–2014) for each scenario (i.e., Price Effects Only, Price and Availability Effects, Supply Side). For each scenario, we developed the NTGR by weighting the NTGR for each bulb type by its respective contribution to overall ULP-incented sales for the given time period.

4. We computed a "combined" NTGR, by scenario and overall, that effectively weights the results of the PY2010–2012 and PY2013–2014 studies, by bulb type, by their respective contribution to overall combined ULP-incented sales across both time periods. This final step was taken to provide a comprehensive single picture of both the overall "awarded" NTGR across both ULP Impact Studies and the combined NTGR by scenario.

[122] An "upper bound" estimate would likely also include input from manufacturers that did not participate in ULP to better understand how the program might have affected their sales in both participating and nonparticipating retailers. For obvious reasons, getting input from nonparticipating manufacturers is very difficult.

Prior to presenting the results of the sensitivity analysis, it is important to point out that we do not mean to imply (by asking DNV GL to perform this additional analysis) that the decisions regarding how to weight LCM results and supply-side results made as part of the ULP Impact Studies represent a methodological error. In fact, we fully understand and appreciate the fact that the weighting methodology applied in both ULP Impact Studies reflects a desire to balance a variety of methodological attributes. Each of the three potential NTGR impact estimates has strengths, limitations, and various threats to validity. Most importantly, DNV GL staff—who completed both studies—are clearly in the best position to judge these attributes and the relative merits of each source of input (e.g., store intercepts, retailers, suppliers), as well as how the LCM and supply-side results were constructed and ultimately weighted together.

To be clear, the sole objective of this sensitivity analysis is to assess where the overall program NTGR, awarded through the two ULP Impact Studies, falls on the continuum of inclusion of spillover. The results of this sensitivity analysis should not be taken as anything other than what they were intended for.

Sensitivity Analysis – Results

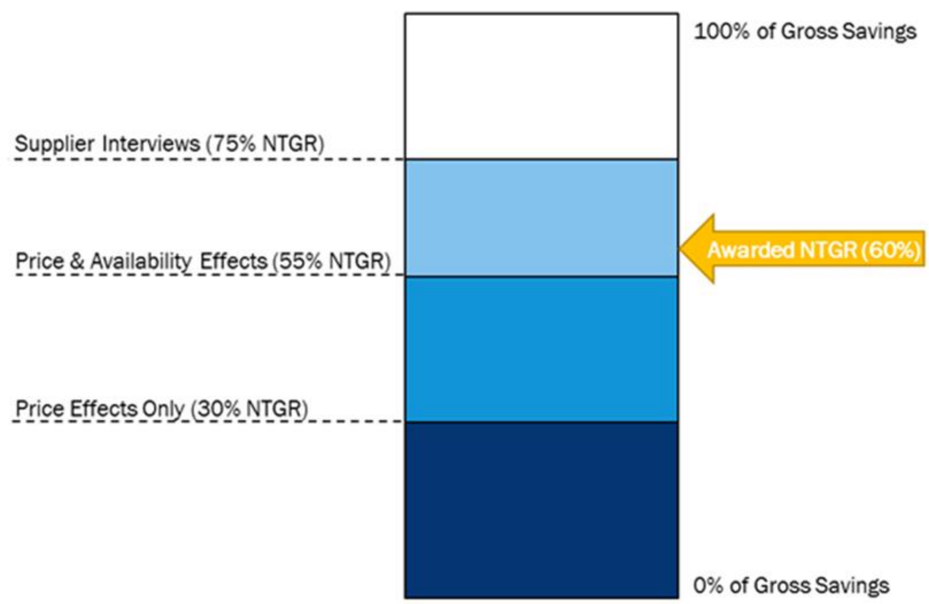
The results of the combined PY2010–2012 and PY2013–2014 ULP NTGR sensitivity analysis are provided in Table 127. The overall combined NTGR "awarded" through the two ULP Impact Studies is 0.60. The supply-side scenario produces a NTGR of 0.75. At the other end of the continuum, the Price Effects Only scenario provides a NTGR of 0.30. In between these two is the NTGR of 0.55 that comes from the Price and Availability Effects scenario. The combined awarded NTGR (0.60) is double the combined NTGR resulting from the application of the Price Effects Only scenario (0.30) and above the combined NTGR implied by the application of the Price and Availability Effects scenario (0.55).

Table 127. Overall NTGRs across the Study Period

Estimation Method	Combined
Supply-Side Scenario	0.75
Awarded	***0.60***
Price and Availability Effects Scenario	0.55
Price Effects Only Scenario	0.30
Number of Incented Bulbs	*87,140,617*

We further illustrate the "combined" results in Figure 9 below. The illustration provides a visual depiction of amount of spillover credit that would be realized through the application of each of the potential NTGR estimation scenarios (i.e., Price Effects Only, Price and Availability Effects, Supply Side) and where the awarded NTGR falls on the continuum. Clearly, as illustrated in the figure, the combined "awarded" NTGR (.60) provides a significant amount of spillover credit when compared to the application of a Price Effects Only scenario. And, as previously discussed, we equate the Price Effects Only estimate, based entirely on in-store intercepts, as analogous to the NTGR one would get through traditional consumer telephone surveys. The combined "awarded" NTGR (0.60) also provides spillover credit beyond what would be awarded through the application of the Price and Availability Effects scenario, which includes a significant amount of spillover as changes in product availability clearly include market effects (a component of spillover) that would not be perceivable to the end-user. Finally, given that it falls above the Price and Availability Effects NTGR, the combined "awarded" NTGR includes additional market effects. These market effects, captured in the supply-side scenario, include impacts captured in broad market-based assessments of the impact of ULP on overall energy-efficient lighting sales in California.

Figure 9. Overall NTGRs across the Study Period



Summary and Conclusions

The sensitivity analysis clearly demonstrates that the spillover credit already awarded through the ULP Impact Studies NTGRs:

- Goes well beyond any spillover credit that would have been awarded by following the working definition of spillover used in this study (i.e., that which is perceivable by the end-user).
- Includes significant elements of spillover, such as market effects, that would not have been credited in absence of the market-based evaluation approach necessitated by ULP. Specifically, both ULP Impact Studies include impacts related to program-influenced changes in stocking practices (i.e., what was made available to consumers at retail locations) as reported by retailers and lighting manufacturers, as well as impacts captured in broad market-based assessments, gathered through manufacturer interviews, of the impact of ULP on overall energy-efficient lighting sales in California.

Therefore, we conclude that the existing NTGR methodology, employed as part of both ULP Impact Studies, captures a good deal of spillover, though perhaps not all. Additionally, we do not think we should attempt to quantify any additional spillover for ULP through this overarching residential spillover study because it would require second-guessing the weight given to different NTGR methods in the ULP Impact Studies in a manner that would likely put excessive weight on the supply-side interviews. In short, the DNV GL team did its best to balance the various methodological attributes (including their strengths, weakness, and threats to validity) when determining an appropriate ULP NTGR. More importantly, perhaps, the chosen overall methodology was to take a market-based approach to the NTGR determination, toward the goal of understanding ULP's net impact on the overall California lighting market. This market-based approach assessed both direct and indirect effects that, in theory, effectively and appropriately capture both free-ridership and spillover in the overall NTGR estimate.

Appendix I. CSS/CMST Spillover Sample Development

Goal of the Study: Review and Analysis of CSS/CMST data for IOU EE Program Participants and Non-participants to Identify Sample for Spillover Interviews.

This study identifies businesses within the Commercial Saturation Survey and Commercial Market Share Tracking (CSS/CMST) surveys where spillover may have occurred during the 2010-12 time period. Identification of these sites will provide a sample of sites that could be re-interviewed under the 2013-2014 Nonresidential Spillover Evaluation using the spillover battery of questions developed as part of the 2013-14 Evaluation. The identification of potential spillover sites was a four step process.

1. Itron conducted a review of the CSS/CMST data, identifying sites that had recently purchased Linear technologies, CFLs, LEDs, HVAC, and Refrigeration measures.
2. The newly purchased measures were reviewed, using make and model lookups where necessary, to determine their base or high efficiency status.
3. Sites where new high efficiency measures had been installed between 2010 and 2012 were compared with program tracking data to determine if the installed measures had received an incentive from IOU energy efficiency programs.
4. Sites where high efficiency measures were installed without the receipt of an IOU incentive were divided into those that had participated in an IOU energy efficiency program during 2010-2012 and those that were non-participants during this time period.

The following sections describe the screening process undertaken to arrive at the sample of CSS/CMST sites eligible for spillover surveys. The number of sites and the types of high efficiency measures eligible for the spillover analysis will also be described.

New Equipment

The recent 2010-12 Commercial Market Share Tracking Study (CMST) analyzed the non-residential recent purchase market for Linear Fluorescents, Televisions, and small packaged HVAC units in California. The 2010-12 Commercial Saturation Survey (CSS) focused on the whole building and business characteristics and many of the electric end uses within commercial businesses. End uses analyzed for the CSS included Lighting, Televisions (TV), Office Equipment, Refrigeration, HVAC, Energy Management Systems (EMS), and Distributed Generation systems (DG). In addition to the recent purchases of Linear Fluorescents and small packaged HVAC units included in the CMST study, this spillover analysis includes recent purchases of other high efficiency Lighting equipment like LEDs and CFLs, as well as other HVAC and Refrigeration measures installed after 2010, captured by the CSS/CMST on-site survey effort. The technologies analyzed for this study are listed in Table 128.

Table 128. High Efficiency Equipment in Analysis

Lighting*	HVAC	Refrigeration
Linear Fluorescents	Chillers	Auto-Closers
LEDs	Furnaces	Case Lighting
CFLs	Package Single Zone Systems	Condensers
	Split Single Zone Systems	Refrigerators
	Package Terminal Units	Freezers
	Evaporative Coolers	Strip Curtains
	EMS	Night Covers
	Central Plant	Refrigeration Motors
		Controllers

[a] Lighting Controls were studied in this analysis. The age of lighting controls, however, was not collected during the on-site data collection. Occupancy sensor on new lighting systems were studied but not included as a unique lighting measure.

As a first step, the study identified sites that installed measures belonging to the categories listed in Table 128 during and after 2010.[123] The counts of new purchasing businesses surveyed by the CSS/CMST effort are listed in Table 129 by end use and kWh size. Businesses purchasing new Lighting and HVAC measures are more frequently observed than Refrigeration and EMS measures. The higher frequency of Lighting and HVAC measures is likely due, at least in part, to the CMST's focus on recent purchases of Linear Fluorescents and Packaged and Split HVAC systems and the higher incidence of these measures within the commercial businesses surveyed for the CSS.

Table 129. Sites with Recent Purchases of Equipment Found During CSS/CMST by Size

Business Size[a]	Lighting	Refrigeration	HVAC	EMS
Very Small	167	11	42	0
Small	177	34	76	6
Medium	169	28	125	41
Large	44	9	18	8
Unknown	7	0	1	0
Total	**564**	**82**	**262**	**55**

[a] Large sites have annual usage over 1,750,000 kWh, Medium have greater than 300,000 kWh and less than or equal to 1,750,000, Small have max annual usage greater than 40,000 kWh and less than or equal to 300,000, and Very Small have annual usage less than or equal to 40,000 kWh. The Unknown usage category represents accounts found in the CIS that do not have a matching record in the billing data.

[123] New measures were restricted to those whose installation or manufacture year was 2010 and later. The self-reported year of installation was collected where possible during the on-site survey. Many site contacts, however, were unable to provide information on the year of installation. The year of manufacture was collected if the date was listed on the measure name plate.

Table 130 displays the counts of new purchasing businesses surveyed by the CSS/CMST effort by end use and business type.[124]

Table 130. Sites with Recent Purchases of Equipment Found During CSS/CMST by Business Type

Business Type	Lighting	Refrigeration	HVAC	EMS
College	0	0	1	0
Food/Liquor	48	30	17	6
Health/Medical - Clinic	38	2	26	3
Health/Medical - Hospital	2	0	1	0
Hotel	3	0	4	0
Industrial	28	0	11	0
Miscellaneous	99	6	41	9
Office	78	4	51	18
Restaurant	51	23	17	2
Retail	106	7	35	9
School	59	6	33	6
Warehouse	52	4	25	2
Total	**564**	**82**	**262**	**55**

High Efficiency Equipment

The new equipment was then classified as high efficiency based on information gathered on site in combination with a make and model number lookup to determine measure efficiency. The CSS/CMST make and model lookup database was leveraged for the analysis of Linear Fluorescent and HVAC measures included in the development of the sites for the spillover analysis. The HVAC and Refrigeration analyses, however, required additional lookups as part of the effort to identify high efficiency equipment recently installed in CSS/CMST businesses.[125] Make and model number lookups were performed to fill in missing information on capacity and efficiency, as well as to verify the information found on site. Additionally, this study seeks to determine what percent of Lighting equipment found on site was controlled by an occupancy/motion sensor. A brief description of the additional efficiency analyses conducted as part of this study is detailed in Table 131.

[124] Colleges, Hotels, Hospitals, and Industrial businesses were surveyed as part of the CMST but were not included in the CSS on-sites. The CMST on-site data collection effort did not collect information on Refrigeration measures or EMS.

[125] All new EMS, LEDs, and CFLs were counted as high efficiency equipment.

Table 131. Additional Make and Model Lookups

End Use	Additional Make/Models Looked Up	Technologies Classified as High Efficiency
HVAC	229	168
Refrigeration	34	30

Lighting Make and Model Lookups

Make and model lookups develop crucial secondary information needed to classify the efficiency level of Linear Fluorescent measures.[126] The on-site form allows for the collection of make, model, size specifications, and wattage information from the bulbs and ballasts. Additional information needed for a thorough analysis includes lumens, rated life, and light color. These details can be difficult or impossible to collect on site, but can be determined as part of a make and model lookup. Lookup tables were developed using the data collected on site to determine the efficiency level of the new Linear Fluorescents. The lookups also provided information on lumens, rated life, and light color. LEDs, CFLs, and occupancy sensors were not included in the make and model lookup effort because these are high efficiency by their very nature.

Recently installed Lighting technologies were classified as being either high or base efficiency. Make and model lookups were used to allocate the Linear Fluorescents to one of seven performance groups based on efficiency. For the purposes of this analysis, T5s, Reduced Wattage T8s, High Performance T8s, and Standard 800-Series T8s were treated as high efficiency Linear technologies that could qualify for program rebates.[127] These high efficiency technologies are eligible for potential spillover analysis if the customer did not receive a rebate for their installation.[128] The make and model lookups undertaken in the CSS/CMST analyses addressed the needs of the efficiency analysis, so no additional Linear Lighting efficiency lookups were necessary for the spillover analysis undertaken for this memo. For the CSS/CMST analyses, the efficiency level of Linear Lighting technologies was determined using the May 2013 Commercial Lighting Qualifying Products Lists from the CEE.[129] Technologies not mapped from the CEE lists were assigned an efficiency level using on-site and lookup data.[130]

[126] This section of the report uses the common term efficiency to represent what lighting designers would term efficacy. These two terms are very similar for lighting applications, with efficiency used by the wider community and efficacy used by lighting designers and other professionals.

