2019 Energy Efficiency Potential and Goals Study

BROS Pre-Release Documentation

Prepared for:

California Public Utilities Commission

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Reference No.: 205201
March 21, 2019

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DISCLAIMER

This report was prepared by Navigant Consulting, Inc. (Navigant) for the California Public Utilities Commission. The work presented in this report represents Navigant's professional judgment based on the information available at the time this report was prepared. Navigant is not responsible for the reader's use of, or reliance upon, the report, nor any decisions based on the report. NAVIGANT MAKES NO REPRESENTATIONS OR WARRANTIES, EXPRESSED OR IMPLIED. Readers of the report are advised that they assume all liabilities incurred by them, or third parties, as a result of their reliance on the report, or the data, information, findings and opinions contained in the report.

1. BROS METHODOLOGY

For the purposes of this study, the Navigant team defines behavior-based initiatives as those providing information about energy use and conservation actions, rather than financial incentives, equipment, or services. The market potential modeled for these initiatives is incremental to savings from equipment change-outs.

Equation 1-1 is the general equation for the BROs potential model. Each of the components are described below.

Equation 1-1. General Equation for Calculating Incremental Market Potential for BROs

$$Incremental\ Market\ Potential = Population \times Applicability\ Factor \times Unit\ Energy\ Savings \times Penetration\ Rate$$

Where,

- **Population** is a global input that can be represented in two ways - number of homes and square feet of floor space or in sector energy consumption.
- **Applicability Factor** represents eligibility and other program-specific variables, including existing saturation that precludes customers from participating in future IOU interventions.
- **Unit Energy Savings** represent the savings expected from participants and can also be represented in two ways – kWh and therms or in percent of consumption.
- **Penetration Rate** represents participation and varies over time and by scenario (reference or aggressive). This reflects both the utility-driven rollout and the customer uptake of the program, depending on the nature of the program.

The initial penetration rates are based on existing levels of participation (either for the California IOUs for existing programs or the program from which data was drawn applied to the California IOUs' territories). The forecasts are the result of professional judgement based upon program operations and whether participation is utility driven (opt-out) or customer driven (opt-in).

The potential for double counting among BROs programs was addressed in the characterization of programs in the same sector. Adjustments to penetration and applicability were made to avoid the double counting of savings.

This effort does not examine programs that focus on demand reduction (i.e. demand response) but does include demand savings from the characterized BROs programs using Equation 1-2.

Equation 1-2. General Equation for Calculating BROs Demand Savings

$$Incremental\ Market\ Potential\ (kW) = Incremental\ Market\ Potential\ (kWh) \times Peak\ to\ Energy\ Ratio$$

Similarly to demand savings, utility program costs are calculated from the energy savings in Equation 1-1. The Cost Factor in Equation 1-3 is a unit energy cost expressed in either dollars per kWh or dollars per therm. For programs that save both electricity and gas, it was sometimes possible to divide the costs by fuel type, but in instances where this was not possible all costs were assigned to one fuel type to avoid double-counting costs.

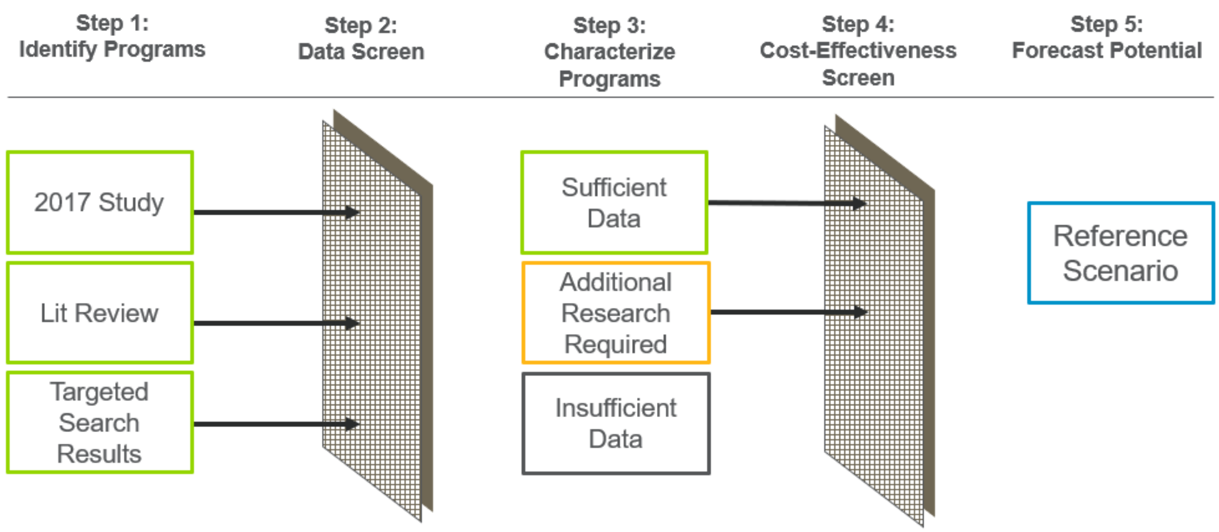
Equation 1-3. General Equation for Calculating BROs Program Costs

$$Program\ Cost = Incremental\ Market\ Potential\ \times\ Cost\ Factor$$

2. BROS DATA SOURCES

To forecast customer behavioral energy savings, the Navigant team considered a wide range of behavioral intervention types for both residential and commercial customers. Because this is an uncertain area that has been getting a lot of interest from the industry and was called out in AB802 and SB350 as an emerging area for increased opportunities given NMEC, we cast the net wide in consideration of interventions. Figure 2-1 illustrates the five-step selection process used to determine intervention types to include in the reference case scenario.

Figure 2-1. Selection Process for Residential and Commercial BROs Energy Efficiency Programs



Step 1: Identify Programs. The first step was to identify general program categories and then to conduct a literature review to identify specific programs. The team augmented our existing knowledge base drawn from the 2017 study with additional findings from numerous evaluations and research studies, as well as findings from the Consortium for Energy Efficiency Database, American Council for an Energy Efficient Economy, and various other secondary research sources. Once appropriate utility programs had been identified, we sought out formal evaluation findings wherever possible—particularly evaluations of programs run the California IOU—as well as other commissioned original research studies.

Step 2: Screen Data. Potential programs were then organized by intervention type and screened to ensure sufficient data. This initial literature review captured all available data, including utility, program name, state, number of years, number of participants per year, participant type, participation rates, eligibility considerations, energy savings, persistence, and cost. Because findings were obtained from many sources, data were inconsistently reported and thus “apples-to-apples” comparisons were not always possible.

Step 3: Characterize Interventions. Behavioral interventions were ultimately included in the model when a sufficiency of data was available for five primary modeling inputs:

- kWh savings
- therm savings

- participation rates
- persistence
- cost

While savings and participation rates were generally readily available from formal EM&V evaluations, cost data were more often scarce. So, in some cases we extrapolated or estimated based on a limited number of data points.

Penetration rates were calculated based on relevant EM&V reported program participation rates for current California IOU program offerings and reported participation in programs in other states.

We modeled an EUL of one year for residential programs. Commercial programs used a two or three-year EUL, per CPUC Decision 16-08-019, unless evidence supported a longer duration.

Specific modelling inputs for each intervention type are discuss in detail in Appendix A.

Step 4. Cost Effectiveness Screen. The cost-effectiveness screen used the total resource cost (TRC) test and the latest CPUC-approved avoided costs for each utility. This screen was used to inform the team if measures should be removed from the reference case.[1] Even programs that were not cost-effective are included in the aggressive scenario as an indication of the data available on the potential of these programs.

Step 5. Forecast Potential. The forecasts are the result of professional judgement based upon program operations and whether participation is utility driven (opt-out) or customer driven (opt-in). The forecasted penetration rates were adjusted to represent a reference and an aggressive scenario.

Many intervention types were characterized to forecast potential. A more detailed description of each of the final intervention types follows in Table 2-1, additional details can be found in Appendix A.

Table 2-1. Behavioral Intervention Summary Table

Sector	Type of Behavioral Intervention	Brief Description	EUL (years)
RES	Home Energy Reports (HERs)	Residential customers are periodically mailed HERs that provide feedback about their home's energy use, including normative comparisons to similar neighbors, tips for improving energy efficiency, and occasionally messaging about rewards or incentives.	1
RES	Web-Based Real Time Feedback (Web RTF)	Real time information and feedback about household energy use provided via websites or mobile apps	1
RES	In-Home Display Real Time Feedback (IHD RTF)	Real time information and feedback about household energy use provided via energy monitoring and feedback devices installed in customer homes	1

[1] For some IOUS, HERS does not pass the TRC test, yet we still include the program in the Reference forecast given they are a major part of current IOU portfolios.

Sector	Type of Behavioral Intervention	Brief Description	EUL (years)
RES	Small Residential Competitions	Small residential competitions are organized competitions with fewer than 10,000 participants per year in which participants compete in events, contests, or challenges to achieve a specific objective or the highest rank compared with other individuals or groups as they try to reach goals by reducing energy consumption.	1
RES	Large Residential Competitions	Large residential competitions are organized competitions with more than 10,000 participants per year in which participants compete in events, contests, or challenges to achieve a specific objective or the highest rank compared with other individuals or groups as they try to reach goals by reducing energy consumption.	1
RES	Universal Audit Tool	An opt-in program that gives the consumer the option to pay for their electricity in advance of their consumption of it. Similar to the “pay-as-you-go” business model popular in the mobile phone industry, the prepay program limits electricity use to the amount the consumer has already paid, with the opportunity to re-up to continue electric service.	1
RES	Prepay Programs	A residential prepay program is an opt-in program that gives the consumer the option to pay for their electricity in advance of their consumption of it. When the associated amount of electricity is consumed and no new payment is received, electric services are discontinued.	1
COM	Commercial Competitions	Commercial competitions are organized competitions between cities, businesses, or tenants in multi-unit buildings in which participants compete in events, contests, or challenges to achieve a specific objective or the highest rank compared with other groups as they try to reach goals by reducing energy consumption.	2
COM	Business Energy Reports (BERs)	BERS are periodically mailed to small and medium size business to provide feedback about their business’s energy use, including normative comparisons to similar businesses, tips for improving energy efficiency, and occasionally messaging about rewards or incentives.	2
COM	Building Benchmarking	Building benchmarking scores a business customer’s facility or plant and compares it to other peer facilities based upon energy consumption. It also often includes goal setting and rewards in the form of recognition.	2
COM/IND/AG	Strategic Energy Management (SEM)	Strategic Energy Management is a long-term continuous improvement process that educates and trains business energy users to develop and execute long-term energy goal setting and strategic planning; and to integrate energy management into business practices throughout the organization, from the corporate board office to the boiler room and the work floor. It can include consulting services, customized training, benchmarking and measurement, feedback, data analysis, and performance review.	5

Sector	Type of Behavioral Intervention	Brief Description	EUL (years)
COM	Building Energy Information Management Systems (BEIMS)	Building Energy Information Management Systems enable building operations staff to achieve significant energy savings by monitoring, analyzing, and controlling building system performance and energy use. BEIMS can include benchmarking and utility bill tracking software, energy information systems (EIS), building automation systems, fault detection and diagnostic tools, and automated system optimization software, as well as value added services and contracts.	3
COM	Building Operator Certification	Building Operator Certification trains and educates commercial building operators about how to save energy by encouraging them to adopt energy efficient behaviors and make building changes that reduce energy use.	3
COM	Retrocommissioning	Commissioning is a whole-building systems approach to improving an existing building's performance by identifying and implementing operational improvements to save energy and increase comfort. Retrocommissioning refers to commissioning a building that has not previously been commissioned. This program also includes recommissioning, or commissioning a building that has been commissioned at least 5 years prior.	3

Navigant conducted an extensive industry scan for data on BROs initiatives and found that many of these programs are relatively new and much learning about their effectiveness is ongoing. The published data spans a wide range in the rigor of analysis conducted on the data around energy savings resulting from these interventions. Table 2-2 provides a snapshot of the quality of data collected for this study. Across the board, demand savings data is often very limited and cost data is hard to obtain. Penetration forecasts are the most uncertain because of limited historic penetration rates upon which to base a forecast.

We recommend the industry consider pilot studies along with measurement and verification to provide better data to future potential studies. Interventions that literature claims to show large promise though limited verified data exists include: prepay programs, strategic energy management, building benchmarking, competitions, web based feedback, and in-home real time feedback.

Table 2-2. Qualitative Assessment of Data Quality

Sector	Program	Savings			Cost	Applicability	Participation Rate	Penetration Forecast	Data Updates
		kWh	therms	kW					
Residential	Audits [1]	●	●	●	◌	●	●	●	✓
Residential	Prepay Programs [1]	○	NA	◌	○	○	◌	○	✓
Residential	Home Energy Reports	●	●	●	●	●	●	●	✓
Residential	In Home Display RT Feedback	○	○	◌	○	●	◌	◌	
Residential	Web-Based Real-Time Feedback	○	○	◌	●	●	●	●	
Residential	Small Residential Competitions	○	○	◌	○	●	○	◌	
Residential	Large Residential Competitions	●	●	◌	○	●	●	◌	
Commercial	Building Operator Certification	●	●	◌	◌	●	◌	◌	
Commercial	Business Energy Reports	●	●	◌	◌	●	◌	◌	
Commercial	BEIMS	●	●	●	●	●	●	◌	✓
Commercial	Commercial Competitions	●	●	◌	○	◌	●	◌	
Commercial	Strategic Energy Management	○	◌	◌	◌	●	◌	◌	✓
Commercial	Building Benchmarking	○	○	◌	●	●	◌	◌	✓
Commercial	Retrocommissioning	●	●	●	●	●	●	◌	✓

Legend	
●	California program data and its derivatives
○	Aggregated reports and non-verified savings reported by utilities outside of California
◌	Assumed equivalence to similar programs or other forms of professional judgment
✓	Indicates that inputs for this program have new data available since the 2018 Potential and Goals Study
NA	The majority of prepay programs reviewed were electric programs. While some gas programs exist, savings were excluded due to data insufficiency.

[1] Program is newly added in the 2020 Potential & Goals Study.

APPENDIX A. BROS PROGRAM DETAILS

This appendix discusses the BROs interventions that are include in the PG model. It describes each intervention and discusses data sources and assumptions. A separate spreadsheet is also made available for stakeholders to review the final detailed inputs for intervention specific each utility and building type.

A.1 Residential - Home Energy Reports

A.1.1 Summary

Home Energy Reports (HERs) are among the most prevalent and widely studied of behavioral interventions. Residential customers are periodically mailed HERs that provide feedback about their home's energy use, including normative comparisons to similar neighbors, tips for improving energy efficiency, and occasionally messaging about rewards or incentives. HERs programs are generally provided to customers on an opt-out basis, although utilities in other states have conducted opt-in programs.

Estimated electric savings range from 1.0-2.3%, while gas savings are 0.6%-1.9%. Costs are set at $0.09-$0.29 per kWh and $3.06-$4.11 per therm.

Table A-1. Home Energy Reports - Key Assumptions

Sector	Type	EUL years	Savings		Cost		kW/kWh Savings Ratio
			kWh	Therm	kWh	Therm	
RES	Home Energy Reports (HERs)	1	1.3 – 5.9%	0.7% – 4.4%	$0.14 - $.26	$3.06 - $8.03	TBD

A.1.1 Assumptions and Methodology

Eligibility and Participation

Although all targeted residential households may receive HERs as participants in an opt-out program, in practice, PG&E found that 0.5% of customers elect to opt out. For this reason, we reduced applicability to 99.5% for single family homes. Applicability for multi-family homes is further reduced to 89.5%, dropping another 10% in order to account for multifamily homes that do not have individual meters.[2] SCE provided data indicating that only 0.17% of their multifamily customers are master-metered, so the applicability in their territory remains higher, at 99.33%.

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[2] Kate Johnson and Eric Mackres, Scaling up Multifamily Energy Efficiency Programs: A Metropolitan Area Assessment, Report Number E135, March 2013, American Council for an Energy Efficient Economy, from http://www.prezcat.org/sites/default/files/Scaling%20up%20MF%20Energy%20Efficiency%20Programs_0.pdf

While participation rates in HER programs fluctuate over time due to program opt-outs, customer moves, and changes in program implementation such as adding new waves, specific forecasts require details beyond those publicly available via 2017 IOU-filed Rolling Business Plans.[3] For this reason, the team reviewed all formal California IOU evaluations of HERS programs to ascertain historic HER program participation rates and wave sizes and then applied a weighted average of IOU wave sizes to forecast the future cohort waves according to the number of households within a given service territory.[4,5,6,7,8,9,10,11,12] [13][14][15][16][17][18]Additionally, SCG indicated that they would not deploy a HER program until 2018,[19] and that it would ramp up over three years.[20] Finally, a cap was placed on the penetration of HERs based on feedback from PG&E that the bottom quartile of energy consumers will not be targeted and an equal number of customers need to be reserved as a comparison group for evaluation purposes. The

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[3] PG&E, Application of Pacific Gas and Electric Company for Approval of 2018-2025 Rolling Portfolio Energy Efficiency Business Plan and Budget, Public Utilities Commission of the State of California, January 17, 2017

SCE, Southern California Edison Company's Energy Efficiency Rolling Portfolio Business Plan Application, Statewide Administration Approach, Public Utilities Commission of the State of California, January 17, 2017

SDG&E, Application of San Diego Gas & Electric Company (U 902-M) to adopt Energy Efficiency Rolling Portfolio Business Plan Pursuant to Decision 16-08-019, Public Utilities Commission of the State of California, January 17, 2017

SCG, Energy Efficiency Business Plan for Southern California Gas Company, Public Utilities Commission of the State of California, January 17, 2017

[4] DNV-GL, Review and Validation of 2014 Pacific Gas & Electric Home Energy Reports Program Impacts (Final Report) 04/01/2016, California Public Utilities Commission, page 4, 19

[5] DNV-GL,2013 PG&E Home Energy Reports Program Review and Validation of Impact Evaluation ED Res 3.1, April 06, 2015, California Public Utility Commission

[6] DNV KEMA, Review of PG&E Home Energy Reports Initiative Evaluation, 5-31-2013, CPUC Energy Division

[7] Freeman Sullivan and Company, Evaluation of Pacific Gas and Electric Company's Home Energy Report Initiative for the 2010–2012 Program, April 25, 2013, Pacific Gas and Electric Company, p 8, 26-31

[8] DNV-GL, Review and Validation of 2014 Southern California Edison Home Energy Reports Program Impacts (Final Report) 04/01/2016, California Public Utilities Commission, page 3, 13

[9] DNV-GL, 2013 SCE Home Energy Reports Program Review and Validation of Impact Evaluation ED Res 3.2, April 06, 2015, California Public Utilities Commission, p 3, 8

[10] August 2015 Advanced Metering Semi-Annual report provided by SCG staff. Appendix E - Nexant, Evaluation of Southern California Gas Company's 2015-2016 Conservation Campaign, August 2016, August 31, 2016, page E3

[11] DNV-GL, Impact Evaluation of 2014 San Diego Gas & Electric Home Energy Reports Program (Final Report), 04/01/2016, California Public Utilities Commission, page 3, 24

[12] DNV-GL, SDG&E Home Energy Reports Program 2013 Impact Evaluation ED Res 3.3, October 17, 2014, California Public Utility Commission

[13] 2. DNV-GL. May 5, 2017. Review and Validation of 2015 Southern California Edison Home Energy Reports Program Impacts (Final Report). California Public Utilities Commission, May 5, 2017. CALMAC Study ID: CPU0156.01.

[14] 1. DNV-GL. May 5, 2017. Review and Validation of the Pacific Gas & Electric Home Energy Reports Program Impacts (Final Report). California Public Utilities Commission, May 5, 2017. CALMAC Study ID: CPU0155.01.

[15] 3. DNV-GL. May 5, 2017. Impact Evaluation of 2015 San Diego Gas and Electric Home Energy Reports and Manage Act Safe Programs (Final Report). California Public Utilities Commission, May 5, 2017. CALMAC Study ID: CPU0157.01.

[16] 4. PG&E.2017. RTR for the Review and Validation of 2015 Pacific Gas and Electric Home Energy Reports Program Impacts (Final Report) (DNV GL, Calmac ID #CPU0155.01,ED WO #ED_D_Res_3). California Public Utilities Commission, 2017. Calmac ID: CPU0155.01.

[17] 5. SCE. 2017. RTR for the Review and Validation of 2015 Southern California Edison Home Energy Reports Program Impacts (Final Report) (DNV GL, Calmac ID #CPU0156.01). California Public Utilities Commission, 2017. Calmac ID: CPU0156.01.

[18] 6. SDG&E. 2017. RTR for the Impact Evaluation of 2015 San Diego Gas & Electric Home Energy Reports and Manage-Act-Save Programs (Final Report) (DNV GL, Calmac ID #CPU0157.01). California Public Utilities Commission, 2017. Calmac ID: CPU0157.01.

[19] Informal comments on the webinar presented on April 20, 2017.

[20] Comments of Southern California Gas Company on Proposed Decision Adopting Energy Efficiency Goals for 2018 – 2030.

behavioral model then applies these projected penetration rates to the number of forecasted IOU households, which increases over time from 2016-2030, resulting in an increase in the absolute number of actual HER participants over time.

Savings

The team reviewed the above-mentioned evaluations of all IOU HER programs to compile per-household adjusted savings rates for each wave of each year of each HER program, spanning from 2011-2015, depending upon each utility's first year of operation.[21,22] We then calculated weighted averages using each individual wave treatment participation numbers and per household savings percentages to derive singular values for kWh and therm savings that can be applied across the full treatment populations for each utility.

The model uses an EUL of one year for HER program participants. That is, while customers may participate in a utility HER program for more than one year, their average adjusted savings is assumed to be the same as for all other participants in that year. While some recent evaluations of HERs programs have found savings persistence of more than one year, reported savings percentages vary, with some sources citing higher later year savings and others showing a degradation of savings over time. For this model, an EUL of one year is assumed, as is standard with traditional persistence calculations for HER programs.

The ratio of kW to kWh savings was developed using a weighted average of adjusted kW and kWh savings as reported in the above mentioned DNV-GL 2017 evaluation findings for PG&E, SDG&E and SCE.