[127] This classification differs slightly from the high efficiency Linear classification used in the CSS/CMST reports. In the CSS/CMST report, Standard 800-Series T8s were classified as base efficiency. Review of the program tracking data found that 800-Series T8s were eligible for EE rebates during the early portion of the 2010-2012 program cycles. Due to their early program eligibility, they are classified as high efficiency for the development of potential spillover sites.

[128] The initial site and measure development for the spillover evaluation includes sites where CFLs were installed. CFLs, however, represent a high efficiency technology where the customer may not be aware that they received a rebate due to the upstream rebates available for this measure. The decision to include or exclude CFLs from the analysis will be made as part of the 2013/2014 Spillover Evaluation.

[129] http://library.cee1.org/content/commercial-lighting-qualifying-products-lists

[130] The spillover evaluation looked at all T8 Linear lamps regardless of their length. The CMST Linear lamp analysis focused on 4ft lamps.

An analysis of lighting controls at the sites where high efficiency lighting equipment was installed revealed that occupancy sensors were installed at 108 sites, i.e. at 23% of the 460 sites with high efficiency lighting equipment.

HVAC Make and Model Lookups

Make and model lookups for HVAC measures verified the classification of equipment found on site and helped to determine the efficiency level of observed equipment. The model numbers reported by surveyors were compared to a database of compiled performance specifications. While the focus of the make and model lookups was to find cooling capacity and cooling efficiency ratings, other information was also collected during the lookups such as the heating type and heating fuel type. Approximately 3,200 unique model numbers were found on site for the package single zone (PSZ) and split single zone (SSZ) units with direct expansion (DX) or evaporative cooling.

Under the CMST effort, performance tiers were defined using the 2010-2012 SCE Qualifying Minimum Equipment Efficiencies & Incentive Levels for Commercial Air Conditioners.[131] There were four tiers in total for each of the HVAC system types (single package and split system). All classifications were made using the SCE standards and a combination of the on-site and lookup data. The on-site data rely on the site contact's ability to recall the installation of the HVAC technology. The efficiency distribution, however, is dependent on the make and model lookups of efficiency information, leading to a more accurate picture of the efficiency distribution during this time period.

The CSS study, in coordination with the CMST HVAC analysis, reviewed make and model lookups for package single zone, split single zone, and ground source heat pump system types. These systems could have direct expansion or evaporative cooling as well as gas or electric heating types. Looking up the make and model number information, the research team was able to determine the efficiency level of each technology. The CSS on-site survey effort collected information on key variables for heating systems including heating equipment type, heating fuel type, and make and model numbers.

In addition to the efforts undertaken for the CSS and CMST analyses, the spillover research team looked up make and model numbers of boilers, chillers, mini split systems, and package terminal units. These lookups supplemented the CSS lookup effort of split systems by finding the AFUE or thermal efficiency of the furnaces and comparing them against the Title 20 Appliance Efficiency Regulations in order to determine if they were high efficiency. For these equipment types, efficiency and capacity were the main parameters that were looked up using manufacturers' technology specification sheets found online.

Refrigeration Make and Model Lookups

The Commercial Saturation Survey included the collection of make and model numbers for some Refrigeration equipment types. These data were not used in the CSS analysis of Refrigeration equipment, but were stored for use in future efforts. The Refrigeration lookups investigated energy efficient self-contained refrigerators and freezers. Refrigeration equipment found on site was classified as energy efficient primarily using the Food Service Technology Center (FSTC) and Energy Star lists. All self-contained Refrigeration make and model

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[131] Southern California Edison Commercial HVAC Distributor Incentive Program, 2010-2012 Qualifying Minimum Equipment Efficiencies & Incentive Levels for Commercial Air Conditioners and Heat Pumps. https://www.cainstantrebates.com/ca_media/er/img/SCE_HVAC_Incentive_Levels_2012.pdf

numbers from the CSS study were compared to these lists and, if necessary, were researched online to record efficiency information. The research team recorded specific service types, case types, volumes, energy use and rebate amounts when available and used these to conduct the efficiency analysis.

High Efficiency Equipment Lookup Findings

The results of the efficiency analysis conducted using the make and model lookups are summarized in Table 132. The CSS/CMST sites that were found to have installed high efficiency equipment during the 2010-2013 time period are divided into two groups: businesses that participated in an IOU EE program during PY 2010-2013 and businesses that did not participate in an EE program. A total of 386 businesses installed high efficiency equipment belonging to one or more of the technology end uses analyzed above and were found to have participated in utility EE programs. The study also determined that 254 CSS/CMST businesses recently installed new high efficiency equipment and did not participate in recent utility energy efficiency programs. For both the participant and non-participant groups, a business could have installed equipment within multiple end uses. Thus, the number of businesses by end use may sum to more than the total.

Table 132. Sites with High Efficiency Equipment Found During CSS/CMST by IOU EE Program Participation

EE Program Participation	Lighting	Refrigeration	HVAC	EMS	Total
EE Program Participant	300	32	100	30	386
EE Program Non-Participant	160	20	92	25	254

Participant and Non-Participant Spillover Sample

The 254 non-participant sites listed in Table 132 are qualified to be interviewed as part of the non-participant potential spillover sample. The 386 participant sites listed in Table 132 were further analyzed to determine if any of the recently installed high efficiency equipment had received an IOU EE rebate during PY2010-2012. The analysis required a two-step process. First, the equipment installed in participant businesses was reviewed to determine if the observed equipment appeared to be rebated. If the observed equipment did not appear to be similar to the equipment in the program tracking data, the high efficiency equipment was determined to be eligible for the participant potential spillover analysis. Second, if the observed equipment was similar to the equipment in the IOU EE program tracking data, the quantities of the high efficiency equipment found on site were compared to those listed in the tracking data. If the on-site quantity exceeded the rebated equipment, a one-to-one comparison of data recorded on site with information reported in utility tracking databases was undertaken for the business to determine if the site installed high efficiency equipment in excess of the quantity recorded in program tracking databases. This two-step analysis yielded 243 participant sites where the recently installed high efficiency equipment was determined to either be not incentivized or be in excess of the incentivized quantity.

A total of 243 participant sites and 254 non-participant sites were included in the sample across the four end uses. Table 133 displays the breakdown of sites included in the potential spillover sample by end use and EE program participation. The distribution of sites across participant and non-participant segments is quite even.

Also noted in the analysis results, Occupancy sensors were found to be installed on at 92 EE program participant sites and 16 non-participant sites of the sample selected for spillover interviews.[132]

Table 133. Sites with High Efficiency Equipment Included in Spillover Sample by IOU EE Program Participation

EE Program Participation	Lighting	Refrigeration	HVAC	EMS	Total
EE Program Participant	159	22	84	23	243
EE Program Non-Participant	160	20	92	25	254

Table 134 and Table 135 show how the potential spillover sample is distributed by end use and business size for participant sites and non-participant sites, respectively. Among both EE participants and non-participants sites in Table 134 and Table 135 Medium-sized sites are found to have the highest number of potential spillover sites at 98 and 90, respectively. These data also indicate that Large sized sites are substantially more likely to be in the potential spillover EE program participant sample than in the non-participant sample while Very Small site are more common in the non-participant sample than the participant sample. Across all size categories and participation status, high efficiency lighting is the most common end use installed without the receipt of a utility incentive.

Table 134. EE Program Participant Sites with High Efficiency Equipment Included in Spillover Sample by Size

Business Size	Lighting	Refrigeration	HVAC	EMS	Total
Very Small	33	2	9	0	**38**
Small	51	10	19	1	**72**
Medium	54	5	48	16	**98**
Large	21	5	8	6	**35**
Unknown	0	0	0	0	**0**
Total	**159**	**22**	**84**	**23**	**243**

* Large sites have annual usage over 1,750,000 kWh, Medium have greater than 300,000 kWh and less than or equal to 1,750,000, Small have max annual usage greater than 40,000 kWh and less than or equal to 300,000, and Very Small have annual usage less than or equal to 40,000 kWh. The Unknown usage category represents accounts found in the CIS that do not have a matching record in the billing data.

132 Occupancy sensors were also found to be installed on new lighting at 46 EE program participant sites not included in Table 133. These 46 sites were included in Table 132 but not Table 133 because the high efficiency lighting measures where the occupancy sensors were installed were rebated by the program. The 46 occupancy sensor sites will be included in the potential spillover sample to determine if these high efficiency measures were installed in 2010-2012 but are not included in the sites analyzed in this memo because it is not clear that the occupancy sensors on the new lighting are new occupancy sensors.

Table 135. EE Program Non-Participant Sites with High Efficiency Equipment Included in Spillover Sample by Size

Business Size	Lighting	Refrigeration	HVAC	EMS	Total
Very Small	50	5	18	0	**65**
Small	53	6	34	5	**85**
Medium	47	8	37	18	**90**
Large	5	1	3	2	**9**
Unknown	5	0	0	0	**5**
Total	**160**	**20**	**92**	**25**	**254**

* Large sites have annual usage over 1,750,000 kWh, Medium have greater than 300,000 kWh and less than or equal to 1,750,000, Small have max annual usage greater than 40,000 kWh and less than or equal to 300,000, and Very Small have annual usage less than or equal to 40,000 kWh. The Unknown usage category represents accounts found in the CIS that do not have a matching record in the billing data.

Table 136 and Table 137 show the distribution of the potential spillover sample by end use and business type for participant sites and non-participant sites, respectively.

Table 136. EE Program Participant Sites with High Efficiency Equipment Included in Spillover Sample by Business Type

Business Type	Lighting	Refrigeration	HVAC	EMS	Total
Food/Liquor	16	8	7	4	**29**
Restaurant	11	7	8	0	**21**
Office	22	2	14	10	**42**
School	30	0	10	1	**35**
Retail	26	2	10	4	**37**
Miscellaneous	22	2	12	2	**31**
Industrial	12	0	3	0	**12**
Health/Medical - Clinic	9	0	11	1	**18**
Warehouse	9	1	5	1	**12**
Hotel	1	0	4	0	**5**
Health/Medical - Hospital	1	0	0	0	**1**
Total	**159**	**22**	**84**	**23**	**243**

Table 137. EE Program Non-Participant Sites with High Efficiency Equipment Included in Spillover Sample by Business Type

Business Type	Lighting	Refrigeration	HVAC	EMS	Total
Food/Liquor	8	9	4	1	**17**
Restaurant	14	5	6	2	**24**
Office	18	1	15	8	**37**
School	12	2	9	5	**22**
Retail	29	0	14	2	**40**
Miscellaneous	39	1	17	5	**52**
Industrial	6	0	4	0	**10**
Health/Medical - Clinic	11	0	9	1	**20**
Warehouse	22	2	12	1	**29**
Health/Medical - Hospital	1	0	1	0	**2**
College	0	0	1	0	**1**
Total	**160**	**20**	**92**	**25**	**254**

Distribution of High Efficiency Equipment within the Spillover Sample

This sub-section provides information on the types of lighting, refrigeration, and HVAC equipment found in the potential spillover sample developed from the CSS/CMST sites. The information in this sub-section will be presented at the equipment level instead of the site level. For example, if a particular site installed 10 lighting fixtures, all 10 fixtures are recorded instead of simply noting that the site installed fixtures using a binary 0/1 flag. Neither the site level information above nor the equipment information in this sub-section have been weighted up to the population in the non-residential frame. The information is this memo are intended to help characterize the customers and equipment in the sample and indicate the relative distributions of quantities of individual high efficiency equipment categories found on site at these businesses.

Table 138 and Table 139 present the distribution of high efficiency lighting equipment found at businesses in the potential spillover sample by technology and business size for participant sites and non-participant sites, respectively. As seen, a majority of the high efficiency lighting equipment at businesses in the participant sample were found in the Medium and Large sized businesses and concentrated in the Medium segment for non-participants. When comparing the distribution of Lighting equipment by business size in Table 138 and Table 139, a larger share of non-participant Very Small and Small sites are associated with the non-participant Lighting installations than the participant installations.

Table 138. Distribution of High Efficiency Lighting Equipment Installed at EE Program Participant Sites Included in Spillover Sample by Size

Business Size	Linear Fluorescents	CFLs	LEDs
Very Small	2%	7%	2%
Small	8%	16%	4%
Medium	51%	24%	57%
Large	40%	53%	37%
Unknown	0%	0%	0%

* Large sites have annual usage over 1,750,000 kWh, Medium have greater than 300,000 kWh and less than or equal to 1,750,000, Small have max annual usage greater than 40,000 kWh and less than or equal to 300,000, and Very Small have annual usage less than or equal to 40,000 kWh. The Unknown usage category represents accounts found in the CIS that do not have a matching record in the billing data. The data in this table are not weighted.

Table 139. Distribution of High Efficiency Lighting Equipment Installed at EE Program Non-Participant Sites Included in Spillover Sample by Size

Business Size	Linear Fluorescents	CFLs	LEDs
Very Small	3%	14%	16%
Small	20%	38%	47%
Medium	75%	44%	27%
Large	2%	3%	9%
Unknown	1%	0%	0%

* Large sites have annual usage over 1,750,000 kWh, Medium have greater than 300,000 kWh and less than or equal to 1,750,000, Small have max annual usage greater than 40,000 kWh and less than or equal to 300,000, and Very Small have annual usage less than or equal to 40,000 kWh. The Unknown usage category represents accounts found in the CIS that do not have a matching record in the billing data. The data in this table are not weighted.

Table 140 and Table 141 present the distribution of Refrigeration equipment found on-site at businesses in the spillover sample by technology and business size for participant sites and non-participant sites, respectively. Medium-sized EE participant businesses have a majority of the equipment installed on-site, with the exception of Condensers and Refrigeration Motors which were found mainly at the Large sites. For non-participant sites within the potential spillover sample, greater percentages of the non-incented high efficiency equipment is found in Very Small and Small sites as compared to the participant sites.

Table 140. Distribution of High Efficiency Refrigeration Equipment Installed at EE Program Participant Sites Included in Spillover Sample by Size

Business Size	Auto-Closers	Case Lighting	Con-densers	Refrig-erators	Freezers	Strip Curtains	Night Covers	Refrig. Motors	Control-lers
Very Small	0%	0%	0%	6%	33%	0%	0%	0%	0%
Small	0%	9%	0%	35%	0%	19%	0%	1%	100%
Medium	100%	89%	0%	56%	67%	81%	100%	25%	0%
Large	0%	1%	100%	3%	0%	0%	0%	74%	0%
Unknown	0%	0%	0%	0%	0%	0%	0%	0%	0%

* Large sites have annual usage over 1,750,000 kWh, Medium have greater than 300,000 kWh and less than or equal to 1,750,000, Small have max annual usage greater than 40,000 kWh and less than or equal to 300,000, and Very Small have annual usage less than or equal to 40,000 kWh. The Unknown usage category represents accounts found in the CIS that do not have a matching record in the billing data. The data in this table are not weighted.

Table 141. Distribution of High Efficiency Refrigeration Equipment Installed at EE Program Non-Participant Sites Included in Spillover Sample by Size

Business Size	Auto-Closers	Case Lighting	Con-densers	Refrig-erators	Freezers	Strip Curtains	Night Covers	Refrig. Motors	Control-lers
Very Small	23%	21%	0%	60%	67%	6%	0%	19%	0%
Small	46%	0%	0%	20%	33%	10%	0%	13%	0%
Medium	31%	79%	100%	20%	0%	61%	0%	67%	100%
Large	0%	0%	0%	0%	0%	23%	0%	0%	0%
Unknown	0%	0%	0%	0%	0%	0%	0%	0%	0%

* Large sites have annual usage over 1,750,000 kWh, Medium have greater than 300,000 kWh and less than or equal to 1,750,000, Small have max annual usage greater than 40,000 kWh and less than or equal to 300,000, and Very Small have annual usage less than or equal to 40,000 kWh. The Unknown usage category represents accounts found in the CIS that do not have a matching record in the billing data. The data in this table are not weighted.

Table 142 and Table 143 present the distribution of HVAC equipment at businesses in the potential spillover sample by technology and business size for participant sites and non-participant sites, respectively. Large participant sites in the sample were found to have high proportions of Furnaces and Split/Package systems installed, while the Medium-sized participant and non-participant segments once again dominate the efficiency distribution for the HVAC end uses overall.

Table 142. Distribution of High Efficiency HVAC/EMS Equipment Installed at EE Program Participant Sites Included in Spillover Sample by Size

Business Size	Chillers	Furnaces	Split/Package Single Zone Systems	Package Terminal Units	Evaporative Coolers	EMS
Very Small	0%	1%	2%	17%	0%	0%
Small	0%	14%	13%	12%	0%	3%
Medium	100%	45%	52%	71%	0%	77%
Large	0%	39%	33%	0%	0%	20%
Unknown	0%	0%	0%	0%	0%	0%

* Large sites have annual usage over 1,750,000 kWh, Medium have greater than 300,000 kWh and less than or equal to 1,750,000, Small have max annual usage greater than 40,000 kWh and less than or equal to 300,000, and Very Small have annual usage less than or equal to 40,000 kWh. The Unknown usage category represents accounts found in the CIS that do not have a matching record in the billing data. The data in this table is not weighted.

Table 143. Distribution of High Efficiency HVAC/EMS Equipment Installed at EE Program Non-Participant Sites Included in Spillover Sample by Size

Business Size	Chillers	Furnaces	Split/Package Single Zone Systems	Package Terminal Units	Evaporative Coolers	EMS
Very Small	0%	5%	6%	30%	0%	0%
Small	0%	17%	28%	9%	0%	20%
Medium	100%	77%	64%	61%	0%	72%
Large	0%	1%	2%	0%	0%	8%
Unknown	0%	0%	0%	0%	0%	0%

* Large sites have annual usage over 1,750,000 kWh, Medium have greater than 300,000 kWh and less than or equal to 1,750,000, Small have max annual usage greater than 40,000 kWh and less than or equal to 300,000, and Very Small have annual usage less than or equal to 40,000 kWh. The Unknown usage category represents accounts found in the CIS that do not have a matching record in the billing data. The data in this table is not weighted.

Table 144 and Table 145 present the distribution of Lighting equipment at sites included in the potential spillover sample by technology and business type for participant sites and non-participant sites, respectively. As seen, participant School and Retail segments dominate the efficiency distribution chart. Among non-participants, the distribution of high efficiency Lighting equipment within the sample is largely concentrated in the School, Miscellaneous, and Warehouse segments. The Retail segment is seen to have a high share the of LED installations for both participants and non-participants.

Table 144. Distribution of High Efficiency Lighting Equipment Installed at EE Program Participant Sites Included in Spillover Sample by Business Type

Business Type	Linear Fluorescents	CFLs	LEDs
Food/Liquor	2%	0%	5%
Health/Medical - Clinic	2%	7%	2%
Health/Medical - Hospital	0%	0%	0%
Hotel	1%	3%	0%
Industrial	4%	0%	0%
Miscellaneous	12%	5%	2%
Office	9%	11%	7%
Restaurant	0%	2%	1%
Retail	14%	46%	31%
School	47%	25%	52%
Warehouse	9%	0%	0%

* The data in this table is not weighted.

Table 145. Distribution of High Efficiency Lighting Equipment Installed at EE Program Non-Participant Sites included in Spillover Sample by Business Type

Business Type	Linear Fluorescents	CFLs	LEDs
College	0%	0%	0%
Food/Liquor	3%	2%	2%
Health/Medical - Clinic	5%	6%	8%
Health/Medical - Hospital	0%	0%	0%
Industrial	3%	1%	0%
Miscellaneous	10%	38%	18%
Office	3%	12%	2%
Restaurant	1%	4%	7%
Retail	6%	6%	57%
School	51%	22%	0%
Warehouse	18%	8%	5%

* The data in this table is not weighted.

Table 146 and Table 147 present the distribution of Refrigeration equipment within the potential spillover sample sites by technology and business type for participant sites and non-participant sites, respectively. As expected, the Restaurant and Food/Liquor segments dominate this distribution among both EE program participants and non-participants.

Table 146. Distribution of High Efficiency Refrigeration Equipment Installed at EE Program Participant Sites Included in Spillover Sample by Business Type

Business Type	Auto-Closers	Case Lighting	Con-densers	Refrig-erators	Freezers	Strip Curtains	Night Covers	Refrig. Motors	Control-lers
Food/Liquor	0%	100%	0%	65%	33%	93%	100%	28%	100%
Health/Medical - Clinic	0%	0%	0%	0%	0%	0%	0%	0%	0%
Health/Medical - Hospital	0%	0%	0%	0%	0%	0%	0%	0%	0%
Hotel	0%	0%	0%	0%	0%	0%	0%	0%	0%
Industrial	0%	0%	0%	0%	0%	0%	0%	0%	0%
Miscellaneous	0%	0%	0%	3%	0%	0%	0%	0%	0%
Office	0%	0%	0%	3%	0%	0%	0%	0%	0%
Restaurant	100%	0%	0%	26%	33%	7%	0%	0%	0%
Retail	0%	0%	100%	0%	0%	0%	0%	72%	0%
School	0%	0%	0%	0%	33%	0%	0%	0%	0%
Warehouse	0%	0%	0%	3%	0%	0%	0%	0%	0%

* The data in this table is not weighted.

Table 147. Distribution of High Efficiency Refrigeration Equipment Installed at EE Program Non-Participant Sites Included in Spillover Sample by Business Type

Business Type	Auto-Closers	Case Lighting	Con-densers	Refrig-erators	Freezers	Strip Curtains	Night Covers	Refrig. Motors	Control-lers
College	0%	0%	0%	0%	0%	0%	0%	0%	0%
Food/Liquor	8%	100%	100%	70%	100%	65%	0%	87%	100%
Health/Medical - Clinic	0%	0%	0%	0%	0%	0%	0%	0%	0%
Health/Medical - Hospital	0%	0%	0%	0%	0%	0%	0%	0%	0%
Industrial	0%	0%	0%	0%	0%	0%	0%	0%	0%
Miscellaneous	8%	0%	0%	0%	0%	0%	0%	0%	0%
Office	0%	0%	0%	10%	0%	0%	0%	0%	0%
Restaurant	31%	0%	0%	20%	0%	1%	0%	6%	0%
Retail	0%	0%	0%	0%	0%	0%	0%	0%	0%
School	23%	0%	0%	0%	0%	2%	0%	0%	0%
Warehouse	31%	0%	0%	0%	0%	32%	0%	7%	0%

* The data in this table is not weighted.

Table 148 and Table 149 present the distribution of qualifying HVAC equipment at businesses in the potential spillover sample by technology and business type for participant sites and non-participant sites, respectively. Participant Schools show a high share of the newly installed Furnaces and Split/Package systems. The Hotel segment dominates the distribution of Package Terminal units among participant potential spillover sites, while the Health/Medical – Clinic segment predominates for Package Terminal units in non-participant potential spillover sites.

Table 148. Distribution of High Efficiency HVAC/EMS Equipment Installed at EE Program Participant Sites Included in Spillover Sample by Business Type

Business Type	Chillers	Furnaces	Split/ Package Single Zone Systems	Package Terminal Units	Evaporative Coolers	EMS
Food/Liquor	0%	1%	3%	0%	0%	17%
Health/Medical - Clinic	30%	5%	7%	24%	0%	7%
Health/Medical - Hospital	0%	0%	0%	0%	0%	0%
Hotel	0%	2%	18%	57%	0%	0%
Industrial	0%	1%	1%	2%	0%	0%
Miscellaneous	40%	5%	9%	5%	0%	13%
Office	0%	10%	10%	7%	0%	33%
Restaurant	0%	3%	3%	2%	0%	0%
Retail	0%	8%	5%	2%	0%	23%
School	30%	64%	42%	0%	0%	3%
Warehouse	0%	1%	1%	0%	0%	3%

* The data in this table is not weighted.

Table 149. Distribution of High Efficiency HVAC/EMS Equipment Installed at EE Program Non-Participant Sites Included in Spillover Sample by Business Type

Business Type	Chillers	Furnaces	Split/Package Single Zone Systems	Package Terminal Units	Evaporative Coolers	EMS
College	0%	0%	0%	0%	0%	0%
Food/Liquor	0%	3%	1%	0%	0%	4%
Health/Medical - Clinic	20%	6%	6%	57%	0%	4%
Health/Medical - Hospital	0%	0%	0%	0%	0%	0%
Industrial	0%	0%	1%	9%	0%	0%
Miscellaneous	0%	11%	19%	0%	0%	20%
Office	80%	11%	22%	0%	0%	32%
Restaurant	0%	2%	3%	4%	0%	8%
Retail	0%	8%	8%	30%	0%	8%
School	0%	56%	32%	0%	0%	20%
Warehouse	0%	3%	8%	0%	0%	4%

* The data in this table is not weighted.

Appendix J. WO29 and WO33 Participant Spillover

The purpose of this memo is to present the findings of the Nonresidential Downstream Lighting (WO029) Spillover analysis and to compare the findings with those of the Custom Programs Evaluation (WO033) Spillover analysis.[133]

Nonresidential Downstream Lighting Spillover Analysis

The WO029 Spillover analysis reviewed the data collected by the Nonresidential Downstream Lighting Impact Evaluation (WO029 Evaluation) of the PY2010-2012 investor-owned utilities' (IOU) energy efficiency (EE) programs. The spillover battery of questions included in the phone survey attempted to identify the high efficiency lighting equipment purchases made by participants of these programs without the benefit of program assistance and determine if these purchases were influenced by previous program participation.[134] The WO029 Spillover analysis provides an estimate of participant spillover savings associated with downstream lighting program participation in PY2010-2012. This information can later be compared with the PY2013-2014 Spillover Evaluation findings.

Using the data from both the Nonresidential Lighting participant phone survey and a separate Nonresidential LED participant phone survey, the analysis team identified 240 sites that installed high efficiency lighting equipment through a utility EE program and that also self-reported recently installing lighting equipment without assistance from a program. These 240 sites were further analyzed to determine if the sites attributed the additional lighting installations to their participation in the program and to determine if the additional lighting installations led to spillover energy savings. For 141 of these sites, phone survey respondents indicated that they were sufficiently influenced by the program to purchase additional equipment outside of an EE program, thereby qualifying as potential participant spillover.[135] Sites were then eliminated from the spillover analysis if the respondent did not know what the pre-retrofit equipment was, if the self-reported pre- and post- retrofit equipment combination was illogical,[136] if the post-retrofit equipment was the same as the pre-retrofit equipment,[137] and if the self-report retrofit quantity was zero, resulting in 76 sites used in the final analysis.

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[133] The analysis of the WO033 spillover questions was provided to the CPUC in a separate memo entitled, "Spillover Findings in PY2010-2012 Custom Programs Evaluation."

[134] Spillover was not an analysis focus of the PY2010-2012 evaluations. Questions relating to lighting participant spillover, however, were included in the PY2010-2012 CATI telephone survey battery of questions.

[135] The WO029 phone survey included a question about the degree to which the EE program influenced the participant's decision to install high efficiency equipment outside of a utility program on a scale of 0 to 10, where 0 indicates that they strongly disagree that the program influenced their decision and 10 indicates that they strongly agree. The survey also included a counterfactual question, asking the respondent to rate the likelihood that they would have implemented the same high efficiency measure if they had never participated in the program on a scale of 0 to 10, where 0 indicates that they definitely would not have implemented the measure and 10 indicates that they definitely would have. For the WO029 analysis, sites qualified as potential participant spillover if the respondent gave a rating of 5-10 for program influence or if they gave a rating of 0-5 for the counterfactual question.

[136] An example of an illogical pre- and post-retrofit equipment combination is a screw-in CFL replacing a T8.

[137] Since efficiency information about the additional non-program equipment (such as wattage and operating hours) was not collected as part of the phone survey effort, savings could not be calculated for measures where the retrofit equipment was the same as the baseline equipment (e.g. T8 replacing a T8).

Using phone survey data from the 76 sites, the analysis team identified configurations based on IOU, building type, and self-reported pre- and post-retrofit equipment. Table 150 lists the values used in the analysis for these four parameters. The parameters yielded 77 unique combinations of IOU, building type, pre-retrofit equipment, and post-retrofit equipment, hereafter referred to as configurations.

Table 150. WO029 Spillover Analysis Parameters

IOU	Building Type	Pre-Retrofit Baseline Equipment	Post-Retrofit Measure Equipment
PG&E	Assembly	T12	Standard T8
SCE	Education - Community College	Standard T8	High Performance T8
SDG&E	Education - Primary/Secondary	Incandescent	T5
	Food Store	CFL Basic	CFL Basic
	Health/Medical - Clinic	Halogen	LED
	Health/Medical - Hospital	HID	CFL Reflector
	Lodging - Hotel		LED Reflector
	Manufacturing - Light Industrial		Occupancy Sensor
	Miscellaneous Commercial		
	Office - Large		
	Office - Small		
	Restaurant - Fast-Food		
	Restaurant - Sit-Down		
	Retail - Single-Story Large		
	Retail - Small		
	Storage - Unconditioned		
	Transportation - Communication - Utilities		

Additional information about the efficiency of the non-program equipment is needed in order to estimate the savings that resulted from the potential participant spillover. This efficiency information, which includes the wattage and operating hours of the lighting equipment installed outside of an EE program, was not collected through the phone survey effort. Instead, the analysis team used average metrics of participant installations developed by the WO029 Evaluation in order to estimate the efficiency level and savings of the non-program equipment for the potential participant spillover.

Unit energy savings values (kWh and kW) were calculated for each configuration found at the 76 potential spillover sites using data from the WO029 Evaluation. For linear fluorescents, CFLs, and LEDs, unit energy savings values were calculated based on post-retrofit operating hours, pre-/post-retrofit lamp wattages, and post-retrofit coincidence factors. Occupancy sensor unit energy savings were calculated using controlled wattages, percent time off (PTO) factors, and pre-/post-retrofit coincidence factors. Operating hours and lamp wattages were weighted by an ex-post fixture weight, developed at the measure/building type level using the ratio of the WO029 deemed population quantity rebated to the on-site deemed sample quantity rebated. Operating hours and coincidence factors were generated at the site/measure/activity area level and aggregated up to the measure/building type level. Operating hours were weighted by the fixture-weighted delta wattage of the measure.[138] For non-occupancy sensor measures, pre- and post-retrofit operating hours were assumed to be the same. For occupancy sensors, PTO was calculated as the change in lighting operation between the pre- and post-retrofit cases, and the occupancy sensors were then credited with that reduction in hours of use. To calculate wattages, the analysis team determined the most commonly installed combination of lamp wattage and number of lamps per fixture (per the WO029 Evaluation) for each spillover measure at the activity area level. These predominant wattages were then weighted by the fixture-weighted operating hours and aggregated to the building type/measure level.