Cost

Costs per unit of kWh and therm savings were based on DNV-GL's Cost-Effectiveness of the 2013, 2014 and 2015 Home Energy Report memo.[23] These costs were divided by the adjusted kWh and therm savings as reported in the above-mentioned DNV-GL evaluation findings. While costs for PG&E of $0.16 per kWh and $4.85 per therm were included in the cost-effectiveness memo, values of $0.14 per kWh and $4.11 per therm were retained from the 2018 model were based on feedback from PG&E received by Navigant is the stakeholder comment period.

A.2 Residential – Universal Audit Tool (UAT)

A.2.1 Summary

The Universal Audit Tool (UAT) is an opt-in online tool that asks residential customers questions about their homes, their use of household appliances, and occupancy patterns and then it offers energy efficiency advice regarding ways they can save money and energy. The UAT is provided by all four of California's investor owned utilities. While each utility has its own branding, and some utilities require customers to log in while others do not, on the whole their features and functionality are similar. All four

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[21] KEMA, SDG&E Home Energy Reports Program Savings Results, August 23, 2013, San Diego Gas and Electric

[22] Southern California Gas Company, 2013 Program Implementation Plan, California Public Utility Commission, sourced from http://eestats.cpuc.ca.gov/EEGA2010Files/SCG/PIP/2013/Clean/1.3%20Energy%20Advisor%20Attachment.pdf

[23] DNV-GL, Cost-Effectiveness of the 2013, 2014 and 2015 Home Energy Report programs, Memo No.: HER_CE1_2017, April 12, 2017

tools enable customers to develop plans to save energy based on estimates of the annual savings they are likely to see if the enact the recommended energy-saving advice.

Estimated electric savings range from 1.2-1.8%, while gas savings are 1.5-2.6%. Costs are set at $0.06 - $0.14 per kWh and $1.15 -$4.02 per therm. For low income customers costs range from $0.11 -$0.47 per kWh and $3.73 -$7.78 per therm.

Table A-2. Home Energy Reports - Key Assumptions

Sector	Type	EUL years	Savings		Cost		kW/kWh Savings Ratio
			kWh	Therm	kWh	Therm	
RES	Universal Audit Tool (UAT)	1	1.2 - 1.8%	1.5 - 2.6%	$0.09 - $.29	$0.06 - $0.14	0.00007675 - 0.00025282
RES – Low Income	Universal Audit Tool (UAT)	1	1.2 - 1.8%	1.5 - 2.6%	$0.11 - $0.47	$3.73 - $7.78	0.00007675 - 0.00025282

A.2.2 Assumptions and Methodology

Eligibility and Participation

All residential customers of the four IOUs are eligible to use the UAT. Customers can access the tool after sign up for online services through their utility's My Energy or Energy Advisor web portals. Moreover, as we did with the HERS forecast, we reduced the applicability for multi-family homes by 10% in order to account for multifamily homes that do not have individual meters.

According to a 2017 evaluation of the UAT by DNV-GL24, over the years the tools have been active the number of customers has grown. Customer engagement and online survey completion vary by IOU, as does the associated level of marketing effort to drive customers to participate or re-participate for deeper savings. To forecast participation levels for the 2020 model the team relied on the participation numbers reported in the DNV-GL evaluation to establish cumulative treatment sizes and then determined saturation levels based on the number of households per utility. (Because evaluated participation rates were not available for SCE in reviewed sources, this value was calculated using an average percentage of saturation from the other California electric utilities.) Starting saturation rates for early model years range from 0.5% to 0.8% and grow at compound growth rate of 12% per year, topping out at between 2.5% and 3.9% participation by 2030.

Savings

The team relied on the above-mentioned 2017 DNV-GL evaluation of the UAT to set per-household adjusted kWh and therm savings values for participating customers at each utility. Because evaluated kWh savings were not available for SCE, a rate of 1.2% kWh savings was applied since it was equivalent

[24] 7. DNV-GL. March 31, 2017. Universal Audit Tool Impact Evaluation-Residential: California Public Utilities Commission, March 31, 2017. CALMAC ID: CPU0160.01.

to the evaluated savings for PG&E, which was more conservative than the higher percentage of evaluated savings for SDG&E.

The model uses an EUL of one year for UAT participants. That is, while customers may participate in a utility UAT for more than one year, their average adjusted savings is assumed to be the same as for all other participants in that year. For this model, an EUL of one year is assumed, as is standard with traditional persistence calculations for residential behavior programs.

Because evaluated demand savings data was unavailable for UAT participants we applied a 0.00019047 ratio of kW to kWh to savings, which is the figure used for HERs for all three electric utilities.

Cost

Costs per unit of kWh and therm savings were based on utility-reported HER program costs for 2013 and 2014 as found at eestats.cpuc.ca.gov. These costs were divided by the adjusted kWh and therm savings as reported in the above-mentioned 2013 and 2014 DNV-GL evaluation findings for SCE and SDG&E. PG&E provided their own cost values.[25] Therm savings for multiple years of SCG HER programs were obtained from Nexant's Evaluation of Southern California Gas Company's 2015-2016 Conservation Campaign, August 31, 2016.

A.3 Residential - Real-Time Feedback: In Home Displays and Online Portals

A.3.1 Summary

Unlike HERs that arrive in the mail on a periodic basis, real-time feedback programs change customer behaviors by delivering advanced metering data on household consumption to utility customers via an in-home display (IHD) or remotely via an online portal, such as a website or a smart phone application. While some feedback programs only provide information, others provide energy saving tips, rewards, social comparisons, and/or alerts.

Although utility behavior programs utilizing IHDs and online portals both afford feedback opportunities, we have separated our modeling inputs for the two categories to better capture differences in adoption, energy savings, and costs between the two types of programs. Of note is the higher cost typically associated with offering in-home displays, due to the need for the installation of specialized hardware, whereas online portals typically provide cloud-based information directly to the customer's smartphone, tablet, or computer.

Real-time feedback programs may also be associated with different customer rates, including time of use plans and more traditional usage based billing. Although real-time feedback is a popular behavioral intervention for demand response programs, our analysis focused on programs designed to drive energy efficiency. In all, we reviewed a total of 38 programs, including 20 providing IHDs and 18 offering online portals. Several programs offered both types of feedback. In those cases, we categorized them in the IHD category since they had associated costs for the hardware.

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[25] Informal comments on the webinar presented on April 20, 2017.

Table A-3. Real-Time Feedback - Key Assumptions

Sector	Type	EUL years	Savings		Cost		kW/kWh Savings Ratio
			kWh	Therm	kWh	Therm	
RES	Real-Time Feedback – In Home Display	1	2.3%	--	$0.19	--	0.00019058
RES	Real-Time Feedback – Online Portal	1	2.2%	1.3%	$0.07	--	0.00019058

A.3.2 Assumptions and Methodology

Eligibility and Participation

Both web-based and IHD real-time feedback programs are offered on an opt-in basis to customers with smart-meter equipped homes. Although most residential feedback programs are focused on providing information about electricity consumption, some natural gas savings result from these programs which are likely the result of tips and recommendations concerning thermostat settings. For modeling purposes, we assume 100% applicability for electric savings among individually metered homes and 59% applicability for gas. This latter figure is conservative given that 59% of California households use natural gas as their main source of space heating and 84.4% of CA homes use natural gas for water heating.[26]

In-home displays did not pass the cost-effectiveness screen, and so are not included in the reference case. SCE indicated they would not deploy these programs until 2019, and they would still only be pilots at that time.[27] This assumption was used for all utilities. We assume penetration rates for programs that use online portals to display customer information will be higher than those that rely on in-home displays. For online portals, our reference case assumes an 8% increase in penetration per year, while the aggressive case assumes a 15% annual increase, based on professional judgement. PG&E provided penetration rate data for IHDs.[28]

Savings

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[26] U.S. EIA Residential Energy Consumption Survey (RECS). "Table CE2.5 – Household Site Fuel Consumption in the West Region, Totals and Averages." (2009). Available at: http://www.eia.gov/consumption/residential/data/2009/index.php?view=consumption#fuel-consumption

[27] Informal comments on the webinar presented on April 20, 2017.

[28] Ibid.

Savings forecasts differ for online portals and IHDs. For online portals, we estimate 1.3% savings for both kWh and therms. For IHDs, we estimate 2.3% savings for kWh and no gas savings. These estimates were developed based on numerous data points for kWh savings.[29,30,31,32,33,34]

The model uses an EUL of one year, the same as we apply for HER program participants. Because insufficient demand savings data was available for real time feedback for non-demand response programs, for ratio of kW to kWh to savings, we applied 0.00019058, which is the figure used for HERs for all three electric utilities.

Cost

Hardware acquisition and installation constitute the primary cost associated with IHD programs, and they are accrued during the first year of customer participation. Sometimes these costs are paid by the utility, and other times by the customer. For modeling purposes, we assumed that the utilities will provide the hardware and that IHDs cost $100, annualized over 5 years – similar to the life of other consumer electronics.[35]

To calculate the cost, we began with a 2014 report by the Alberta Energy Efficiency Alliance for the City of Calgary that notes the cost for a real-time direct feedback program are estimated to be about $0.07 per kWh saved not including the hardware.[36] For IHDs, we add in the annualized $100 hardware acquisition and installation costs, resulting in $0.19 per kwh of savings (assuming 7,000 kwh per household).

A.4 Residential - Competitions: Large and Small

A.4.1 Summary

Residential competitions are a behavioral intervention approach in which participants compete in energy-related challenges, events, or contests. The goal of such challenges is generally to reduce energy consumption either directly or by raising awareness, increasing knowledge, or encouraging one or more types of action. Competitions can run for different lengths of time, ranging from a single month to multiple years. They can also include a mix of behavioral strategies, including goal-setting, commitments, games,

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[29] Kira Ashby, 2016 Behavior Program Summary, 2016, Consortium for Energy Efficiency, from https://library.cee1.org/content/2016-behavior-program-summary-public

[30] Susan Mazur-Stommen and Kate Farley, ACEEE Field Guide to Utility-Run Behavior Programs, 2013, American Council for an Energy-Efficient Economy, from http://aceee.org/research-report/b132

[31] Illume Advising, Energy Efficiency Behavioral Programs: Literature Review, Benchmarking Analysis, and Evaluation Guidelines, Conservation Applied Research & Development (CARD) FINAL REPORT, Prepared for: Minnesota Department of Commerce, Division of Energy Resources, May 4, 2015

[32] Ben Foster and Susan Mazur-Stommen. 2012. "Results from Real-Time Feedback Studies." American Council for an Energy Efficient Economy. Report Number B122

[33] Reuven Sussman and Maxine Chikumbo. 2016. "Behavior Change Programs: Status and Impact." American Council for an Energy Efficient Economy. Report Number B1601

[34] Opinion Dynamics. "PY2013-2014 California Energy Efficiency and Demand Response Residential Behavior Market Characterization Study Report: Volume 1. Prepared for the California Public Utilities Commission Energy Division. July 2015.