A few configurations required special treatment. For example, the WO029 Evaluation did not have sufficient data for Hospitals, so hours of use and coincidence factors were obtained from the Database for Energy Efficient Resources (DEER). Additionally, there was limited data on LED retrofits by building type, so CFLs were used as a proxy for hours of use and coincidence factors for configurations that did not exist in the WO029 Evaluation. There were no CFLs as pre-retrofit baseline equipment in the WO029 Evaluation, so post-retrofit CFL wattages were used as a proxy. Occupancy sensor kW savings were calculated using the change in coincidence factors from pre-retrofit to post-retrofit. In some cases, the post-retrofit coincidence factor was higher than the pre-retrofit coincidence factor, resulting in negative kW savings. While negative kW savings are naturally found during peak hours, for the purposes of this spillover analysis, negative kW savings were set to zero.

The WO029 participant phone survey collected the self-reported quantity of non-program fixtures installed at a participant's facility ("inside") and the quantity of non-program fixtures installed at other facilities owned by the participant ("outside"). Inside and outside spillover savings were estimated by IOU using the self-reported quantities and the calculated unit energy savings. The inside and outside spillover estimates are presented in Table 151.

Table 151. WO029 Inside and Outside Spillover Savings Estimates by IOU

IOU	Inside Spillover		Outside Spillover	
	kWh	**kW**	**kWh**	**kW**
PG&E	41,457	6	157,246	35
SCE	51,400	8	149,335	22
SDG&E	1,722	14	57,937	7
Statewide	94,578	27	364,518	63

* Sample spillover savings estimates were not weighted to the population level.

Table 152 presents the ex-post spillover savings estimates by IOU as compared to the gross ex-post savings derived from the WO029 Evaluation. The gross ex-post savings were not adjusted for free ridership. Statewide, the estimated participant lighting spillover savings represent over 1% of gross ex-post kWh and kW savings.

[138] Delta wattage is the difference between the pre-retrofit and post-retrofit wattage. Delta wattages were generated at the site/measure/activity area level.

Table 152. WO029 Spillover Savings Estimates and WO029 Gross Ex-Post Savings by IOU

IOU	Spillover kWh Savings	Gross Ex-Post kWh Savings	Spillover % of Gross Ex-Post kWh Savings	Spillover kW Savings	Gross Ex-Post kW Savings	Spillover % of Gross Ex-Post kW Savings
PG&E	198,703	15,458,479	1.29%	40	2,886	1.40%
SCE	200,735	20,833,195	0.96%	29	3,697	0.80%
SDG&E	59,659	8,613,882	0.69%	20	1,412	1.43%
Statewide	459,097	44,905,556	1.02%	90	7,995	1.13%

* Sample spillover and gross ex-post savings estimates were not weighted to the population level. Gross ex-post savings were derived from the WO029 Evaluation sample savings and were not adjusted for free ridership.

WO033/WO029 Spillover Comparison

This section presents a comparison of spillover calculation methods and findings from two CPUC PY2010-2012 nonresidential impact evaluations: the Custom Programs Impact Evaluation (WO033) and the Nonresidential Downstream Lighting Impact Evaluation (WO029). The WO033 Spillover analysis results are presented in a separate memo entitled, "Spillover Findings in PY2010-2012 Custom Programs Evaluation." The WO029 Spillover analysis results are presented in the preceding section of this memo.

To start, it is important to note the difference in measure mix between WO033 and WO029. The WO033 Evaluation looked at all measures that were part of a nonresidential custom application, while the WO029 Evaluation focused on lighting measures for both deemed and custom nonresidential applications. Thus, in the two evaluations there are inherent differences in the program participants, their facilities, and their behaviors. With that caveat, this section of the memo will proceed to discuss the methods of spillover calculation used in each analysis and then present a comparison of findings.

Methodology Comparison

WO033 and WO029 both assessed participant inside and outside spillover separately, with inside spillover characterized as non-program installations at the same facility as the EE project and outside spillover as installations at other facilities owned by the participant.

The WO033 analysis identified nine potential spillover sites based on participating customer surveys that included a question about the degree to which the EE program they participated in influenced their decision to install high efficiency equipment outside of a utility program. Respondents were asked to rate program influence on a scale of 0 to 10, where 0 indicates that they strongly disagree that the program influenced their decision and 10 indicates that they strongly agree. Respondents who rated the program influence as 8, 9, or 10 qualified as potential participant spillover for the WO033 analysis. Sites that demonstrated sufficient program influence to purchase high efficiency equipment outside of an EE program were contacted for a follow-up in-depth phone survey from an engineer. The engineer then used the collected site- and measure-specific data to conduct a desk review estimate of savings, primarily using engineering calculations. Spillover could be substantiated at five of the nine potential spillover sites.

The WO029 analysis identified 240 sites that indicated during a participant telephone survey that they installed high efficiency lighting without assistance from a utility program. Like the WO033 survey, the WO029 survey included a question about the degree to which the EE program influenced the participant's decision to install high efficiency equipment outside of a utility program on a scale of 0 to 10, where 0 indicates that they strongly disagree that the program influenced their decision and 10 indicates that they strongly agree. The WO029 survey also included a counterfactual question, asking the respondent to rate the likelihood that they would have implemented the same high efficiency measure if they had never participated in the program on a scale of 0 to 10, where 0 indicates that they definitely would not have implemented the measure and 10 indicates that they definitely would have. For the WO029 analysis, sites qualified as potential participant spillover if the respondent gave a rating of 5-10 for program influence or if they gave a rating of 0-5 for the counterfactual question. Based on these criteria, 141 sites were sufficiently influenced by the program to purchase equipment outside of the program. Since the WO029 phone survey effort did not collect detailed information about the efficiency of the non-program equipment, the analysis team used average metrics of participant installations developed by the WO029 Evaluation in order to estimate the efficiency level and savings of the non-program equipment for the potential participant spillover. The WO029 spillover analysis was based on self-reported phone survey data rather than in-depth engineering phone surveys with self-identified spillover sites. WO029 spillover savings could be estimated for 76 sites.[139]

The above-mentioned criteria for WO029 spillover was chosen to reflect the criteria that will be applied for CPUC PY2013-2014 program spillover. For the purpose of comparison with WO033, the WO029 spillover analysis was replicated with the more stringent WO033 criteria: a program influence rating of 8-10 or a rating of 0-2 for the counterfactual question. This resulted in 98 potential spillover sites and 53 sites for which savings could be estimated.

Findings Comparison

WO033 spillover savings were reported across sites and as a percentage of gross ex-post kWh, kW, and therm savings. Table 153 summarizes the WO033 spillover savings estimates. The WO033 calculated spillover represents 0.54% of gross ex-post kWh savings and 1.00% of kW savings. The small sample size enabled the WO033 spillover results to also be presented by site. The by-site results can be found in the WO033 Spillover memo, "Spillover Findings in PY2010-2012 Custom Programs Evaluation."

Table 153. WO033 Spillover Savings Estimates

	kWh	kW	Therms
Spillover Savings	900,022	178	19,800
Gross Ex-Post Savings	166,179,901	17,888	33,396,694
Spillover % of Ex-Post Savings	0.54%	1.00%	0.06%

* Sample spillover and gross ex-post savings estimates were not weighted to the population level. Gross ex-post savings were derived from the WO033 Evaluation sample savings and were not adjusted for free ridership.

The WO029 spillover results were reported across sites and as a percentage of gross ex-post kWh and kW savings. Therm savings were not reported for WO029 because the Evaluation focused solely on lighting measures. The WO029 results were also calculated by IOU and are presented in the first section of this memo. Table 154 summarizes the WO029 spillover savings estimates based on the WO029 Spillover criteria. The calculated spillover represents 1.02% of gross ex-post kWh savings and 1.13% of kW savings. Table 155

[139] Sites were eliminated from the WO029 spillover analysis if the respondent did not know what the pre-retrofit equipment was, if the self-reported pre- and post- retrofit equipment combination was illogical, if the post-retrofit equipment was the same as the pre-retrofit equipment, and if the self-reported retrofit quantity was zero.

displays the W0029 spillover savings estimates based on the more stringent W0033 Spillover criteria. Applying the W0033 criteria reduced W0029 spillover savings by over half for kWh and kW. Under the W0033 criteria, W0029 calculated spillover represents 0.48% of gross ex-post kWh savings and 0.51% of kW savings. In terms of spillover savings as a percentage of gross ex-post savings, the W0029 results are higher than the W0033 results when the W0029 criteria are applied, but are lower than the W0033 results when the W0033 criteria are applied.

Table 154. W0029 Spillover Savings Estimates (W0029 Spillover Criteria)

	kWh	kW
Spillover Savings	459,097	90
Gross Ex-Post Savings	44,905,556	7,995
Spillover % of Ex-Post Savings	1.02%	1.13%

* Sample spillover and gross ex-post savings estimates were not weighted to the population level. Gross ex-post savings were derived from the W0029 Evaluation sample savings and were not adjusted for free ridership.

Table 155. W0029 Spillover Savings Estimates (W0033 Spillover Criteria)

	kWh	kW
Spillover Savings	216,108	41
Gross Ex-Post Savings	44,905,556	7,995
Spillover % of Ex-Post Savings	0.48%	0.51%

* Sample spillover and gross ex-post savings estimates were not weighted to the population level. Gross ex-post savings were derived from the W0029 Evaluation sample savings and were not adjusted for free ridership.

Appendix K. Nonresidential Engineering Analysis: Savings Calculations, Algorithms and Notes

Refrigeration

The evaluation team reviewed the refrigeration on-site data from the Commercial Saturation Survey for spillover and identified several areas where spillover savings were found.[140] Savings were calculated separately for Refrigerated Display Cases and for Refrigerated Walk-Ins.

Display Cases

The evaluation team first reviewed PGE workpapers in an attempt to quantify savings resulting from spillover of refrigeration cases. The workpaper PGECOREF104 Revision 5 was reviewed for new refrigeration display cases with doors – low temperatures (R4) and medium temperatures (R5). The workpapers assumed that the new retrofit units were equipped with low energy glass doors, high-efficiency fans, LED lights and anti-sweat heaters. As it was not possible to confirm that all of the measures identified in the on-site data met these standards, PGE workpapers were not used to estimate the spillover savings.

Unit energy consumption for the units were determined from make and model lookups that were collected from the on-site surveys. Daily kWh data was also gathered for these units where possible. For most of the units, it was determined that as these were older cases with ineligible or missing nameplate information and no spillover savings were credited for these measures.

Federal refrigeration codes and standards, as stated in the Code of Federal Regulations 431.66[141] was used to determine baseline energy consumption for all measures that were determined to have possible energy savings. The information was determined based on specified algorithms for different case set-ups as well as the total case volume. The following algorithms were used:

- Refrigerators with Solid Doors

$$Daily\ kWh = 0.10 * Volume + 2.04$$

- Refrigerators with Transparent Doors

$$Daily\ kWh = 0.12 * Volume + 3.34$$

- Freezers with Solid Doors

[140] For some of the units in the 2013-2014 participant spillover analysis there was not enough information to determine specific refrigeration values like were available from the CSS/CMST. These were evaluated using the DEER READI tool where the READI exports are determined based on building type and climate zone. The READI exports are multiplied by the listed quantity of refrigeration units to calculate first year savings. The first year savings were multiplied by DEER EUL to calculate lifetime savings.

[141] http://www.ecfr.gov/cgi-bin/text-idx?SID=ea9937006535237ca30dfd3e03ebaff2&mc=true&node=se10.3.431_166&rgn=div8

$$Daily\ kWh = 0.40 * Volume + 1.38$$

- Freezers with Transparent Doors

$$Daily\ kWh = 0.75 * Volume + 4.10$$

- Commercial Ice Cream Freezers – Horizontal Closed Solid – Self Contained

$$Daily\ kWh = 0.38 * Volume + 0.88$$

- Commercial Ice Cream Freezers – Horizontal Closed Transparent – Self Contained

$$Daily\ kWh = 0.56 * TotalDisplayArea + 0.43$$

The final savings took the difference between the rated daily kWh and the baseline kWh across the entire year and those first year savings were multiplied by the DEER EUL to generate lifecycle savings:

$$Annual\ kWh\ Savings = \left(DailykWh_{baseline} - DailykWh_{post}\right) * Quantity * 365$$

$$Lifecycle\ kWh\ Savings = (Annual\ kWh\ Savings) * EUL$$

Walk-Ins

As of now, there are no standards that regulate energy consumption for the walk-in units. Standards will be going in place in 2017, but as of now, there is no comparable baseline. Therefore, the evaluation team credited spillover savings for energy efficient measures within walk-ins including LED lighting, ECM fans, Strip Curtains and Auto-Door Closers. The savings were estimated using a PGE document titled Analysis of Standards Options for Walk-In Coolers (Refrigerators) and Freezers.[142] A ratio was used to determine the savings of the actual walk-in square footage, based on the savings listed in Table 2 and Table 3 of the document and an estimated 80-sqft walk-in. These savings are found below.

- **Walk-in Cooler Energy Savings:**

$$ECM\ Evaporator\ Fan\ Motor\ kWh\ Savings\ per\ SqFt\ per\ fan = 17.075$$

$$Strip\ Curtains\ kWh\ Savings\ per\ SqFt = 34.975$$

$$Auto\ Door\ Closers\ kWh\ Savings\ per\ SqFt = 33.138$$

- Walk-in Freezer Energy Savings:

$$ECM\ Evaporator\ Fan\ Motor\ kWh\ Savings\ per\ SqFtper\ fan = 10.825$$

[142] Codes and Standards Enhancement Initiative for PY2004: Title 20 Standards Development. *Analysis of Standards Options for Walk-In Coolers (Refrigerators) and Freezers*. Prepared for PG&E. May 10th, 2004.

$$Strip\ Curtains\ kWh\ Savings\ per\ SqFt = 63.963$$

$$Auto\ Door\ Closers\ kWh\ Savings\ per\ SqFt = 60.613$$

HVAC

HVAC savings were generally estimated using the READI[143] tool developed by the Database for Energy Efficient Resources (DEER). Existing baselines were not used to estimate savings for these measures. The 2010-12 savings were estimated for the HVAC units that were above the 2010-12 Codes and Standards and 2013-14 savings were calculated using the appropriate DEER vintage year method as all DEER vintage years were applicable to the 2013-14 standards.

The DEER READI tool exports savings on a "per unit" basis. The units they refer to are tons. Therefore, each READI export was multiplied by the associated tonnage of the unit. Any high efficiency SEER value listed as a fraction was rounded down to code savings following DEER guidance.[144] 2010-2012 vintage READI exports were not always available for the capacity and efficiency values the evaluation team found in the CSS/CMST program. In these cases, the READI exports only accounted for savings to a higher efficiency SEER value.

- Energy Savings with appropriate DEER vintage year

$$kWh(app) = READI(kWh) * Ton * N$$

- Demand Savings with appropriate DEER vintage year

$$kW(app) = READI(kW) * Ton * N$$

- Therm Savings with appropriate DEER vintage year

$$Therm(app) = READI(T) * Ton * N$$

READI(kWh) = READI tool export of kWh for selected capacity, efficiency, PA, building type and climate zone. Savings in READI tool are provided per ton.

READI(kW) = READI tool export of kW for selected capacity, efficiency, PA, building type and climate zone. Savings in READI tool are provided per ton..

READI(T) = READI tool export of Therms for selected capacity, efficiency, PA, building type and climate zone. Savings in READI tool are provided per ton.

Ton = Number of Tons for each Unit

N = Number of Units

(app) = Stands for appropriate DEER vintage year

[143] READI version 2.4.3

[144] A reported SEER of 13.5 would be rounded down to a SEER value of 13.

2010-2012 vintage READI exports were not always available for the capacity and efficiency values the evaluation team found in the CSS/CMST program. In these cases, the READI exports only accounted for savings to a higher efficiency SEER value. Factors were applied to calculate savings back to the efficiency levels at the time of the CSS/CMST program. For example, a 2014 READI export for a 15 SEER unit would only account for savings above 14 SEER as 14 SEER is the minimum code compliant savings amount in 2014. Therefore, a factor was applied to the savings value to account for the additional savings above 13 SEER which was the base value in 2010-2012.

- Energy Savings with inappropriate DEER vintage year

$$kWh(in) = READI(kWh) * (\frac{\frac{1}{EFFold} - \frac{1}{EFFins}}{\frac{1}{EFFnew} - \frac{1}{EFFins}})$$

- Demand Savings with inappropriate DEER vintage year

$$kW(in) = READI(kW) * (\frac{\frac{1}{EFFold} - \frac{1}{EFFins}}{\frac{1}{EFFnew} - \frac{1}{EFFins}})$$

- Therm Savings with inappropriate DEER vintage year

$$Therm(in) = READI(T) * (\frac{\frac{1}{EFFold} - \frac{1}{EFFins}}{\frac{1}{EFFnew} - \frac{1}{EFFins}})$$

EFFold = Code efficiency value in 2010-2012

EFFins = Efficiency of the installed unit

EFFnew = Minimum code efficiency based on DEER vintage year. Ex. In 2014, the SEER base value is 14.

(in) = Stands for inappropriate DEER vintage year

All furnace measures recorded did not have an efficiency past the 2010-2012 standards, therefore, there were no Therm savings calculated for these measures. Only 2 heat pump units were high efficiency. For one of these units only the heating portion was above code and there were no savings from the cooling component. An engineering adjustment factor was used to the savings from the READI tool to represent the savings from the heating portion of the unit.

- Heat Pump Savings Adjustment

$$kWh(hp) = READI(kWh) * \left(\frac{\frac{1}{coolEFFold} - \frac{1}{coolEFFins}}{\frac{1}{coolEFFnew} - \frac{1}{coolEFFins}}\right) * \left(\frac{\frac{1}{heatEFFold} - \frac{1}{heatEFFins}}{\frac{1}{heatEFFnew} - \frac{1}{heatEFFins}}\right)$$

$$kW(hp) = READI(kW) * \left(\frac{\frac{1}{coolEFFold} - \frac{1}{coolEFFins}}{\frac{1}{coolEFFnew} - \frac{1}{coolEFFins}}\right) * \left(\frac{\frac{1}{heatEFFold} - \frac{1}{heatEFFins}}{\frac{1}{heatEFFnew} - \frac{1}{heatEFFins}}\right)$$

$$Therm(hp) = READI(kWh) * \left(\frac{\frac{1}{coolEFFold} - \frac{1}{coolEFFins}}{\frac{1}{coolEFFnew} - \frac{1}{coolEFFins}}\right) * \left(\frac{\frac{1}{heatEFFold} - \frac{1}{heatEFFins}}{\frac{1}{heatEFFnew} - \frac{1}{heatEFFins}}\right)$$

coolEFF = Efficiency related to cooling portion of heat pump
heatEFF = HSPF related with heat pump portion of the heat pump units

Lighting

The impacts resulting from the installation of lighting equipment where developed in a number of manners. All CFL and LED lamps were considered replacement on burnout (ROB) for both the 2010-12 and 2013-14 analysis. These technologies are generally replacing incandescent and halogen lighting which generally have short effective useful lives (EUL). For linear fluorescent technologies, two approaches were used. For the 2010-12 nonparticipants, all linear technologies were considered ROB, however, for the 2013-14 participant analysis, all linear technologies were subject to a dual baseline approach. The general algorithm that was used to developed first year and lifecycle savings are as follows:

- First Year savings for lighting measures

$$FirstYearimpact = Quantity * (PreWatts - PostWatts) \times (HOU) \times (Interactive\ Effects)$$

Quantity = total number of fixtures/lamps installed

PreWatts = For CFLs and LEDs this was developed by measure configuration, based on data that was collected as part of the 2010-12 Nonresidential Downstream Lighting Impact Evaluation (NRL) for the 2010-12 analysis and the 2014 Nonresidential Downstream Deemed Lighting Impact Evaluation (COM). For linear fluorescent measures replacing linear fluorescent measures analyzed in 2010-12, this represents an industry standard practice (ISP).[145] For linear fluorescent measures replacing linear fluorescent measures analyzed in 2013-14, that were determined to be early replacement, this represents the in-situ baseline. For LF measures determined to be ROB, the same ISP from 2010-12 is used.

For high bay LF measures replaced by metal halides in 2013-14, that were determined to be early replacement, this represents the in-situ baseline. For LF measures replacing MH determined to be ROB, this represents a lumen equivalent pulse-start metal Halide (PSMH).

[145] This represents the average wattage among nonparticipant installations (including participants that installed linear fluorescents outside of a program – without a rebate or incentive – that occurred between 2010-12 for the same measure configuration (and whether or not it was high output or not) installed by the customer. These data were obtained from CMST database and excluded T12 fixtures.

For measures that were not evaluated as part of the 2013-14 COM impact evaluations – exit signs, LED fixtures – workpapers were referenced.

PostWatts = For the 2010-12 analysis, this represents the measure case fixture/lamp wattage that was collected as part of the make and model lookups from the CMST data. For the 2013-14 analysis, if an engineering review or onsite was completed this represents the measure case fixture/lamp wattage. If the respondent was able to recollect the configuration or wattage of the equipment installed, there self-reported data was used. If data was insufficient or missing, average wattage values were developed based on the 2013-14 impact evaluation or workpapers were referenced.

HOU = For CFLs and LEDs this was developed based on Hours of Use (by technology and building type), based on data that was collected as part of the 2010-12 Nonresidential Downstream Lighting Impact Evaluation (NRL) for the 2010-12 analysis and the 2014 Nonresidential Downstream Deemed Lighting Impact Evaluation (COM). For demand savings, coincidence demand factors (CDFs) were created in the same manner as above (by technology and building type).

Interactive effects = These represent the HVAC interactive effects. The Database for Energy Efficient Resources (DEER) provides a set of factors that incorporate the kWh and kW and therm interactive effects. Factors were used based on if the measure was a CFL or not, the participant's IOU, climate zone, building type and whether or not the facility was existing or new.

- First Year savings for lighting control measures

$$Firstyearimpact = Quantity * (Controlled\ Wattage) \times (HOU) \times (Interactive\ Effects)$$

Quantity = total number of controls installed.

Controlled Wattage = The total wattage associated with the equipment being controlled.

HOU = For first year energy savings, this represents the change in annual operating hours from prior to the installation of the occupancy sensor to the annual hours represented after the installation. These data were collected in the same manner as those collected for lighting measures in 2010-12 and 2013-14 (by technology and building type). For demand savings, this represents the change in peak demand savings from pre- to post-retrofit.

Interactive effects = same as above for lighting measures.

- Lifecycle savings for ROB lighting measures and lighting controls.

1. $$Lifecycleimpact = (FirstYearImpact) \times (EUL)$$

2. *FirstYearImpact* = discussed above.
3. *EUL* = The effective useful life of the installed measure. The EUL is a function of the lamp service life of the measure for CFL and LED lamps or the ballast service life for linear measures divided by the site-specific annual operating hours. For occupancy sensors the EUL was fixed at 8 years. For measures that were not explicated evaluated as part of the 2010-12 or 2013-14 impact evaluations, workpaper EULs were referenced.

- Lifecycle savings for ER lighting measures

$$Lifecycleimpact = (RULImpact \times RUL) + ((PostRULImpact) \times (EUL - RUL))$$

4. *RULImpact* = The remaining useful life (RUL) impact is the first year impact for ER measures throughout the RUL of the replaced measure. This represents the in-situ baseline as discussed above.

5. *RUL* = The RUL is calculated as 1/3 of the EUL of the installed measure per the DEER methodology.
6. *PostRULImpact* = This represents the measure impact after the RUL period. This impact is developed in the same manner as the first year impact is developed for ROB measures – using ISP wattages or lumen equivalent PSMH halides. This impact is multiplied by the difference between the EUL of the measure and RUL of the replaced equipment.

Other Miscellaneous

Other end-uses such as motors, pipe insulation, and various custom measures were also calculated using the appropriate engineering assumptions. Customer responses regarding solar PV are captured in the survey data but are not part of the study scope and are thus excluded from this spillover analysis.

EMS

Savings for EMS measures are determined through custom, site-level calculations. A top-down approach was used for 2010-2012 because little information was available except for the building square footage end-uses controlled by the EMS (e.g. HVAC, interior/exterior lighting, etc.). Energy intensities were derived from CEUS[146] according to building type, climate zone, and IOU. For EMS measures, the evaluation team used an engineering estimate of 5% savings.

A similar approach was used in the 2013-2014 evaluation, however there was less information available and the quantity of measures were smaller. For the 2013-2014 approach, building square footage and end use controlled were coupled with building energy intensities from CEUS. For EMS savings the evaluation used an engineering estimate of 15%, 10% or 5% based on project specific information.

The above methods were used to calculate first year savings. Lifetime savings multiplied DEER EUL by the first year savings.

Fan Optimization

Savings for fan optimization were calculated using an algorithm from the Illinois TRM v2. Key inputs in the calculation include motor horsepower, load factor, hours of operation and motor efficiency. For fan optimization a deemed savings value of 5% was used. These variables were used to calculate first year savings, which was multiplied by DEER EUL to calculate lifetime savings.

Heat Recovery

The heat recovery measure used a standard engineering algorithm to calculate savings. The algorithm considered average heat recovery, flow rate, specific heat of water, temperatures in and out of the stack economizer, annual hours of operation, boiler efficiency and gallon of water heated per day. These variables were used to calculate first year savings, which was multiplied by DEER EUL for a heat exchanger to calculate lifetime savings.

[146] http://capabilities.itron.com/ceusweb/

Chiller

The chiller project used an algorithm from the Texas TRM to calculate savings. The calculation used deemed values for baseline chiller efficiency as well as installed chiller capacity and efficiency in order to calculate first year savings. First year savings were multiplied by DEER EUL to calculate lifetime savings.

VFD

Savings for VFD's come from the Illinois TRM. Variables used to calculate savings include motor horsepower, load factor, motor efficiency, hours of operation and deemed energy and demand savings factors. First year savings were multiplied by DEER EUL to calculate lifetime savings.

Air Receiver Tank

The Air Receiver Tank measure used an engineering calculation to develop savings. The calculation looks at pre- and post-air receiver tank compressor lag and percent kW. It also looks into full load compressor efficiency and hours of use. These variables were used to calculate first year savings, which was multiplied by DEER EUL to calculate lifetime savings.

Pool Heater

The pool heater measure calculated savings using an algorithm from the Illinois TRM v2. The algorithm calculates Therm savings using variables such as the annual water use, the input and output temperatures, baseline and installed heater efficiencies and the stand by loss in the baseline heater case. These variables were used to calculate first year savings, which was multiplied by DEER EUL to calculate lifetime savings.

Washer and Dryer

The washer and dryer measure used equations from the Mid Atlantic TRM v3.0 for energy star certified washer and dryer units. This method applies prescriptive savings values to the units based on which energy star tier they fall under. The first year savings were multiplied by DEER EUL to calculate lifetime savings.

Water Heater

The water heater measures use an algorithm from the MidAmerican Energy Company's Iowa Energy Efficiency Plan 2014-2018. The algorithm multiplies a Unit Energy Consumption factor by the difference between the baseline and the installed energy factor. These variables were used to calculate first year savings, which was multiplied by DEER EUL for a gas water heater to calculate lifetime savings.

PTHPs

For the Package Terminal Heat Pump measure an on-site was completed which recoded unit specific values. In this case the algorithm from the Texas TRM was used to determine savings instead of the READI tool as project specific details were more granular. The algorithm looked into the quantity, capacity, baseline and installed heating and cooling efficiencies, full load heating and cooling hours and coincidence factor. These variables were used to calculate first year savings, which was multiplied by DEER EUL for a gas water heater to calculate lifetime savings.

Fryers

The Fryers measure used an algorithm from the Texas TRM v3.1. The algorithm uses deemed values for multiple variables in the equation. The variables used are; pounds of food cooked per day, energy of food, baseline and post measure cooking efficiencies, baseline and post measure idle energy rate, baseline and post measure production capacity per pan, facility operating days per year, facility operating hours per day and peak coincidence factor and quantity of fryers at the facility. These variables were used to calculate first year savings, which was multiplied by DEER EUL for a gas water heater to calculate lifetime savings.

Freezer

The new freezer measure uses an algorithm from the Illinois TRM v2.0. The algorithm examines the volume of the freezer to calculate baseline and installed kWh. This difference is used to calculate energy savings and applies a peak coincidence factor in order to calculate demand savings. The first year savings were multiplied by DEER EUL for a gas water heater to calculate lifetime savings.