[35] PG&E provided this reference in response to the webinar on April 20: https://www.amazon.com/Rainforest-Energy-Monitor-ZigBee-Gateway/dp/B00AII248U

[36] Alberta Energy Efficiency Alliance, Energy Savings through Consumer Feedback Programs, Feb 2014, City of Calgary

social norms, and feedback. Our analysis does not include competitions and challenges that focus on the use of equipment upgrades as a means of generating energy savings.

It is also important to note that the way in which competitions are designed can vary depending upon the size of the targeted participant group. Small-scale competitions are typically designed to engage participants more deeply, with a higher number of touches and a broad spectrum of targeted behaviors that generate higher savings and serve as a model to get the larger population engaged. Large-scale competitions engage greater numbers of people in a more superficial way and encourage a limited number of behaviors. For this reason, we separate our modeling calculations to estimate the savings for the two types of competitions separately.

We define small competitions as having less than 10,000 participants per year and large competitions as having more than 10,000 participants per year. In total, we reviewed 18 small competitions and 5 large competitions. Data availability varied across programs.

Table A-4. Residential Competitions - Key Assumptions

Sector	Type	EUL years	Savings		Cost		kW/kWh Savings Ratio
			kWh	Therm	kWh	Therm	
RES	Small Competitions (<10,000 ppl)	1	8.1%	5.2%	$0.050	$1.344	0.00019058
RES	Large Competitions (>10,000 ppl)	1	14%	5.2%	$0.002	$0.101	0.00019058

A.4.2 Assumptions and Methodology

Eligibility and Participation

All residential customers are considered eligible to participate in competitions. The estimated participation rate of 6.5% for small competitions was determined by averaging available reported participation rates. Participation data for small-scale competitions was derived from SDG&E's "Biggest Energy Saver" program, SMECO's "Energy Savings Challenge", and Minnesota Valley Electric Cooperative's "Beat The Peak" program.[37] CoolChallenge California[38] provided a participation rate of 0.1% for large competitions.

[37] Grossberg, Frederick; Wolfson, Mariel; Mazur-Stommen, Susan; Farley, Kate; and Steven Nadel. 2015.(February) "Gamified Energy Efficiency Programs." ACEEE Report B1501.

[38] PG&E provided the following reference: Jones, Christopher M. and Kammen, Daniel M. 2014 "The CoolCalifornia Challenge: A Pilot Inter-City Household Carbon Footprint Reduction Competition." Contract Number: 10-325, California Air Resources Board. https://www.arb.ca.gov/research/apr/past/10-325.pdf

This information was supplemented with findings from program reviews conducted by the Consortium for Energy Efficiency,[39] American Council for an Energy-Efficient Economy,[40] and Illume Advising.[41]

Penetration rates for the reference case assume that small competitions are conducted by each utility with a consistent target population of 10,000 households per year each year between 2019 and 2030. Starting saturation level is determined by dividing 10,000 by the number of residential households per utility and multiplying by the 6.5% participation rate. The aggressive case also starts in 2019. It assumes that years 2019-2021 are limited to two target groups of 10,000, but then increased to 5 target groups of 10,000 each in subsequent year. These groups may be small towns, neighborhoods within larger cities, or similar.

Penetration rates for large competitions are based upon the participation rate and a targeted percentage of utility households. The reference case for large competitions assumes that each utility targets 10% of its residential customers between 2019 and 2021; then rises to 15% of customers from 2022 to 2024 before increasing to 20% in 2025 and rising to 25% of customers in 2028. The aggressive case uses the same time intervals, but it starts at 20% of customers and rises in increments of 10% rather than the 5% of the reference scenario.

Savings

We averaged the percentage of kWh savings reported to arrive at 8.1% for small competitions and CoolCalifornia Challenge reported 14% for large competitions.[42] Gas savings of 5.3% are used for both small and large competitions and are based on an average of an ACEEE review of three programs that report gas savings between 0.4% and 10%.[43]

Because competitions can be run for different lengths of time, lasting from a few months to multiple years, we have standardized the model on an EUL of one year. (This is the same EUL that we apply for other residential interventions.) Because insufficient demand savings data was available for residential competitions, we applied a ratio of 0.00019058 kW to kWh to savings, which is the figure used for HERs for all three electric utilities.

Cost

Costs associated with competitions are largely associated with program administration and game-related prizes. We used data gathered from the 2015 ACEEE's report on energy efficiency and gamification and information from the CEE database of behavioral programs to create cost estimates for both small and

[39] Kira Ashby, 2016 Behavior Program Summary, 2016, Consortium for Energy Efficiency, from https://library.cee1.org/content/2016-behavior-program-summary-public

[40] Susan Mazur-Stommen and Kate Farley, ACEEE Field Guide to Utility-Run Behavior Programs, 2013, American Council for an Energy-Efficient Economy, from http://aceee.org/research-report/b132

[41] Illume Advising, Energy Efficiency Behavioral Programs: Literature Review, Benchmarking Analysis, and Evaluation Guidelines Conservation Applied Research & Development (CARD) FINAL REPORT, Prepared for: Minnesota Department of Commerce, Division of Energy Resources, May 4, 2015.

[42] PG&E provided the following reference: Jones, Christopher M. and Kammen, Daniel M. 2014 "The CoolCalifornia Challenge: A Pilot Inter-City Household Carbon Footprint Reduction Competition." Contract Number: 10-325, California Air Resources Board. https://www.arb.ca.gov/research/apr/past/10-325.pdf

[43] Grossberg, Frederick; Wolfson, Mariel; Mazur-Stommen, Susan; Farley, Kate; and Steven Nadel. 2015.(February) "Gamified Energy Efficiency Programs." ACEEE Report B1501.

large behavior-based competitions. We approached the calculations for both small and large competitions in the same way. We began by estimating total program costs and total program savings and then divided total program costs by total program savings to get average cost per kWh. We estimated total program savings by multiplying the average number of participants per competition by the cost per participant. We estimated total program savings by multiplying average household electricity consumption by the average number of participants and the average savings rate per participant.

We assume that prizes account for 50% of program costs. We estimated the cost per kWh at $0.007 for large competitions, based on the prizes and participation reported for SDG&E's "San Diego Energy Challenge" and Puget Sound Energy's "Rock the Bulb" program. We estimated the cost per kWh at $0.050 for small competitions based on the prizes and participation reported for SMECO's "Energy Savings Challenge" and Minnesota Valley Electric Cooperative's "Beat The Peak" program.[44]

A.5 Residential – Prepay Programs

A.5.1 Summary

A residential prepay program is an opt-in program that gives the consumer the option to pay for their electricity in advance of their consumption of it. Similar to the "pay-as-you-go" business model popular in the mobile phone industry, the prepay program limits electricity use to the amount the consumer has already paid, with the opportunity to re-up to continue electric service. This service requires the consumer to be more involved in their consumption management, and typically reduces the amount of electricity the consumer uses as compared to consumption with a typical monthly payment structure.

There are currently no prepay programs administered by the California IOUs. However, prepay programs have been run by a number of other utilities for a number of years[45]. Most notably, Salt River Project (SRP) has been running their prepay program, named M-Power, since 1993 with positive results.[46] With the growing prevalence of advanced metering infrastructure (AMI) and web and mobile-based utility account services, prepay programs are becoming easier to implement.

Table A-5. Prepay Programs - Key Assumptions

Sector	Type	EUL years	Savings		Cost		kW/kWh Savings Ratio
			kWh	Therm	kWh	Therm	
RES	Prepay	1	5.5 – 14.0%	NA[1]	$0.01	NA[1]	0.00020376

[1] There are currently too few gas services prepay programs to adequately characterize therm savings in the California market. Gas potential saving are excluded from this study due to insufficient data.

[44] Grossberg, Frederick; Wolfson, Mariel; Mazur-Stommen, Susan; Farley, Kate; and Steven Nadel. 2015.(February) "Gamified Energy Efficiency Programs." ACEEE Report B1501.

[45] September 2015. "Bridging the Gaps on Prepaid Utility Service." U.S. Department of Energy

[46] Neenan, B. 2010. (October) "Paying Upfront: A Review of Salt River Project's M-Power Prepaid Program"

A.5.2 Assumptions and Methodology

Eligibility and Participation

Applicability is set at 100% for residential prepay programs. There would be no prerequisite technology required to opt-in to this program and as such, all consumers would be able to participate if they decided to. However, in order to account for multifamily homes that do not have individual meters, multifamily is decreased to 90% applicability.[47] This is the for both general residential and low income residential. SCE provided data indicating that only 0.17% of their multifamily customers are master-metered, so the applicability in their territory remains higher, at 99.33%.

Forecasting adoption for a program that has not been implemented by a California IOU is relatively uncertain by nature. However, our team was able to determine reasonable estimates for initial penetration and potential forecast by leveraging similar programs that do exists in California and applying growth rates determined by Navigant Research.[48] It is expected that prepay programs would be launched as a web-based service for loading and reloading prepayments for electricity. As such, we assumed that initialy penetrations in California would be consistent with initial penetration for web-based real time feedback (2.33%). We then applied a compound annual growth rate of 17% expected for prepay programs as determined by Navigant Research.

Savings

The team reviewed a wide range of reported savings from utility programs including SRP, Oklahoma Electric Cooperative (OEC), Duke Electric, PenLight, Glacier Electric, Kentucky Co-ops, and the Tennessee Valley Authority (TVA). Based on a review of California's current saturation of energy efficiency programs compared to those of the utilities reviewed, PenLight in the pacific northwest showed the most congruence. As such, the research team used the reported savings from PenLights evaluation as the potential savings for this study. This value should be updated as savings data becomes available in California.[49]

The model uses an EUL of one year for prepay program participants. That is, while customers may participate in a utility prepay program for more than one year, their average adjusted savings is assumed to be the same as for all other participants in that year. For this model, an EUL of one year is assumed, as is standard with other residential programs in the study. Because insufficient demand savings data was available for real time feedback for non-demand response programs, for ratio of kW to kWh to savings, we applied 0.00020376, which is the figure used for HERs for all three electric utilities.

Cost

Costs per unit of kWh savings were calculated based on SRP utility-reported prepay program costs for 2018.[50] These costs were divided by the adjusted kWh savings as reported in the same document. Therm

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[47] Kate Johnson and Eric Mackres, Scaling up Multifamily Energy Efficiency Programs: A Metropolitan Area Assessment, Report Number E135, March 2013, American Council for an Energy Efficient Economy, from

[48] Neil Strother and Richelle Elberg. "Prepaid Metering: Meters, software, and services" 2015. Navigant Research.

[49] Distributed Energy Financia Group, LLC. "Prepay Energy Conservation Impact Study" 2014. Northeast Energy Efficiency Alliance

[50] Salt River Project. 2018. Energy Efficiency Report

savings are not included for prepay programs. There was insufficient data on utility gas savings for prepay programs to include in this study.

A.6 Commercial - Strategic Energy Management

A.6.1 Summary

Strategic Energy Management (SEM) is a process for evaluating and implementing opportunities to optimize energy use in the commercial and industrial sectors. SEM is a continuous improvement approach that focuses on changing business practices to enable companies to save money by reducing energy consumption and waste. In California, pilot SEM programs are currently being administered in the industrial sectors. Customers that benefit the most from SEM, typically fall under one of the following categories:

- Campuses with multiple buildings and building types
- Customers with a large portfolio of buildings and a range of building types
- Buildings with complex energy systems

SEM allows for continuous energy performance improvement by providing the processes and systems needed to incorporate energy considerations and energy management into daily operations. While SEM applications vary depending on customer specific needs, program participants generally implement the following policies and activities:

- Measure and track energy use to help inform strategic business decisions
- Drive managerial and corporate behavioral changes around energy
- Develop the mechanisms to track and evaluate energy optimization efforts
- Implement ongoing operations and maintenance practices
- Reduce total annual energy costs between 5% and 10%
- Identify and prioritize capital improvements or process changes that lead to more savings
- Justify additional resources to energy management as a result of demonstrated success
- Overcome barriers to efficiency
- Boost employee engagement to contribute to sustainability goals
- Embed SEM principles into a company's operations.

The model inputs for electric and natural gas shown in the table below represent savings associated with operational and behavioral changes. Savings are estimated at 3% of customer segment consumption (kWh or therms per year) and are applied consistently by building and fuel type across utilities. Costs for electricity and natural gas are $0.27 per kWh and $3.65 per therm, and are also applied consistently by building type across utilities.

Table A-6. Commercial Strategic Energy Management - Key Assumptions

Sector	Type	EUL years	Savings		Cost		kW/kWh Savings Ratio
			kWh	Therm	kWh	Therm	
COM	Strategic Energy Management	5	3.0%	3.0%	$0.27	$3.65	0.000126

A.6.2 Assumptions and Methodology

Eligibility and Participation

Segments of the commercial market are considered suitable for SEM type program approaches. Customers that benefit the most from SEM typically operate portfolios or campuses with multiple buildings, building types, and a variety of complex energy systems, each with its own unique set of energy management requirements. The market defined for the PG BROS Model therefore includes the following segments:

- Schools
- Colleges
- Healthcare
- Large Office Buildings

Depending on the segment, the model assumes that between 10% and 55% of buildings have already implemented SEM,[51] resulting in reduced applicability of any commercial SEM program. After accounting for the estimate of customers that have already implemented SEM outside of any program intervention, the PG BROS model applies an applicability factor of between 45% and 90%. A compound annual growth rate (CAGR) was used to forecast growth in participation over time, starting in 2020.[52] A 2% CAGR was used in the reference case, while the aggressive case used a 4% CAGR. Because current SEM penetration in the market segments studied is low, it is expected that these CAGRs will achieve segment penetrations by 2030 of approximately 1.2% for the reference case and 1.5% for the aggressive case.

Savings

Estimated electric savings for all activities associated with SEM range from 5% to 10% of customer segment consumption for electricity and gas (kWh or therms per year). These savings estimates include a mix of operational savings and savings associated with capital investments (i.e., equipment retrofit and replacement projects). Because savings from capital investments are addressed in other components of the potential model, the SEM savings associated with BROS activities are constrained to estimates of

[51] Healthcare participation estimates are based on the 'Hospitals and Healthcare Initiative Market Progress Evaluation Report 7, Northwest Energy Efficiency Alliance. March 26, 2015. REPORT #E15-310. Participation estimates for other market segments are based on professional judgement.

[52] Informal comments in response to the webinar held April 20, 2017.

operational savings. Based on a literature review of 16 institutional SEM plans, such as the LW Hospitals Alliance 2014 plan,[53] and market studies such as the Northwest Energy Efficiency Alliance (NEEA) Market Progress Evaluation Report,[54] operations and maintenance savings are estimated to be 3% applied consistently by building and fuel type across all utilities for the market segments considered.

The model uses an EUL of five years.[55] A ratio of kW to kWh of 0.000126 was applied to all three electric utilities based on an analysis of several third-party programs operating in California during the 2014-2015 portfolio cycle that included some components of SEM initiatives. The EUL and kW to kWh ratio values are consistent with the 2018 Study.

Cost

Consistent with the 2018 Study, costs for electricity and natural gas savings in the 2020 study are estimated at $0.27 per kWh and $3.65 per therm, applied consistently by building and fuel type across utilities based on an analysis of several third-party programs operating in California during the 2014-2015 portfolio cycle that included some components of SEM initiatives, including the Commercial Energy Advisor, Monitoring-Based Persistence Commissioning, and Energy Fitness programs

A.7 Commercial - Building Operator Certification

A.7.1 Summary

Building Operator Certification (BOC) offers energy efficiency training and certification courses to commercial building operators in the commercial sector. BOC has been modelled as a component of behavioral savings in the 2011, 2013, and 2015 Potential Studies and research conducted for those studies indicate that operations and maintenance practices mostly fell into the following categories:[56]

- Improved air compressor operations and maintenance
- Improved HVAC operations and maintenance
- Improved lighting operations and maintenance
- Improved motors/drives operations and maintenance
- Water conservation resulting in energy savings
- Adjusted controls of HVAC systems
- Adjusted controls of energy management systems

[53] Joint Strategic Energy Management Plan for Listowel Wingham Hospitals Alliance, 2014

[54] Hospitals and Healthcare Initiative Market Progress Evaluation Report 7, Northwest Energy Efficiency Alliance. March 26, 2015. REPORT #E15-310

[55] Personal communication with Kay Hardy, CPUC. May 9, 2017.

[56] Analysis to Update Potential Goals and Targets for 2013 and Beyond, literature search results provided in Appendix C. Navigant Consulting Inc., March 19, 2012

The inputs for electric and natural gas shown in the table below represent savings associated with changes in operation and behavior, estimated on a population basis of 1,000 sq. ft. of floor space. Savings vary depending on the energy intensity of facilities in each market segment[57] and IOU from 153 kWh to 14 kwh for electricity, and as defined in the 2009 CEUS. EUL is set to 3 years per CPUC Decision 16-08-019, and costs for electricity and natural gas savings are $0.29 per kWh and $3.65 per therm. Cost and EUL values are applied consistently by building and fuel type across all utilities.

Table A-7. Commercial Building Operator Training - Key Assumptions

Sector	Type	EUL years	Savings (per 1,000 sq. ft.)		Cost		kW/kWh Savings Ratio
			kWh	Therm	kWh	Therm	
COM	Building Operator Certification	3	14-153	0.3-35	$0.29	$3.65	0.000114

A.7.2 Assumptions and Methodology

Eligibility and Participation

Consistent with prior studies, BOC savings apply to all commercial market segments, though the applicability factor of BOC ranges from 5% to 100%, depending on the market segment. This model assumes that BOC program interventions in the commercial market have been ongoing (though SoCalGas does not claim savings until 2018) and a CAGR was used to forecast growth in participation through the model forecast horizon. In the reference case, a 12.5% CAGR was used to forecast growth in BOC, while the aggressive case used a 18.0% CAGR. While these growth rates appear ambitious, low initial sector engagement in BOC results in forecast market penetrations of 6.52% and 12.12% for the reference and aggressive cases, respectively. While there is the potential for overlap in savings between BOC and SEM interventions, the current saturation of these measures and relatively low penetration rate forecasted indicate that the risk of double counting savings is minimal and was therefore was not considered in this model.

Savings

The method of calculating unit energy savings has changed over time and the 2020 Study uses the same approach and values used in the 2018 study. For context, the 2015 Study used the same average electric and natural gas savings of 58 kWh and 5.6 therms per 1,000 sq. ft. of participating building space for all market segments.[58] The 2018 Study refined this approach and applied a market segment-specific UES value that accounted for differences in building energy density. For example, a grocery store with much higher energy densities than a warehouse would experience a proportionally greater savings rate per unit of conditioned space. In this example, a grocery store in PG&E territory is expected to save 151.3 kWh per 1,000 sq. ft. and 5.2 therms per 1,000 sq. ft., compared to an unrefrigerated warehouse, which

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[57] As defined in the California Energy Commission (CEC), California Commercial End-Use Survey, CEC-400-2006-005, Prepared by Itron, Inc., March 2006, Final report available at: http://www.energy.ca.gov/ceus/index.html. Data available at: http://capabilities.itron.com/ceusweb/.

[58] Energy Efficiency Potential and Goals Study for 2015 and Beyond Stage 1. Final Report Section 3.7.1 Non-Residential Behavior Model Updates. Navigant Consulting Inc., September 25, 2015

would be expected to save 18.2 kWh per 1,000 sq. ft. and 0.8 therms per 1,000 sq. ft. after accounting for differences in energy density.

Consistent with the 2018 Study, the 2020 potential model uses an EUL of 3 years, per CPUC Decision 16-08-019, and a ratio of kW to kWh of 0.000114 was applied to all three electric utilities. This value is based on an analysis of several third-party programs operating in California during the 2014-2015 portfolio cycle.

Cost

Costs for electricity and natural gas savings are estimated at $0.29 per kWh and $3.65 per therm, applied consistently by building type across utilities. These cost values did not change between the 2018 and 2020 studies.

A.8 Commercial - Building Energy and Information Management Systems

A.8.1 Summary

The potential for building energy management and information systems (BEIMS) were first modelled by Navigant as part of the AB 802 Technical Analysis.[59] The Technical Analysis was issued in March of 2016 and not used at that time to set goals. That work has now been incorporated into the 2020 potential model.

As discussed in the Technical Analysis, BEIMS includes IT-based monitoring and control systems that provide information on the performance of various components of a building's infrastructure, including systems related to the envelope, heating and ventilation, lighting, plug load, water use, occupancy, and other critical resources. BEIMS infrastructure primarily consists of software, hardware (such as dedicated controllers, sensors, and sub-meters), as well as value-added services (including outsourced software management, building maintenance contracts, and others). This model focuses on the potential for BIEMS to change energy consumption associated with the operation of building HVAC systems as the result of several applications of BEIMS technology, including the following:

- Energy visualization
- Energy analytics
- Operational control and facility management
- Continuous commissioning and self-healing buildings.

The model inputs for electric and natural gas for BEIMS are shown in the table below based on customer segment consumption (kWh or therms per year). Electricity savings range from 1.1% to 4.2% and natural gas savings range from 0.2% to 7.4%. Variations are due to differences in segments' energy densities and differences in climate across utilities. Costs for electricity and natural gas savings also varied by utility between $0.20 and $0.46 per kWh and between $0.18 and $0.49 per therm.

[59] AB802 Technical Analysis, Potential Savings Analysis. Navigant Consulting, Inc., Reference No.: 174655. March 31, 2016

Table A-8. Building Energy and Information Management Systems - Key Assumptions

Sector	Type	EUL years	Savings		Cost		kW/kWh Savings Ratio
			kWh	Therm	kWh	Therm	
COM	Building Energy and Information Management Systems	3	1.1% - 4.2%	0.2% - 9.3%	$0.20 - $0.46	$0.18 – $0.49	0.000138

A.8.2 Assumptions and Methodology

Eligibility and Participation

The technologies that enable BEIMS are primarily associated with energy management systems (EMS) that are broadly applicable across all market sectors, though the existing market saturation of these technologies, which cannot be claimed by IOU programs moving forward, ranges across market segments from 1% to 80%.[60] In general, segments that operate larger facilities (e.g., large offices) or facilities that are energy intensive (e.g., grocery stores) will have a higher existing saturation of BEIMS-enabling technologies. Penetration reflects that SoCalGas does not claim savings until 2018, and a CAGR was used to forecast growth in BEIMS technology penetration over time. A 12% CAGR was used in the reference case, while the aggressive case used a 24% CAGR. The same CAGR was applied to all commercial market segments and utilities. Based on estimates of market saturations as of 2017, these growth rates result in BEIMS forecasted penetrations of 5.6% and 20.9% for the reference and aggressive cases, respectively by the end of the forecast horizoin in 2030.