Appendix L. Public Comments and Study Team Responses

Table 156. Public Comments and Study Team Responses

Number	Commenter	Page/ Section	Comment	Evaluator's Response
1	SCG and SDG&E	Overarching	Clearly define the definition for spillover, market effect and market transformation so this can be consistent with OP37, D. 12-11-015. The study assumed that the spillover effects included both market effect and market transformation effects. For this study, all upstream programs are excluded. The spillover study is based primarily on an end-user approach. The study design and study goals are not consistent.	We updated the executive summary and other sections to more clearly define spillover.
2	SCG and SDG&E	Overarching	Did the study teams conduct a literature review to look at spillover methodologies, treatment of non-participants, and results comparison? If yes, can this information be included in the report or publish separately as appendixes?	The evaluation team reviewed internal studies when developing the work plan to understand common spillover measures and to help develop the scope. However, we did not conduct a formal literature review. We also solicited input from the IOUs through the PCG process throughout the study to draw upon their expertise and experience related to key methodological decisions.
3	SCG and SDG&E	Overarching	Using residential and non-residential population studies (CLASS, CMST/CSS) is an excellent strategy to leverage these studies to cost effectively identify non-participants, but this is a double-edged sword. a. For residential spillover, the elimination of upstream programs, MF accounts, other programs and the methodology for extrapolation and expansion, may have resulted in a lower spillover effect than necessary. b. For the non-residential spillover may be under estimated due to insufficient representation of commercial, industrial/agriculture customers (i.e., this	a. For residential spillover, we believe that Appendix H provides clear and convincing evidence that past upstream lighting program impact studies already include market effects, thus they were not included in this study. With respect to other programs such as multifamily, we did not sample from these programs, but did not exclude them from the overall results. For these programs, we applied the same overall spillover rate determined for the sampled programs because that is the best estimate available. While the actual spillover rate of these programs will be different than this assumption (and it is unknown if it would be higher or lower), we believe that they still should be included in the study. The only residential program types that are not accounted for in this study are low

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			may impact gas/therm spillover more adversely).	income and codes and standards programs. See Comment 52 for additional details on Codes & Standards. b.The evaluation team agrees that the inclusion of the CSS/CMST data was not only cost effective, but it provided a unique dataset of confirmed high efficiency measure installations from on-site verification (no reliance on self-reported data). The evaluation team developed the estimate of nonparticipant nonresidential spillover by removing program savings in the spillover rate calculation that included agriculture/industrial customers and certain end uses (See Section 3.1.3). These market segments and end uses constituted roughly 30% of 2010-12 portfolio of savings. Given that the evaluation team included 70% of program savings in the denominator and the numerator represents more than 70% of nonparticipants, the estimate of nonparticipant spillover may be overstated for kWh. Given the under-representation of gas measures in the CSS/CMST study, we cannot comment on the therm spillover impact.
4	SCG and SDG&E	Overarching	Please consider making residential and non-residential program participant attribution threshold rules the same. The current method un-necessarily punish the program participant spillover effect. Please make program participant spillover threshold "5 or greater" for both prompted and unprompted responses.	The attribution threshold for PSO and NPSO are the same for both the residential and nonresidential sectors. The attribution threshold of 7 or greater is commonly used in spillover studies in many states. Recognizing that a utility likely had a greater influence if it caused a respondent to identify that influence without being asked about it explicitly, we also included a lower threshold (5 or greater) for unprompted responses and added consistency check questions to ensure that we were capturing all respondents who were truly influenced by the program.
5	SCG and SDG&E	Overarching	For future studies, we should consider including all upstream/midstream programs, especially since spillover is inclusive of market effects and market transformation effects. If we are unable to randomly	As described in detail in Appendix H, this study did not include upstream lighting programs in the analysis because the ULP impact analysis already accounts for these market effects. If we were to account for

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			recruit enduser participants, the study team may wish to explore using manufacturers/distributors inputs. For spillover effects, it seems like an omission to not include these market transformation programs.	participant spillover related to ULP, it would be double counting spillover. Because the upstream lighting programs already includes savings related to spillover, we did not include any additional spillover savings related to these programs in the numerator of the spillover rate calculation, but did include the program savings in the denominator of the equation. Early on in the study process, the study team (along with the CPUC, CPUC advisors, and early IOU input) decided to use a definition of spillover that relied on participant and nonparticipant self-reports (i.e., spillover effects perceptible to the end user) and did not address upstream market actors. As described in the study, market effects are better handled through end use-specific research and this was already underway in other CPUC research efforts.
6	SCG and SDG&E	Overarching	The study confidence and precision are hard to understand, given the sampling strategy, data elimination and other data cleaning steps. a. Please provide a sample and data elimination disposition table, for participants and non-participants, so the readers can better follow the study steps. This information is somewhat provided, but scattered about. b. Please also provide an explanation on how "population weighting, extrapolations and expansion" may have impacted these parameters.	We reviewed the methodology description and enhanced it based on this and other feedback. We believe this represents our best effort to clearly explain the research steps in an orderly and understandable fashion. The study includes disposition tables and figures throughout the study to describe the population, the sample, and the dispositions of respondents. These are provided in the relevant sections (e.g., the residential participant survey dispositions are provided in the residential participant methodology section). Additionally, the sample development for all surveys is described in detail in the applicable appendixes. For example, tables 50, 51 and 57 provide the sample disposition tables requested for nonresidential spillover. We have included a dialogue in the recommendation section that discusses this limitation in extrapolating results to, not only this population, but prospectively as well.

Number	Commenter	Page/ Section	Comment	Evaluator's Response
7	SCG and SDG&E	Overarching	Please add a section to talk about "study limitations". This information is scattered throughout the report in piece-meal fashion. Please address this fully, so we can better understand the report findings, its context, and implications for future research.	We have added a section describing the study's limitations in the executive summary and introduction.
8	SCG and SDG&E	Residential Spillover	a. Study data and sampling strategy – mix-matching program periods for participants and non-participants, and data eliminations b. The decision to make residential 2010-2012 CLASS data base as the eligible population, for non-participants, is an elegant one. This decision did wonders to reduce sampling design complexity for non-participant spillover study, but it also introduced other trade-offs to the study design. c. The next important decision is to use 2013-2014 program participants samples to estimate participant spillover. To make the matter more complex, ODC used a list of data elimination rules to dispose available programs and samples, with information scattered throughout this report, making understanding a challenge. Can we provide a comprehensive explanation of the data treatment in one single chapter, starting with the source data?	*a.* Due to scoping and budgetary decisions, many jurisdictions conduct participant and nonparticipant spillover research at different times and combine the results with free-ridership research conducted at yet another time. *b.* Correct – using data collected onsite by trained auditors decreased the uncertainty around characteristics of the installed equipment and, therefore, the spillover savings (i.e., it reduced measurement error). However, utilizing these studies constrained our sample sizes for nonparticipant research, which led to lower levels of precision due to sampling error and larger confidence intervals. *c.* Appendix C provides a detailed description of the residential participant spillover survey sampling strategy. This strategy was discussed with utilities in memos and presentations during the course of the study.
9	SCG and SDG&E	Page 23-28	The decision to eliminate (a) non-residential accounts, (2) accounts with the wrong contact information (i.e., property owners/managers), and (3) all renters may have contributed to the elimination of spillover effects at the MF property level. At the MF property level, gas boilers and laundry washing and drying operations are often a part of common area meters or master meters typically would be classified as non-residential accounts.	If a multifamily tenant was influenced to install energy efficient equipment because of what they saw in the common area of a building and could tie it back to a commercial program, this would be captured in the residential nonparticipant spillover. In this study, the CLASS sample included multifamily tenants, so this type of spillover is covered in this study. A nonparticipant could be influenced by the utility's messaging from programs outside of their immediate sector, such as in common spaces or at work.

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			a. According to Ralph Prahl's comment, other states (Massachusetts and NY) may claim Non-residential spillover for their residential program. b. This should be reviewed for future research consideration since these data eliminations essentially screened out spillover assessment for residential MF properties, at a minimum. c. This may also contribute to under-stating, residential gas (therm) spillover since MF programs contribute significantly to gas applications. d. As a result of these data eliminations, the residential spillover effect is more about single family home owners. Can you discuss if it is your intention to eliminate MF properties from the spillover study? Can you tell us if your data elimination rules have essentially ruled out all MF properties from this study?	We did not sample multifamily participants for the residential participant survey due to reasons explained in the report, but applied the overall spillover rate (determined from the sampled programs) to these programs because this is the best information available.
10	SCG and SDG&E	Residential Spillover	Residential upstream programs such as ULP and Plug Load and Appliances Point of Sales activities are excluded. Perhaps, we need consider using manufacturers, retailers and distributors to estimate spillover. These upstream programs are designed with the intention to create market transformation effects.	As described in Appendix H, we did not calculate spillover savings related to ULP because these programs already account for market effects in its impacts. This is done through research with manufacturers and retailers, as suggested. We did not sample upstream programs for non-lighting measures due our inability to identify and contact participants, but applied the overall spillover rate from sampled programs to these programs. We recommend conducting future spillover research at the program level, because market effects research may be more easily incorporated into these studies.
11	SCG and SDG&E	Page 18	Thank you for the recommendation to consider tagging spillover research into future impact	In the "Considerations for Future Research" section, we recommend completing crosscutting

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			evaluation studies. This make sense but would need to be implemented in a staggered manner (i.e., doing spillover research within current year impact evaluation to assess spillover of the prior impact evaluation participants). Although this is a good approach, but how would we account for non-participant spillover for these future studies? This should be discussed in your recommendation for future research.	nonparticipant spillover research on a two to three year cycle.
12	SCG and SDG&E	Pages 19 and 31	Recommendation to look at cross fuel effects of spillover study—We agree, this is a peculiar finding from this spillover study. The current study design led with electric measures to investigate spillover, leading to incidences of gas-spillover for households. If the residential study design had a more balanced focus on gas measures, would we have found more substantial gas/therm spillover?	The cross fuel effects was a very interesting and impactful finding from this study. We believe that if future research is conducted at a program level, this effect will be minimized somewhat because programs that are primarily gas-oriented will address the spillover arising from those programs specifically.
13	SCG and SDG&E	Page 31	The concept of interactive effect was introduced on the top of page 31. What exactly is the treatment of interactive effect for the residential study, given ULP and lighting measures have been removed from the residential spillover study? Can you provide clarification in the report? (This comment may not apply to SCG as a single fuel utility).	ULP was not removed from the study – the programs' savings are still accounted for in the denominator of the spillover equation (including interactive effects). We simply did not calculate spillover savings related to ULP because the programs' impacts already account for market effects and we did not want to double count these savings.
14	SCG and SDG&E	Page 14	For the executive summary, the report is mixing residential and non-residential sample discussion together, making reading very difficult. It may be better to clearly delineate the residential and non-residential in the executive summary to make the report easier to read. For example, consolidate all residential narratives together rather than weaving them in and out of the non-residential content.	Thank you for the comment. Given that the methods to estimate spillover differed more along lines of participant versus non-participant rather than residential versus non-residential, the evaluation team is comfortable presenting the ES in the manner that it is.
15	SCG and SDG&E	Page 26	The non-residential spillover study has limited representation for key customer sectors such as hotels, hospitals, industrial businesses, agriculture, colleges/universities inherit in the CMST/CSS studies—These limitations have the effect of under-estimating the non-residential spillover effect.	This limitation is understood and detailed throughout the report. It is one of the reasons program savings from these key customer sectors (and end uses like process equipment, plug loads, etc.) were removed from the denominator of the spillover calculation for 2010-12 nonparticipants. As presented in Section

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				3.1.3, the resulting lifecycle kWh nonparticipant spillover rate of 6.0% was estimated on 71% of program savings (the other 29% includes the sectors you mention in your comment) and not the full portfolio savings. The point estimates developed by the evaluation team were developed without these customer segments, but we had initially recommended to apply the spillover rate to them.
16	SCG and SDG&E	Page 33	The non-residential non-participant spillover does merit additional exploration, since the samples excluded industrial and agriculture gas/therm activities due to limited representation of key customer sectors such as industrial and agriculture customers. The sampling strategy for future non-participant studies can be difficult and costly actions. The study recommendation should include a discussion on this topic.	We have added dialogue regarding this issue in the recommendations/future research section.
17	SCG and SDG&E	Section 5, starting on page 65	Can you please provide an overall sample disposition so we can clearly see the data step-by-step, starting for both data sources. This data is scattered throughout this section but very difficult to follow. a. To track sample dispositions, the Itron provided a series of tables in this section. However, the numbers in the narrative portion of the report, usually cannot be found directly in the various tables. The reader must sum several numbers from the various table to track the numbers presented in the report. Please refer to table-44 and-45 and narrative on page 72/73. b. Can you update the tables and narrative in section-5, so the reader can track the sample disposition and match the values identified in the table-contents?	All spillover dispositions on pages 72-73 are by site-measure, because each one went through the attribution algorithm individually. Tables 50 and 51 provide the sample dispositions.
18	SCG and SDG&E	Page 27	For non-residential sample development, the targeted measures are all electrical measures. No gas	For participant and nonparticipant spillover, the evaluation team utilized the sampling strategy

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			measures seem to be included upfront (i.e., essentially a lopped sided sample design with a heavy loading of electrical measures). The end result is a study using electrical results to explore spillover effect leading to gas spillover effects. As the study team indicated, this may be a result of larger electrical EE programs, resulting in gas/therm spillovers elsewhere for the same customers. One can't help but wonder, if the study started out with a targeted list of gas measures, would the study result in additional non-residential gas/therm spillover effects?	developed for the respective studies covered…the CSS/CMST for nonparticipant and the Commercial/IALC sampling strategies for participant spillover. The participant spillover evaluation included any gas measures on the ESPI uncertainty list from the 2013-14 program years, so some were evaluated. The IALC evaluate targeted many gas fuel measures. Again, for non-participant spillover, we were working with a dedicated dataset from the CSS/CMST. We have provided recommendations for future spillover evaluations that addresses the need to generate sampling strategies that distinguish between fuel type. Future evaluations that target spillover by fuel type may better answer that question moving forward.
19	SCG and SDG&E	Non-residential spillover	Can you please add a section to talk about study limitations for the non-residential spillover study? This information is scattered throughout the report, requiring the readers to piece this together.	The evaluation team has added a section.
20	SCG and SDG&E	Page 25-28 and 80	Why is the guidance for attribution threshold be different between program participants and non-participants? Please consider making "prompted", "unprompted" and "program influence" thresholds all the same at "5 or greater". Given the complexity of this study, this is one place we can simplify to make all the spillover thresholds consistent. Interestingly, for non-participant spillover, the threshold consideration is the same for residential and non-residential studies. If this is the case, why couldn't the residential and non-residential thresholds rules be consistent? These threshold attribution rules seem un-necessarily complex	See response to comment #4. The evaluation team used the same thresholds for the residential and nonresidential sectors, including for participant prompted, participant unprompted, and nonparticipant spillover attribution.
21	SCG and SDG&E	Appendix G	These error calculation appendixes are not clear enough. Can you provide clarification on the final	Appendix G was an interim memo provided to utilities during the study period to discuss sampling error. The

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			precision/confidence analysis, especially consider the layers of weighting to extrapolated and expand the results? Thank you for Appendix-G, but this information does not explain the final calculation for the residential study precision. Appendix-G provided insights towards sample needed, range of precision and trade-off to project cost.	final precision estimates are provided in the results sections for each sector.
22	SCG and SDG&E	Market effect, market transformation and spillover, page 22 & Appendix-H, page 158	Please refer to D. 12-11-015, 2012. In this Decision, CPUC is referring to spillover and market effect interchangeably. In this study, ODC/Itron provided the definition for spillover, market effect and market transformation. It makes sense to provide clarification on the interpretation of D. 12-11-015.	We updated the executive summary and other sections to more clearly define spillover and the subset of spillover that was studied in this evaluation.
23	SCG	Pages 16 and 35	SCG is exempt from Therm penalties from interactive effects, so portfolio-level gas savings should not reflect any interactive effects for SCG's portion of the savings. The formula in Section 2.2 would overestimate Therm spillover if interactive effects against SCG savings were deducted from the term in the denominator. Please recalculate Therm spillover to remove any Therm deductions for SCG's savings contributions, for both residential and nonresidential portfolios. When the evaluators speak of "the importance of including interactive effects", it is important to recognize that current policy does not apply Therm penalties to SCG in order to encourage SCG to continue offering gas programs. As long as the current policy remains unchanged, the evaluators should frame their results within the current policy in order to produce useful and actionable recommendations.	Thank you for the comment. This is an important consideration. The study utilized the reported savings for each sector and for each program cycle period to develop a portfolio-level estimate of spillover, not at the utility-level. However, given that the study is recommending continuing to use the existing 5% market effects adder, we believe that this comment is no longer applicable
24	SCG	Page 18	Ex post savings: Can the evaluators include suggestions on how to deal with baselines particularly	The spillover effects associated with ISP were outside the scope of this evaluation as our team was