Savings

As discussed in the AB 802 Technical Analysis, unit energy savings (UES) associated with BEIMS are calculated using the following equation:

> *Unit Energy Savings, BIEMS = Starting Saturation of EMS by Building Type x Total Annual Consumption x % End Use Consumption for HVAC x % End Use Savings by Building Type.*

This equation resulted in a range of unit energy savings (UES) values associated with BEIMS. While there is the potential for overlap in savings between BEIMS, BOC, and SEM interventions, the current saturation of these measures and relatively low penetration rates forecasted indicate that the risk of double counting savings is minimal and was therefore was not considered in this model. Additionally, BEIMS often requires capital investment while BOC and SEM are typically not capital investments, thus providing some differentiation in the market penetration models and potential to mitigate the risk of double counting savings. This UES, defined through work on the AB 802 Technical Analysis, is then used in the potential model to calculate annual segment level savings for each fuel type and IOU using the following equation:

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[60] AB802 Technical Analysis, Potential Savings Analysis. Navigant Consulting, Inc. Reference No.: 174655, March 31, 2016

Segment Savings, BIEMS = Segment UES x Penetration Rate x Total Annual Segment Consumption x Segment Applicability Factor.

Consistent with the 2018 Study, the model uses an EUL of three years per CPUC Decision 16-08-019 and a ratio of kW to kWh of 0.000138 was applied to all three electric utilities as defined in the AB802 Technical Analysis.[61]

Cost

Costs for electricity and natural gas savings are estimated based on research referenced in the AB 802 Technical Analysis.[62] The costs per unit of fuel savings were calculated for each utility and fuel type as shown in the table below.

Table A-9. Building Energy and Information Management Systems Cost per Unit Energy Savings

Fuel	Utility	Cost
kWh	PG&E	$0.435
kWh	SCE	$0.204
kWh	SDG&E	$0.323
kWh	SCG	NA
Therms	PG&E	$0.340
Therms	SCE	NA
Therms	SDG&E	$0.489
Therms	SCG	$0.180

A.9 Commercial - Business Energy Reports

A.9.1 Summary

Business Energy Reports (BERs) are the commercial sector equivalent to the HERs sent to residential customers. BERS (and other similar programs) typically share reports (via mail or electronic format) with small and medium-sized businesses at specific intervals (often monthly). The objective is to provide feedback about their energy use, including normative comparisons to similar businesses, tips for improving energy efficiency, and occasionally messaging about rewards or incentives. BERs and other similar programs typically send reports to customers on opt-out basis. BER-type programs are a relatively new addition in the emerging field of behavior change programs and are now in pilot testing at PG&E and other non-California utilities.

Navigant's modeling estimates are primarily based on three sources: 1) PG&E's response to the webinar on April 20, 2017, 2) a Cadmus review of a BER pilot with Xcel Energy business customers (smaller than 250 kW service) in Colorado (10,000 participants) and Minnesota (20,000 participants) that was

[61] Ibid.

[62] Ibid.

conducted between June 2014 and June 2015, and 3) a commercial customer behavior change pilot conducted by Commonwealth Edison and Agentis Energy in Illinois beginning in 2012. In the first instance, Xcel Energy provided BERs to a sample of businesses operating in the following sectors: small office, small retail trade, small retail service, and restaurants.[63] In the Commonwealth Edison pilot the utility engaged 6,009 medium sized (100-1,000 kW) commercial customers in Illinois.[64] While the Commonwealth Edison customers represented numerous sectors, only those businesses in the "lodging" and "other" categories showed significant savings.

Table A-10. Business Energy Reports - Key Assumptions

Sector	Type	EUL years	Savings		Cost		kW/kWh Savings Ratio
			kWh	Therm	kWh	Therm	
COM	Business Energy Reports (BERs)	2	0.32%	0	$0.20	$6.12	0.0001261

A.9.2 Assumptions and Methodology

Eligibility and Participation

BERs typically target small and/or medium sized businesses. In addition, utilities may use BERs to target businesses across all business sectors or only a select set of business sectors. As the number of BERs pilots continues to grow, a greater amount of information about the effectiveness of BERs programs in different business sectors will become available. As information concerning the effectiveness of these programs in different business sectors becomes more readily available, we assume that utilities will be more likely to limit the use of BERs to those sectors for which significant savings have been documented. Therefore, the model presented here constrains our savings estimates to those business sectors that have already achieved significant energy savings by means of business energy feedback programs such as BERs.

The model includes businesses in the following sectors: retail, restaurants, lodging, and "other." Within each of these business sectors, the applicability of savings is further constrained by the estimated proportion of business customers in each of the relevant sectors that may be classified as either small or medium sized enterprises (given that BER type programs are typically limited to small to medium sized businesses). Based on data from the Commercial Building Energy Consumption Survey (CBECS), we estimated that roughly 63% of retail customers can be considered to be small or medium businesses given that approximately 63% of retail space is shown to be under 100,000 sq ft.[65] Given the small size of restaurants, we assume 100% applicability for this sector.

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[63] Jim Stewart, Energy Savings from Business Energy Feedback [for Xcel Energy], Cadmus, October 21, 2015, Behavior, Energy, and Climate Change Conference 2015

[64] Gajus Miknaitis, John Lux and Deb Dynako, Mark Hamann and William Burns, Tapping Energy Savings from an Overlooked Source: Results from Behavioral Change Pilot Program Targeting Mid-Sized Commercial Customers, 2014 ACEEE Summer Study on Energy Efficiency in Buildings, Commonwealth Edison and Agentis Energy, from: http://aceee.org/files/proceedings/2014/data/papers/7-153.pdf

[65] U.S. Energy Information Administration, Commercial Building Energy Consumption Survey, http://www.eia.gov/consumption/commercial/data/2012/index.php?view=consumption#c13-c22

The Commonwealth Edison study specifically targeted medium sized businesses in the lodging and "other" sectors. Therefore, our savings estimates are only calculated for medium sized customers in the lodging and "other" categories based on relevant data from CBECS. For lodging, for example, we assume that 50% of lodging establishments can be considered medium-sized establishments based on CBECS data indicating that 50% of lodging establishments have an average annual energy consumption of 500,000 kWh or more per year. For businesses in the "other" category, we look at CBECS data to estimate the proportion of establishments that fall in the medium sized category (<1m kWh per year). We estimate that 25% of buildings in the "other" category are using an average of 400,000 kWh per year.

Our projected penetration rates assume a delayed start for BERs with formal utility programs launching in 2019. Our reference scenario assumes no penetration. Under the aggressive scenario, penetration begins at 2% in 2019 and ramps up at 2% per year, reaching 24% by 2030.

Savings

The model uses electricity savings of 0.32%, no gas savings,[66] and an EUL of two years per CPUC Decision 16-08-019. Because no demand savings data was available for BERs, we averaged the ratio of kW to kWh savings calculated for BEIMS, BOC, and Strategic Energy Management. This yielded 0.0001261, which is the figure used for all four utilities.

Cost

Because BER programs are new and in pilot phases, data regarding utility costs is scant. Furthermore, the limited availability of statistically significant adjusted savings percentages reported to-date indicates that BER-related savings are lower among businesses than household savings produced by HERs. For these reasons, we modeled BER costs that are double those of HERs. We project $0.20 per kWh (2 x $0.10) for electric savings for PG&E, SCE, and SDG&E.

A.10 Commercial - Benchmarking

A.10.1 Summary

Building benchmarking scores a business customer's facility or plant and compares it to other peer facilities based upon energy consumption. It also often includes goal-setting and rewards in the form of recognition. Benchmarking is generally an opt-in activity, although some municipalities, such as San Francisco, have passed ordinances requiring it for buildings of certain types and sizes.

Estimated electric savings range from 1.1% to 2.2%, while gas savings are 0.7% to 1.3%. These are applied consistently across utilities, but vary by building type. Costs were estimated to be $0.0396 per kWh and $0.2352 per therm and are not utility specific.

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[66] Informal comments on the webinar presented on April 20, 2017 from PG&E cite results of a trial that ran January to October in 2014.

Table A-11. Benchmarking - Key Assumptions

Sector	Type	EUL years	Savings		Cost		kW/kWh Savings Ratio
			kWh	Therm	kWh	Therm	
COM	Building Benchmarking	2	1.1%-2.2%	0.7%-1.3%	$0.0396	$0.2352	0.0001261

A.10.2 Assumptions and Methodology

Eligibility and Participation

In San Francisco, there is a benchmarking ordinance for any building over 10,000 sq. ft. According to the EIA, approximately 20% of all commercial buildings are under 10,000 sq. ft.[67] While any building and business type may be subject to benchmarking, reliable savings data exists for the following: colleges, healthcare, lodging, large offices, retail, and schools. For these sectors, we applied CBECS data to determine applicability.[68] For instance, we applied 100% applicability for both fuel types to colleges, while for retail we estimated 35% applicability since CBECS data indicates that roughly 35% of all retail buildings exceed 10,000 sq. ft. For healthcare, we used CBECS data to ascertain the proportion of electricity and natural gas consumed by large inpatient facilities. This information suggests that roughly 69% of all electricity and 83% of natural gas used in the healthcare sector is consumed by large healthcare facilities. School applicability is assumed to be 90% after a 10% reduction to account for smaller private learning centers.

Projected penetration rates for the reference scenario assume a constant 0% for all utilities to reflect uncertainty in whether the utilities will be able to claim savings from these initiatives if benchmarking is mandated by some level of government. For the aggressive scenario, PG&E begins with 7.9% penetration, but then climbs to 15.7% in 2020 and 23.6% in 2025. The aggressive scenario for the other three utilities are 7.9% in 2019 and 15.7% starting in 2024.

Savings

Estimated electric savings range from 1.1% to 2.2%, while gas savings range from 0.7% to 1.3% and are applied consistently by building and fuel type across utilities. Savings estimates are based on actual

[67] U.S. EIA. Commercial Building Energy Consumption Survey (CBECS) “Table B6. Building size, number of buildings, 2012.” (May 2016).

[68] U.S. EIA. Commercial Building Energy Consumption Survey (CBECS) “Table C1. Total energy consumption by major fuel, 2012.” (May 2016).

savings levels from city benchmarking reports.[69,70,71,72,73] We divided reported savings in half because we assume that half of the savings come from technologies and half from operation-related behaviors. Furthermore, we have applied a consistent split of 60% electric savings and 40% gas savings. This likely varies by building type, but as these data were not available we have not made this calculation based on specific building-type consumption information.

The model uses an EUL of two years per CPUC Decision 16-08-019.

Because no demand savings data was available for Benchmarking, we averaged the ratio of kW to kWh savings calculated for BEIMS, BOC, and Strategic Energy Management. This yielded 0.0001261, which is the figure used for all three electric utilities.

Cost

Available data suggest that benchmarking programs often include a utility in concert with a municipality. Our estimates used PG&E's estimated 3-year program budget of $2.3 million.[74] Attributing all costs to either electricity or gas, this utility program cost was divided by estimated savings to calculate a per unit savings cost. Costs amounted to $0.0396 per kWh and $0.2352 per therm and are not utility specific.

A.11 Commercial - Competitions

A.11.1 Summary

Commercial competitions are a behavioral intervention approach in which participants compete in events, contests, or challenges to achieve a specific objective or the highest rank compared with other individuals or groups as they try to reach goals by reducing energy consumption. Competitions can run for varying time periods ranging from a single month to multiple years. They can include a mix of behavioral strategies, including goal-setting, commitments, games, social norms, and feedback. Those designed to produce energy savings via equipment upgrades were not included in our analysis.

Competitions may be designed differently depending upon the size and nature of the targeted participant group. Smaller scale competitions are designed to engage people in a deep way with a higher level of touches and a broad spectrum of behaviors that generate higher savings and serve as a model to get the larger population engaged. Large scale competitions engage greater numbers of people in a more

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[69] SF Environment and ULI Greenprint Center for Building Performance. "San Francisco Existing Commercial Buildings Performance Report: 2010-2014." (2015)

[70] Katherine Tweed. "Benchmarking Drives 7 Percent Cut in Building Energy. (October 2012) Greentech Media

[71] City of Chicago. "City of Chicago Energy Benchmarking Report 2016."

[72] Jewel, Amy; Kimmel, Jamie; Palmer, Doug; Pigg, Scott; Ponce, Jamie; Vigliotta, David; and Weigert, Karen. "Using Nudges and Energy Benchmarking to Drive Behavior Change in Commercial, Institutional, and Multifamily Residential Buildings." 2016. Proceedings of the ACEEE Summer Study on Energy Efficiency in Buildings.

[73] Navigant Consulting. "New York City Benchmarking and Transparency Policy and Impact Evaluation Report." (May 2015). Prepared for the U.S. Department of Energy by Navigant Consulting, Inc., Steven Winter Associates, Inc., and Newport Partners, LLC.

[74] CPUC, Statewide Benchmarking Process Evaluation, Volume 1, CPU0055.01, Submitted by NMR Group and Optimal Energy, April 2012.

superficial way and encourage a limited number of behaviors. Because we had limited data for this type of behavioral intervention all commercial competitions are considered as a single category.

In additional to overall summary data available through the ACEEE[75] and the CEE,[76] we considered 10 different challenges, including the EPA's Energy Star Building Competition, NEEA's Kilowatt Crackdown, Chicago's Green Office Challenge, and PG&E's Step Up and Power Down pilot.[77,78] The completeness of data available on each program varied with some of the most robust data coming from Duke Energy's Smart Energy Now effort in Charlotte, NC.[79]

Table A-12. Commercial Competitions - Key Assumptions

Sector	Type	EUL years	Savings		Cost		kW/kWh Savings Ratio
			kWh	Therm	kWh	Therm	
COM	Competitions	2	1.9%	--	$ 0.04	--	0.0001261

A.11.2 Assumptions and Methodology

Eligibility and Participation

Eligibility for commercial competitions is defined by the program administrator. Competitions can focus on occupants within an individual building or across a single company, but more often they embrace wider audiences at the municipal level, in which groups of tenants within large buildings or across campuses or neighborhoods compete with one another. Nonetheless, certain business sectors and business types constitute more receptive customer types than others.

For this model, we focused on savings in those building types that have been targeted by PG&E's Step Up and Power Down campaign that is currently being carried out in San Francisco and San Jose. This effort is focused on the following five building types: large offices, small offices, retail, restaurants, and lodging.[80,81] The applicability factor was defined in terms of potential program reach as it applies to larger

[75] Kira Ashby, 2016 Behavior Program Summary, 2016, Consortium for Energy Efficiency, from https://library.cee1.org/content/2016-behavior-program-summary-public

[76] Susan Mazur-Stommen and Kate Farley, ACEEE Field Guide to Utility-Run Behavior Programs, 2013, American Council for an Energy-Efficient Economy, from http://aceee.org/research-report/b132

[77] Edward Vine and Christopher Jones, A Review of Energy Reduction Competitions. What Have We Learned?, 2015 (May), California Institute for Energy and Environment. Report sponsored by the California Public Utilities Commission. Available at: http://escholarship.org/uc/item/30x859hv

[78] Edward L. Vine and Christopher M. Jones. Competition, carbon, and conservation: Assessing the energy savings potential of energy efficiency competitions. 2016. Vol 19: 158-176. *Energy Research and Social Science*.

[79] TecMarket Works, Impact Evaluation of the Smart Energy Now Program (NC) (Pilot) for Duke Energy, February 21, 2014.

[80] Linda Dethman, Brian Arthur Smith, Jillian Rich, and James Russell. Engaging Small and Medium Businesses in Behavior Change through a Multifaceted Marketing Campaign. 2016. Proceedings of the ACEEE Summer Study on Energy Efficiency in Buildings.

[81] Kat A. Donnelly. Workplace Engagement: Finding and Filling the Gaps for Fruitful Energy Savings. 2016 (October). Presentation at the 2016 Behavior, Energy and Climate Change Conference. Baltimore, MD.

and smaller types of buildings. We assume an applicability of 8% for large offices and lodging and a lower applicability factor of 4% for small to medium businesses - small offices, restaurants, and retail.[82]

At the time this model was prepared, PG&E was the only California IOU running a commercial competition, but they were not claiming savings. Because of this, our penetration forecast for PG&E shows 0% until 2019, at which point we anticipate they will begin to claim savings for one city and hold steady through 2030. SCE and SDG&E do not begin claiming savings until 2021. We do not anticipate that SCG will run commercial competitions given that we currently do not have sufficient data with which to model gas savings. For the aggressive scenario, PG&E, SCE, and SDG&E all begin to claim savings in 2019, and in 2024, they add a second city-size competition.

The penetration rates for each utility assume that they will target the largest cities within their service territories, such as San Francisco, San Jose, Anaheim, and San Diego, or that groups of smaller communities - the size of Walnut Creek, Santa Barbara, or Oceanside - may be pooled together within a service territory to reach a similar number of businesses.

Savings

Savings estimates are based on PG&E's study of Step Up and Power Down(1.9% kWh). No gas savings are modeled.

The model uses an EUL of two years to maintain consistency with CPUC Decision 16-08-019.

Because no demand savings data was available, we averaged the ratio of kW to kWh savings calculated for BEIMS, BOC, and SEM. This yielded 0.0001261, which is the figure used for all three electric utilities.

Cost

Costs of $0.04 per kWh are drawn from Smart Energy Now. [83]

A.12 Commercial - Retrocommissioning

A.12.1 Summary

The potential for Retrocommissioning (RCx) was modelled as a component of behavioral savings in the 2013, 2015, and 2018 studies and this update refines several of the underlying assumptions and inputs used. RCx is defined as commissioning performed on buildings that have not been previously commissioned. This model also includes the allowed recommissioning of buildings that have undergone commissioning after 5 years have passed. The model focuses on RCx activities that impact HVAC system operations and includes, for example, measures such as the following:[84]

- Correct actuator/damper operations

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[82] Informal comments received in response to the webinar on April 20, 2017 from PG&E indicate a limited willingness to participate in commercial competitions.

[83] TecMarket Works, Impact Evaluation of the Smart Energy Now Program (NC) (Pilot) for Duke Energy, February 21, 2014.

[84] 2016 Statewide Retrocommissioning Policy & Procedures Manual, Version 1.0. Effective Date: July 19, 2016

- Correct economizer operations
- Adjust condenser water reset
- Adjust supply air temperature reset
- Adjust zone temperature deadbands
- Adjust equipment scheduling
- Adjust duct static pressure reset
- Adjust hot or cold deck reset
- Optimize Variable Frequency Drives on fans or pumps
- Recode Controls HVAC airflow rebalance/adjust
- Reduce simultaneous heating and cooling
- Adjust boiler lockout schedule

The model inputs for electric and natural gas for RCx, shown in the table below, are based on customer segment consumption (kWh or therms per year). Electricity and natural gas savings range from 2.3% to 12.7%, and are applied consistently level for all utilities. Costs for electricity and natural gas savings are also constant across utilities at $0.39 per kWh and $0.29 per therm. Industry literature indicates that demand savings associated with RCx are minimal and the 2020 Study does not forecast demand savings for RCx, as such the kW/kWh savings ratio is 0.

Table A-13. Commercial Retrocommissioning - Key Assumptions

Sector	Type	EUL years	Savings		Cost		kW/kWh Savings Ratio
			kWh	Therm	kWh	Therm	
COM	RCx	5	2.3% - 5.17%	2.3% - 5.17%	$0.21	$0.39	0.000

A.12.2 Assumptions and Methodology

Eligibility and Participation

Consistent with previous Studies, RCx savings are applied to select commercial market segments, and the applicability factor ranges from 18% to 91%. Consistent with the 2018 Study, the 2020 Study also adjusted the eligibility and participation estimates for RCx to exclude BEIMS market potential, and to exclude buildings built after 2011 when commissioning became a requirement under CalGreen. It is estimated that approximately 92% of commercial building stock was constructed before 2011. The exclusion of market savings from BEIMS is intended to reduce the risk of double counting savings because the EMS technologies inherent in the BEIMS measure allow for continuous commissioning that would exclude commissioning activities defined in the RCx measure. The model assumes that RCx program interventions in the commercial market have been ongoing since the 2015 Study (though SoCalGas does not claim savings until 2018), and a CAGR was used to forecast growth in participation through the model forecast horizon. In the reference case, a 3,1% CAGR was used to forecast growth in

RCx, while the aggressive case used a 4.5% CAGR. Recommissioning is anticipated in 25% of RCx participants after 5 years, and reparticipation is additionally discounted by 25% to avoid double counting of savings influenced by other programs, such as BOC and SEM. Low initial penetration of RCx results in forecasted penetrations of 2.3% and 2.8% for the reference and aggressive cases, respectively, over the forecast horizon.

Savings

Energy savings associated with RCx are calculated using the following equation:

Energy Savings, RCx = Penetration of RCx by Building Type x Total Annual Consumption x % End Use Consumption for HVAC x % End Use Savings by Building Type

The percent of end use consumption for HVAC systems impacted by RCx is based on CEUS, while the end use savings by building type is based on literature reviewed for the 2015 and 2018 Studies.[85,86,87] Savings for offices, colleges, and schools were capped at 5% to reflect feedback from SCE on their experience.[88] The model uses an EUL of 3 years per CPUC Decision 16-08-019. Demand savings are not forecast to occur through RCx and the ratio of kW to kWh is set to zero.

Cost

Costs for electricity and natural gas savings are estimated based on an analysis of the same programs reviewed and referenced in the 2018 Study.

A.13 Industrial/Agriculture - Strategic Energy Management

A.13.1 Summary

Strategic Energy Management (SEM) in the Industrial and Agricultural sectors is a ‘holistic’ approach to managing energy use that continuously improves energy performance based on various initiatives. SEM, per CPUC and California IOU design, is a continuous improvement approach that focuses on changing business practices to enable companies to save money by reducing energy consumption and waste. The Industrial sector SEM pilot program currently being administered by California IOUs served as the basis for this forecast. As defined in the California Industrial SEM Design Guide,[89] leading SEM programs are designed to support industrial companies by focusing on several high-level objectives:

- Implementing energy efficiency projects and saving energy, primarily from savings in operations and maintenance (O&M).
- Establishing the Energy Management System (EnMS) or business practices that help a facility to manage and continuously improve energy performance.