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			for custom measures that may already include nonparticipant spillover effects as part of industry standard practice; i.e. should those baselines be lowered by the amount of spillover, for all program direct savings?	estimating spillover "as perceived" by the end user. We acknowledge that our estimates of spillover may represent a lower bound as a result.
25	SCG	Page 18	Considerations for Future Research: D.12-11-015 at OP 37 says "Program-specific estimates will be developed by evaluation studies in 2013 and 2014." What barriers prevented this evaluation team from developing program-specific estimates in this study, and what lessons can you share with other evaluators to overcome those barriers if they were to follow this recommendation?	On the residential side, the original scope of work called for the existing program evaluations to include a battery of spillover questions in participant surveys. However, we determined that the number and timeline of these studies made it impractical to use this approach. Therefore, as described in the work plan, we developed an independent survey. Due to budget limitations, we could not target the number of completes needed to develop program-specific estimates of spillover. Given budget limitations and in order to reduce the number of participants "touches" the evaluation team utilized evaluation studies that were ongoing. These studies were generally measure specific (not program specific) as they were developed to evaluate uncertainty measures as per the ESPI decision. These barriers exist and are noted in the report, but we were tasked with developing a portfolio level estimate of spillover. The research that was ongoing in 2013-14 and the availability of verified measure installation data from the 2010-12 studies allowed us to do that within scope and budget.
26	SCG and SDG&E	Page 18	Table 7: The recommended spillover rates come from different portfolios; participant from 2013-2014 and nonparticipant from 2010-2012. Can you relabel the table so that discrepancy is clearer?	Added.
27	SCG	Page 19	NP research: Could the evaluators also give some guidelines on how much to spend on this research, given that nonparticipants may be costly to reach?	It is not up to this study to make recommendations for future budget. Stakeholders will be able to comment on the scoping for future projects during the EM&V research plan update and will be able to discuss the

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				needs and make recommendations on budget allocations for research priorities.
28		Page 19	Table 12 & 13: Total Spillover. How did you calculate Total Spillover, and what does it mean? For example, are you saying that for the Residential Gas portfolio, overall spillover is at a 55.5% rate? Please explain the study strategy to combine across program cycles to produce "Total Spillover" at the portfolio level. 1) The program budgets are different, due to one cycle having 3 years and another having 2 years, 2) measure mixes are different due to code changes, the ban of incandescent lights, etc.3) the 2010-2012 analysis did not include agriculture or industrial businesses. We understand there are study budget, timing and resources trade-offs. We would still like the report to include a narrative to talk about this study design decision.	As described in the response to Comment 8, many jurisdictions conduct participant and nonparticipant spillover research at different times. We have added a section more clearly describing the study limitations, including the lack of coverage of certain programs/end-uses.
29	SCG and SDG&E	Page 55	With only 8 households and savings from 10 measures, three of which are electric-only measures, there isn't enough data to support generalization to the entire residential nonparticipant population of over 5 million households. This approach essentially violated assumptions of a normal distribution that would be necessary to even calculate an arithmetic mean. Also, the CLASS sample was designed to represent the entire population of residential IOU electric customers, not gas customers. Given these issues, would it be more accurate to consider this an evaluability assessment of nonresident nonparticipant spillover, rather than a quantitative evaluation?	The incidence of spillover is low among the CLASS sample, as expected. However, the sample size is much higher because a determination of 0 spillover savings for the other 457 households are also equally valid data points. The CLASS sample was designed to represent electric customers and a gas-specific sample may have been designed differently. But the CLASS study was sufficiently large enough to provide robust enough results for gas equipment for it to be described as a quantitative, not qualitative, evaluation.
30	SCG and SDG&E	Pages 57 and 61	Table 29: It seems the residential non-participant savings were over-generalized. The appropriate population of interest is informed by the earlier	This comment confuses the incidence of spillover with the total spillover savings. The incidence of spillover is an indicator, but does not directly factor into the

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			analyses: the study team determined that only a subset of the population had any potential for spillover (724 out of the CLASS sample of 1987 = an incidence of 36.4% of the sample). The study team's subsequent interviews determined that only 3% of the sample installed measures that qualified as spillover measures. Below is an alternative way to look at this situation--- • It may not be appropriate to assume the entire nonparticipant population (100%) had equal incidence of spillover. Using the findings of the analyses, it is more appropriate to expand Res NPSO savings only to 3% of the total nonparticipant household population (5,060,898 * .03 = 151,827 households). • All criteria that were used to define or narrow down the incidence of spillover needs to also apply to any expansion of spillover findings. • Would the evaluators please recalculate their recommendation for a spillover rate? The same logic should be used for all spillover estimate expansions in this study: Based on your earlier analysis of spillover incidence, it is not appropriate to expand participant spillover beyond the 4.1 % Res PSO incidence.	spillover rate, which is spillover savings divided by total program savings. If 5% of households combined for X kWh of spillover savings and the program had Y kWh of total savings, the spillover rate (X/Y) would be the same as if 50% of households combined for X kWh and the program had Y kWh of total savings. Using the CLASS sample, we calculated a per-household nonparticipant spillover savings value, including the households that had spillover savings as well as those that had 0 savings. To determine the NPSO rate, we multiplied that per-household estimate by the total number of households to get the total NPSO savings and then divided that by the total program savings. This is explained in detail in the text preceding Tables 28 and 29.
31	SCG and SDG&E	Page 65	Why was 2013-2014 non-res nonparticipant spillover not part of the study scope?	2013-14 nonparticipant spillover was not part of the study scope given the time, budget and resources needed to field a population survey to identify individuals that installed high efficiency equipment outside of utility programs. Combined with the low incidence of spillover, that was not a cost-effective use of resources, especially given the fact that a large-scale saturation and market share study was conducted in 2010-12. The CSS/CMST offered an unprecedented level of confidence regarding what HE measures were installed outside of utility programs. This could not be replicated for the 2013-14 period.

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32	SCG and SDG&E	Page 70	Table 27: How did you dispose of surveys in which the main 2010-2012 project decision-maker was no longer there (whether due to retirement, staffing changes, etc.? There doesn't seem to be a category that covers those cases in Table 27. These cases are also mentioned on p.78, but how many cases were there?	The beginning of the survey has screening questions that remove individuals that don't recall participating in the data collection effort for the CMST. If our team was unable to connect with an individual that was familiar with the data collection effort, the interview was terminated (and that survey would represent one of the 253 minus 125 in that table (for non-participants). The case on page 78 is different for participant spillover. These represent completed phone interviews with program participants we called for an IDI with an engineer. These individuals were unavailable for that follow-up engineering call. For both, we have clarified in the text of the report.
33	SCG and SDG&E	Page 82-83	Table 51: Spillover incidence should be calculated without penalizing the portfolio for respondents that do not recall the EE installation. Similar to cases when the original contact was no longer available, the least biased approach to imputing missing frequency data would be to remove those cells from the analysis. The incidence should be calculated against "Respondent Recalled EE Installation" for rates of 25.9% and 51.3% for NP and P, respectively. Table 52: If study teams do not penalize the portfolio for respondents that don't recall the EE site measure, these incidence rates should be 25.9% and 40.7% respectively.	While these tables were presented to provide a step-wise account of sample disposition, we agree with the assessment and have updated the unweighted incidence to reflect that.
34	SCG and SDG&E	Page 83	Why was the 2010-2012 participant spillover incidence so much higher (by an order of magnitude) than in 2013-2014? How does this affect your conclusions about the recommended portfolio-level spillover rates?	As discussed in Section 5.1, the study of 2010-12 participant spillover was a secondary objective that was included based on the fact that: a) the data was readily available; b) the same methodology was being used to assess potential spillover from 2010-12 nonparticipants; c) it allowed for a comparison and frame of reference to the 2013-14 participant spillover study. The intention was not to compare them directly. Furthermore, these estimates represent unweighted incidence of spillover from a sample of projects. Once

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				the spillover savings were weighted up to their respective populations, the spillover rates were more similar, 1.9% for 2010-12 participants and 1.2% for commercial participants in 203-14.
35	SCG and SDG&E	Page 83	"There was a higher incidence of nonparticipants installing high efficiency measures ..." Table 53 suggests that the incidence of lighting measure installations was higher for participants (77/113=68%) than nonparticipants (79/135=59%). Unless the labels in this table Can you please double check all labels for all tables? Please make sure the labels in this table are not switched accidentally.	The labels in that table were not switched accidentally. The text you are referring to "There was a higher incidence of nonparticipants installing high efficiency measures *with shorter effective useful lives (EUL)*.." is referring to the next section where spillover savings are estimated. While average first year savings were similar for participants and nonparticipants, lifecycle savings for nonparticipants were much lower than those for participants. This has to do with nonparticipants installing equipment with shorter EULs like CFLs and LED equipment.
36	SCG and SDG&E	Page 84	Expansion to the population: Like the Res analysis, this expansion is incorrect. You can only expand to the portion of the NP population that had spillover, as found in your sample. All criteria that were used to define or narrow down the incidence of spillover needs to also apply to any expansion of spillover findings. As the authors stated in the report--"spillover is not common." Would the evaluators please recalculate their recommendation for a spillover rate?	This comment confuses the incidence of spillover with the total spillover savings. The incidence of spillover is an indicator, but does not directly factor into the spillover rate, which is spillover savings divided by total program savings. If 5% of customers combined for X kWh of spillover savings and the program had Y kWh of total savings, the spillover rate (X/Y) would be the same as if 50% of households combined for X kWh and the program had Y kWh of total savings We have also modified our recommendation to NOT use these point estimates in lieu of the current 5% adder. Data limitations have been included to justify the action.
37	SCG and SDG&E	Page 96	Can you make clear in Tables 70 and 71 that your Non-res NP spillover comes from 2010-2012 and your Non-res Participant spillover comes from 2013-2014?	We have clarified in the report.

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38	SCG and SDG&E	Overarching	D.12-11-015 explicitly refers to a "5% market effects adjustment"; nowhere does the term "5% spillover" appear in the Decision. Can you fix this? Please use the language of the Decision verbatim whenever possible.	We have clarified the definition of spillover we evaluated in this study throughout the ES, Overview and Results section.
39	PG&E	Pages 13 and 17	PG&E recognizes the formidable challenges in estimating spillover, given its complexity. We appreciate the Commission's and consultants' efforts on this research, particularly in its confirmation that "spillover is real" (p17). We agree that the study provides lower-bound, initial estimates on a subset of spillover (p13). We think the study does a good job of creating a framework for understanding the relationship between spillover and two of its less-understood components: market effects and market transformation. For the purposes of these comments, we are adopting the Study's definition of these terms. Specifically: • Spillover is the reduction in energy consumption and/or demand in a utility's service area caused by the presence of Demand-Side Management (DSM) Programs, beyond program-related gross or net savings of participants. • Market Effects are the portion (subset) of spillover savings that reflect meaningful changes in the structure or functioning of energy efficiency markets. • Market Transformation is the portion of market effects that are substantial and long lasting. Our primary comments regarding this study are provided in the paragraphs below.	No response needed.
40	PG&E	Pages 13, 21-23, and 101. Figure 1.	As cited above, the study defines spillover (p13, p21-23, Figure 1, p101), and divides it into three components: market effects, market transformation, and spillover exclusive of market effects (XME) and	The evaluation team has clarified in the report the specific subset of spillover evaluated in the study.

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			market transformation (MT). Since MT is a subset of ME, by definition, Total Spillover = (Market effects) + (SpilloverXME), where SpilloverXME is Spillover exclusive of market effects. However, the report seems to use Spillover and SpilloverXME interchangeably, without distinguishing SpilloverXME as a specific subset of Spillover. The result is that the findings and recommendations offered in the report are confusing and potentially misleading.	
41	PG&E	Pages 18, 73, and 99	The study recommends the adoption of new residential and non-residential "Spillover" (sic) rates as described in Table 7 (p18) and Tables 72 (p99, participant spillover) and 73 (p100, non-participant spillover). We disagree with this recommendation. The Commission should not replace the 5% placeholder spillover rate (D.12-11-015) with the SpilloverXME estimates found in the study, for the following reasons: • The study does not measure total Spillover. The study authors recognize that the methodology used did not attempt to estimate total Spillover (that is, inclusive of market effects), but only the portion of Spillover that excludes market effects. • The study did not estimate Spillover on a program-specific basis. Program-specific estimates of Spillover are required by D.12-11-015. Given the unique designs and implementations of programs, we expect program-specific estimates to vary considerably. Until these program-specific estimates are studied, we	The evaluation team agrees with this assessment. The recommendation has been modified to NOT recommend using these new point estimates as a replacement for the 5% placeholder. However, spillover estimates generated from this study are meant to guide future program planning and spillover/market effects quantification. We agree this study does not measure total spillover. This have been detailed in the ES, Overview and Results section of the report. Our team was tasked with developing a portfolio level estimate of spillover and, given real world constraints and the availability of data from past/current evaluations, we made the decision to utilize these other studies to that end (this was detailed in the research plan for this study). The evaluation team agrees that program-specific spillover estimates may be different than the estimates developed here, but at the portfolio level, they may be similar still. While we did not conduct any hypothesis testing on the current 5% adder, the estimates generated from this study are not wildly different from that. We have provided some

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			recommend that the 5% placeholder spillover rate be retained. • The study's SpilloverXME estimates do not represent the full EE portfolio. The study could not include upstream programs because utility records do not include contact information for participants of most upstream programs (non-residential upstream lighting programs are an exception). Consequently the SpilloverXME estimates presented in this report exclude upstream programs and thus do not account for the full EE portfolio.	thoughts on future research that may help continue to refine our understanding of spillover.
42	PG&E	Pages 98 and 100	[PG&E agrees with the study's recommendation to "conduct spillover on a program-by-program basis.] This is a good idea since it is the requirement of D.12-11-015. The current study may inform future program-specific studies of spillover.	Thanks for your comment.
43	PG&E	Page 101	As discussed, the study estimated SpilloverXME. PG&E supports the recommendation to conduct research that captures all elements of spillover – including market effects spillover.	Agreed.
44	PG&E	Overarching	At a cost of approximately $2 million, this study was a significant investment. What lessons were learned and what recommendations can be offered for future spillover research? Are there data that programs could collect that would be useful to reduce research costs and improve future estimates of spillover? The report would benefit from recommendations along these lines.	The evaluation team has revised the recommendations/future planning section to better address this question.
45	Carol Yin	Overarching	Would it be possible for the evaluation team to include an appendix with recommendations presented using the table from the CPUC Energy Division Impact Evaluation Standard Reporting Guidelines? Thank you! https://pda.energydataweb.com/api/downloads/1399/IESR_Guidelines_Memo_FINAL_11_30_2015.pdf	We are not providing any specific recommendations that would warrant an RTR as were provided with recently completed evaluations.

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46	SCE	Overarching	Southern California Edison (SCE) appreciates the opportunity to provide input on the "PY2013-2014 California Statewide Residential and Nonresidential Spillover Study" Draft, prepared by Opinion Dynamics and Itron. While SCE appreciates using primary research to help set important parameters such as spillover rates, the challenge of using studies designed primarily for other purposes combined with not having all customer segments and measures represented in the study makes the task of estimating spillover harder than it need be. We believe such an important study is worthy of a dedicated sample and clear methodology which would obviate many of the problems noted in these brief comments, problems we believe were unnecessarily introduced because of the nature of the sample driving the study. SCE believes that no one choice of the research team is unreasonable or indefensible, but that the constraints and limitations of the methodology in total introduced too much uncertainty in the results. As such, SCE encourages further research specifically sampled for spillover analysis that also incorporates closer collaboration with the Program Administrators for such important research. Finally, since the research team has "compared the results to the 5% planning assumption" some detail of that comparison in the final report will help raise issues to be addressed in further research. At this point, it is unclear whether the existing 5% market effects value represents the true value of PA efforts which is a very important question.	Thanks for the comment. The evaluation team was tasked with developing a methodology that could be deployed at a portfolio-level. The ES, Overview and Results sections have all been modified to better explain some of the inherent tradeoffs of this study, along with the uncertainties surrounding the results. We acknowledged that not all types of spillover were captured in the report, and the results likely represent a lower bound of total spillover. We cannot comment on whether or not the 5% adder truly represents the value of PA efforts. We have modified our recommendation to NOT use the spillover estimates developed in this study, however, the results and recommendations do provide program planners with future planning options. As discussed in the report, one significant advantage of this study was having access to on-site data from recently completed market share/saturation studies. This provided the evaluation team with an unprecedented level of verifiable data that reduced the amount of measure error inherently to self-reported only studies.
47	SCE	Page 92	The estimated spillover rates by sector do not adequately represent SCE's Program portfolio since they appear to exclude lighting impact results that do not already incorporate market effects. Lighting measures contributed significantly to SCE cost	Nonresidential participant spillover included the population of custom Industrial and Agricultural programs as they were sampled within the IALC impact evaluations of 2013 and 2014. It's true, however, the 2010-12 nonparticipant spillover estimates using the -

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			effectiveness in the relevant study periods. In addition, Industrial/Ag programs contributed significantly to SCE's portfolios over these two time periods but receive limited representation in these results: "The 2010-12 nonresidential program savings represent the total ex post lifecycle gross MWh savings associated with nonresidential programs excluding programs savings from specific end-uses not covered under the CSS/CMST study - plug loads, food service, water heating, building envelope, and process equipment." In addition, the research team also noted that "…the participant study spanned the 2013-14 program cycle while the nonparticipant study spanned the 2010-12 program cycle." As such, "…the spillover savings rates were calculated using program savings from the applicable cycle (i.e., 2013-14 for participant spillover and associated program savings and 2010-12 for nonparticipant spillover and associated program savings." (Page 92). Having differing time periods might or might not cause inconsistencies in the results but this adds another level of uncertainty to a very important research effort that could have been prevented with a dedicated sample frame.	CSS/CMST studies - did not cover the specific end-uses referred to in the question. However, as discussed in Section 5.1.1, the CSS/CMST was included in this study because the data collected from that study eliminated the uncertainty surrounding customer self-reports of measure installation and the efficiency level of the newly purchased equipment. Given the breadth of data collected as part of that study and the high cost and time constraints associated with conducting another study of that size, the evaluation team was constrained by the data availability from that study. The evaluation team also understands the inherent tradeoffs associated with combining results across program period, but again, it was not within scope to deploy a large-scale population survey and market share tracking study in 2013-14. One other note. While we have retracted our recommendation to use the point estimates developed in this study in lieu of the 5% adder, these estimates were expanded to the respective population of measures. While some measures and sectors were not included in the spillover rate development, we were recommending to apply that rate to the entire population.
48	SCE	Pages 48-49	On pages 48-49, the study describes data stratification methodologies, including constructing "an indicator of programs' hypothesized propensity for spillover… which we used to classify programs into two groups." SCE is concerned that unknown estimation errors might arise from stratifying the sample on the very variable that is being measured. This seems analogous to stratifying an ex post impact	As described in Appendixes C and D, we stratified the residential participant sample to provide us with the best opportunity to interview participants with spillover savings. We agree that this was based on a qualitative variable and because of this, we analyzed the results halfway through the fielding (after 800 completed surveys) to test our hypothesis. As described in Appendix C, we found that the difference between our

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			study by ex post savings. While there are well known relationships between ex ante and ex post earnings to support stratification on kWh, as a qualitative variable with no prior testing, stratifying on "propensity for spillover" seems to warrant a sensitivity analysis on its own.	two groups was not significant and therefore altered our fielding approach for the remaining 800 surveys. When analyzing the full 1604 completes, we found that participants that we hypothesized had a greater propensity for spillover did in fact have a significantly higher incidence of spillover, meaning that our qualitative assumption was sound.
49	SCE	Pages 48-49	SCE notes a potential problem with the formulation of spillover as the ratio of measure savings to program savings: Spillover Rate=Spillover Savings/Program Savings Programs with high program savings in this formulation would, all other things being equal, have lower spillover rates. For example, if a program systematically misses a substantial savings opportunity and customers purchase that technology on their own (bad program), while another program captures all possible opportunities (eliminating opportunities for spillover), the more comprehensive program would technically have a lower spillover rate. This may not be a problem if we don't consider ranking programs by spillover potential. SCE notes that this paradox was addressed in the study somewhat when explaining unexpectedly high therm spillover results as well as the discussion of nonresidential results: The differences between these rates may be due to the fact that large custom projects (the IALC population) involve significant planning and utility involvement throughout all phases of the project (from inception to completion). The detailed planning can often lead to deeper savings when compared to prescriptive projects and may result in few potential	This spillover study was designed to capture additional high efficiency measure installation outside of utility programs as a result of a customer's interaction with the program. It's true that market segments like IALC contribute significantly to portfolio level savings (roughly 26% of lifecycle ex post savings in 2013-14) and result in fewer potential spillover opportunities. This was confirmed in the report – the spillover rate for IALC participants was 0.22% in the combined 2013-14 program year, compared to 1.20% for participants in the Commercial roadmap (Section 3.1.4). This was one of the reasons why the evaluation team reported them separately. Given the objective to develop a portfolio level estimate of spillover, however, these estimates were combined and the weighted spillover rate for all nonresidential participants was 0.70%.

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			spillover opportunities after program participation. (Page 33) We are not sure why a spillover rate was necessary to estimate spillover savings but paradoxes like these can arise.	
50	SCE	Pages 48-49	The research team summed up the challenge well of this important but difficult research effort as they worried rightly about "…false specificity and accuracy in this important area when the appropriate research and data does not yet exist." Given the issues raised here, SCE wonders if the final report should focus on the fundamental research question proposed here: does the data clearly reject the current 5% spillover rate? We think the research team realizes that this remains an important task. We believe that the accuracy challenge is still present even without a discussion of whether 5% is supported by the data.	In a quantitative sense, the research presented in this study does not clearly reject the 5% spillover rate nor was it our intention to conduct hypothesis testing. Qualitatively, the estimates generated from this study are not terribly inconsistent with the 5% value. However, given study limitations that are discussed in the report, we cannot say one way or the other. Until more program-specific research is conducted, we recommend retention of the 5% adder for now.
51	SCE	Overarching	As noted above, there are constraints associated with the study sample and some strong assumptions that cannot be easily undone at this point. As such, it would be useful for the report to examine the fundamental research question of whether the 5% value is supported by the data and plan for future research to determine a more precise statistic by either sector, program or other strata of interest. Since there has been a recent shift in the focus of EE impact evaluations from program savings to measure savings, it may be worth estimating measure level spillover as well especially if the delivery channels associated with measures changes substantially going forward. A measure level focus would also be better aligned with DEER and measure based impact evaluations. Thank you for the opportunity to comment this important study.	Thanks for the comment.

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52	CodeCycle	Overarching	We respectfully submit these comments for consideration on the Codes & Standards conclusions of the "PY2013-2014 California Statewide Residential and Nonresidential Spillover Study." The report states in numerous instances that, "The study team believes there is no direct causal mechanism through which one should expect to see end-user (e.g., residential and nonresidential customer) spillover given that codes and standards programs target architects, builders, and code officials and the end-user would likely be unaware of these types of interventions." Based on that assumption, Codes & Standards savings are excluded from the spillover estimates. We are not commenting on the suitability of that analysis for historic Codes & Standards programs, but it seems unduly constrained for emerging Codes & Standards solutions, particularly those focused on compliance improvement. The initial definition of "spillover" in the report appears sound: "Spillover refers to the energy savings that are caused by energy efficiency programs but are not captured by program savings estimates. In contrast to 'free ridership' that deducts from gross savings the savings that are not attributable to programs, spillover effects add back in the extra savings that are not claimed by programs but are directly or indirectly attributable to them." That definition of "spillover" properly contains no limitations as to the mechanism for "spillover" and is not limited to spillover that occurs on account of the occupants/operators of a building. The definition would appear to include spillover that occurs through	Thank you for the comment and the opportunity to clarify the study objective. The evaluation team has clarified in the ES, Overview Section and Results how spillover is defined within the context of this report. The initial definition of "spillover" in the report remains the same - but we have clarified that we are only measuring (and capturing) spillover that is perceived by the end user. While there could be SO savings above and beyond what is being credited to the C&S program (especially emerging C&S solutions), this study was not designed to capture them (and there is an inherent difficulty in drawing boundaries around them).

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			programs intersecting with "architects, builders, and code officials." We, therefore, do not understand why the authors believe there is no potential for spillover when efficiency programs work with "architects, builders, and code officials" to drive efficiency improvements and energy savings. The implicit limitation that only programs that create spillover through an "end-user (e.g., residential and nonresidential customer)" seems to be unsubstantiated. "Architects, builders, and code officials" is a subgroup where spillover is most likely to occur, as any improvement in their understanding of efficiency systems could be propagated to other buildings that will be occupied by IOU ratepayers. The very concept of "participant" in the future analyses should be expanded to include any individuals with whom an efficiency program interacts that leads to efficiency improvements for ratepayers. By way of example, some of the jurisdictions CodeCycle currently works with contract with 3rd party plan checkers located hundreds of miles away. Those plan checkers work for multiple jurisdictions. Those inspectors are using the CodeCycle software and may learn about nuances of Title 24 that previously went unaddressed. That knowledge could carry-over to plan check reviews conducted for projects external to CodeCycle's immediate scope and outside of the PA's service territory (but still in IOU ratepayer service territory). This would seem to be the very definition of participant spillover.	

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			There are many other ways that advanced Codes & Standards compliance improvement programs can create spillover benefits. Therefore, the report should include a statement to the effect of: "Despite the conclusions in this report with respect to spillover for historic Codes & Standards programs, it is quite possible that new or future Codes & Standards programs will have positive spillover impacts that could be quantified and attributed to Program Administrators. The potential for spillover in Codes & Standards programs should be evaluated as programs with the potential for spillover are brought forward." Similarly, we support this recommendation of the report: "Given the variability in spillover observed among programs and measures, we recommend that program-specific spillover research be completed in the future and, as these studies are completed, the global participant spillover values found here be replaced with program-specific values."	
53	Nikhil Gandhi	Page 7	The draft report (Table 7) recommends the CPUC adopt specific spillover values in which negative spillover of 0.7% found for nonresidential nonparticipants was set to zero based on the following argument. "Although these effects are real, spillover is typically viewed as a positive addition to ex post savings and it does not seem logical to penalize IOUs for additional energy efficient improvements made by customers as a result of their programs. Given that the estimate is close to 0%, we recommend applying a rate of 0.0%." It is not uncommon for EE measures to save one type of fuel while increasing the use of another type of fuel. The CPUC adjusts portfolio savings because of such interactive effects, which are often	The evaluation team has modified our recommendation to NOT apply these point estimates to portfolio level savings. Initially, the compelling argument to set the negative therm rate to zero for nonresidential nonparticipants was based on the fact that the CSS/CMST had very little coverage with gas measures and the study was dominated by electric measures (especially lighting). The point is well understood.

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			automatically adjusted when building simulation models are used. The implementers and evaluators do not have any discretion to ignore the measure interactivity in building simulation and selectively report results. While arguing that a small negative number can be safely rounded up to zero, the report does not use apply the same rationale to small participant SO found for electricity (0.7%) and gas (0.2%) savings in the nonresidential sector. Thus, the treatment of small numbers is not equitable. Suggest consider retaining negative savings or zeroing out all small savings.	
54	Nihil Gandhi	Overarching	The CPUC credits program savings estimated to have occurred on the grid. The draft report lacks discussion on methods used to estimate SO savings on an identical for deemed and custom projects, especially the latter since DEER values appear to have been used for deemed measures. The report should describe the data collected, qualify of data and methods used to ensure that participant and nonparticipant spillover has been estimated applying identical CPUC policies and guidance as that used in ex post evaluations. If this could not be done, a data limitations section should be included in the executive summary.	Thanks for the comment. We have included a limitation section within the report. For the nonresidential spillover evaluation, Appendix K provides a high-level overview of how impacts were developed for each of the spillover measures evaluated. These methods are consistent with other ex post evaluations conducted during respective program cycles.
55	Nikhil Gandhi	Overarching	Qualifying measures implemented during the 13-14 period for prospective use requires assuming that participants and nonparticipants would likely exhibit the same behavior in the future. Measures that have become code since the 13-14 cycle for which a substitute does not exist or the baseline change might result in smaller savings, could adversely impact the savings estimates. Consider including a	We have included a limitations section that points to this.

Number	Commenter	Page/ Section	Comment	Evaluator's Response
			narrative on limitations of using old data for prospective use.	
56	Nikhil Gandhi	Overarching	The study uses a different calculation method to estimate nonparticipant spillover as compared to that used in ex post evaluations, i.e., a response of seven or higher on a scale of 1-10 is considered a reasonable assurance that a participant is not a freerider. Lowering this threshold to four or greater for nonparticipants, the study deviates from the standard used in ex post evaluations. This seems purely a judgment call on part of the research team. A sensitivity analysis presented in an appendix shows that the SO declines significantly (and becomes negligible) if the ex post evaluation threshold is used. The executive summary should include a table similar to Table 6 (rows appear reversed in the executive summary) to show SO estimates using the same threshold used in ex post evaluations. Without access to overall SO estimates prepared under a different scenario, the CPUC cannot make an informed decision on an equitable basis for SO to be allowed in the future.	For nonparticipant spillover, there was no predetermined threshold. Attribution was set to 5 or greater after reviewing the distribution of scoring. We did conduct an analysis using 5 or greater and 7 or greater as the spillover threshold. With the 5 or greater score, the spillover rate as 6.0% LC kWh (as reported). If the scoring threshold was set to 7 or greater the spillover rate decreased marginally, 6.0% to 5.5%. For participant spillover, the score of 5 or greater was only used for unprompted attribution and 7 or greater for prompted responses. If the evaluation team utilized the 7 or greater threshold for all participant the LC kWh spillover rate would go from 0.70% to 0.68%.

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