[85] 2014 Retro-Commissioning (RCx) Program Extreme Makeover, CenterPoint Energy at http://www.centerpointenergy.com/en-us/Documents/2014%20RCx%20Kickoff%20Slides.pdf

[86] EPA. http://www.epa.gov/statelocalclimate/documents/pdf/table_rules_of_thumb.pdf

[87] DEER ExAnte2013 - RTU-Retro, Rooftop Unit retrocommissioning COM IOU Workpaper

[88] Informal comment received in response to webinar held April 20, 2017.

[89] Version 1.0, February 8, 2017. Prepared by Sergio Dias Consulting LLC

- Normalizing, quantifying, and reporting facility-wide energy performance.
- Getting peers to talk to one another.

The model inputs for electric and natural gas shown in the table below represent savings associated with SEM operational and behavioral changes. Savings are estimated based on building type consumption (kWh or therms per year) for each market segment and are applied consistently across utilities. Costs for electricity and natural gas are $0.20/kWh and $1.35/therm, and those are also applied consistently by building and fuel type across utilities.

Table A-14. Industrial/Agriculture SEM - Key Assumptions

Sector	Type	EUL years	Savings		Cost		kW/kWh Savings Ratio
			kWh	Therm	kWh	Therm	
Industrial	Strategic Energy Management (SEM)	4.3	1.9% - 4.4%	1.9% - 3.9%	$0.20	$1.35	0.000195
Agriculture	Strategic Energy Management (SEM)	4.3	3.1% - 3.9%	3.0	$0.20	$1.35	0.000195

A.13.2 Assumptions and Methodology

Eligibility and Participation

Eligibility and participation estimates in the 2020 Study are consistent with the 2018 Study that defined eligibility and participation based on guidance provided by the CPUC regarding the IOUs and as part of the 2017 SEM Pilot Program development effort.[90] Per the design of the CPUC SEM pilot and the market considerations expressed in the IOU business plans, savings in the industrial sector are initially forecasted to begin in 2019 for high use market segments, including the petroleum, food, electronics, and chemicals segments, while more widespread implementation for all other industrial segments begins in 2021. Although in theory SEM applies to all customer sizes, in practice applicability of SEM is constrained to large customers. In general, this guidance does not mean that any industrial or agricultural market segment will be excluded from participating in SEM but does restrict the applicability of SEM to larger participants in each market segment. Consequently, an applicability factor for SEM was defined for all industrial and agricultural market sectors and ranged between 39% and 93% for electricity and 48% to 99% for natural gas for the industrial sector, as shown in Table A-15, and between 40% and 65% for both electricity and natural gas for the agricultural sector as shown in Table A-16.

[90] Strategic Energy Management -- Comments and Responses on Design and EMV Guides, http://www.energydataweb.com/cpuc/search.aspx

Table A-15. Industrial SEM Applicability

Segment	Fuel	Applicability
Ind - Petroleum	kWh	93%
Ind - Food	kWh	77%
Ind - Electronics	kWh	45%
Ind - Stone-Glass-Clay	kWh	85%
Ind - Chemicals	kWh	74%
Ind - Plastics	kWh	75%
Ind - Fabricated Metals	kWh	72%
Ind - Primary Metals	kWh	59%
Ind - Industrial Machinery	kWh	48%
Ind - Transportation Equipment	kWh	56%
Ind - Paper	kWh	82%
Ind - Printing & Publishing	kWh	61%
Ind - Textiles	kWh	39%
Ind - Lumber & Furniture	kWh	48%
Ind - All Other Industrial	kWh	48%
Ind - Petroleum	Therms	99%
Ind - Food	Therms	95%
Ind - Electronics	Therms	64%
Ind - Stone-Glass-Clay	Therms	97%
Ind - Chemicals	Therms	98%
Ind - Plastics	Therms	81%
Ind - Fabricated Metals	Therms	85%
Ind - Primary Metals	Therms	94%
Ind - Industrial Machinery	Therms	48%
Ind - Transportation Equipment	Therms	66%
Ind - Paper	Therms	97%
Ind - Printing & Publishing	Therms	82%
Ind - Textiles	Therms	50%
Ind - Lumber & Furniture	Therms	52%
Ind - All Other Industrial	Therms	48%

Table A-16. Agricultural SEM Applicability

Segment	Fuel	Applicability
Ag - 110 - CEC custom NAICS code	kWh	65%
Ag - 111 - Crop Production	kWh	65%
Ag - 112 - Animal Production and Aquaculture	kWh	65%
Ag - 113 - Forestry and Logging	kWh	65%
Ag - 114 - Fishing, Hunting and Trapping	kWh	65%
Ag - 221 - CEC custom NAICS code - Water Pump	kWh	40%
Ag - 110 - CEC custom NAICS code	Therms	65%
Ag - 111 - Crop Production	Therms	65%
Ag - 112 - Animal Production and Aquaculture	Therms	65%
Ag - 113 - Forestry and Logging	Therms	65%
Ag - 114 - Fishing, Hunting and Trapping	Therms	65%
Ag - 221 - CEC custom NAICS code - Water Pump	Therms	40%

The starting saturation for all segments is estimated at 1.5% with a compound annual growth rate (CAGR) of 6.7% for the reference case and 10.0% for the aggressive case. By 2030 this yields a market saturation of 3.5% and 5.2% for the reference and aggressive cases, respectively.

Savings

The savings forecast for SEM is an estimate of O&M savings based on a literature review indicating that an average UES for O&M savings of 3.0 percent of annual sector level consumption is appropriate for the industrial and agricultural sectors. Savings at the segment level will vary, however, because SEM in the industrial and agricultural sectors applies primarily to usage associated machine drive, process heating, and process refrigeration. As such, segment specific UES values were calculated based on how much energy is consumed for these three uses.

Table A-17 shows how usage varies by sector for the industrial segment where, for example, 93% of petroleum segment consumption is accounted for by the end uses impacted by SEM, versus the textile segment where only 39% of energy is consumed by these same end use categories. On average, these end uses account for 64% on total industrial sector usage. An SEM segment savings adjustment factor was calculated by dividing the SEM applicable segment consumption by the market average consumption, for example for petroleum sector the SEM applicable segment consumption of 93% was divided by the industrial sector average consumption of 64% to yield an SEM segment UES adjustment factor of 1.5 for the petroleum segment. An SEM UES multiplier was then calculated by multiplying the average SEM industrial sector savings of 3.0 percent by the SEM segment savings adjustment factor. In this example, the average SEM industrial sector savings of 3.0 percent was multiplied by the UES adjustment factor of 1.5 for the petroleum segment, yielding a multiplier of 4.4%. Table A-18 provides the UES multipliers used to forecast natural gas savings.

Table A-17. Industrial SEM Electricity UES Multipliers

Segment	SEM Target End Uses			SEM Applicable Segment Consumption	SEM Segment Savings Adjustment Factor	SEM UES Multiplier
	Machine Drives	Process Heat	Process Refrigeration			
Petroleum	88%	0%	6%	93%	1.5	4.4%
Stone-Glass-Clay	61%	24%	1%	85%	1.3	4.0%
Paper	77%	4%	2%	82%	1.3	3.9%
Food	42%	7%	29%	77%	1.2	3.7%
Plastics	51%	15%	9%	75%	1.2	3.6%
Chemicals	61%	5%	9%	74%	1.2	3.5%
Fabricated Metals	49%	20%	3%	72%	1.1	3.4%
Printing & Publishing	52%	2%	7%	61%	1.0	2.9%
Primary Metals	29%	29%	1%	59%	0.9	2.8%
Transportation Equipment	37%	13%	6%	56%	0.9	2.7%
All Other Industrial	33%	9%	6%	48%	0.8	2.3%
Industrial Machinery	33%	9%	6%	48%	0.8	2.3%
Lumber & Furniture	36%	8%	4%	48%	0.7	2.3%
Electronics	21%	12%	12%	45%	0.7	2.2%
Textiles	31%	5%	3%	39%	0.6	1.9%

Source: Navigant analysis

Table A-18. Industrial SEM Natural Gas UES Multipliers

Segment	SEM Target End Uses			SEM Segment Savings Adjustment Factor	SEM UES Multiplier
	Service Hot Water	Process Heat	Other		
Petroleum	14%	59%	26%	1.3	3.861%
Stone-Glass-Clay	1%	90%	6%	1.3	3.765%
Paper	25%	26%	46%	1.3	3.783%
Food	59%	28%	9%	1.2	3.713%
Plastics	46%	24%	11%	1.1	3.162%
Chemicals	28%	28%	43%	1.3	3.834%
Fabricated Metals	15%	65%	6%	1.1	3.330%
Printing & Publishing	13%	64%	5%	1.1	3.199%

Primary Metals	5%	78%	10%	1.2	3.645%
Transportation Equipment	15%	30%	21%	0.9	2.569%
All Other Industrial	16%	20%	12%	0.6	1.873%
Industrial Machinery	16%	20%	12%	0.6	1.873%
Lumber & Furniture	12%	28%	12%	0.7	2.023%
Electronics	42%	10%	12%	0.8	2.496%
Textiles	18%	19%	13%	0.6	1.947%

The 2020 Study uses this same process to develop savings multipliers for the agricultural sector, however because NAICs codes associated with the agricultural sector were changed to align with the IEPR definition of the agricultural sector, the same level of data used in the in industrial sector forecast was not available. As such, the average UES for O&M savings of 3.0 percent of annual sector level consumption was used for most agricultural market segments with adjustments for segments that are primarily large motor loads, such as Municipal and Irrigation Water Pumping as shown in Table C-18.

Table A-19. Agricultural SEM Electricity and Natural Gas UES Multipliers

Segment	Fuel	SEM UES Multiplier
Ag - 111 - Crop Production	kWh	3.1%
Ag - 112 - Animal Production and Aquaculture	kWh	3.1%
Ag - 113 - Forestry and Logging	kWh	3.1%
Ag - 114 - Fishing, Hunting and Trapping	kWh	3.1%
Ag - 221 - CEC custom NAICS code - Water Pump	kWh	3.9%
Ag - 111 - Crop Production	Therms	3.0%
Ag - 112 - Animal Production and Aquaculture	Therms	3.0%
Ag - 113 - Forestry and Logging	Therms	3.0%
Ag - 114 - Fishing, Hunting and Trapping	Therms	3.0%
Ag - 221 – Municipal and Irrigation Water Pumping	Therms	3.0%

Source: Navigant analysis

The 2020 Study uses the SEM UES multiplier to forecast segment level potential net savings using the following equation:

SEM segment level EE net savings potential =
SEM UES Multiplier x Annual Segment Consumption[91]

The model holds the industrial and agricultural segment UES multiplier constant throughout the 2020 PG model forecast horizon.

Cost

Costs for electricity and natural gas savings are estimated at \$0.20/kWh and \$1.35/therm and are applied consistently by building and fuel type across utilities. Costs are based on an analysis of third party Industrial sector programs operating in California during the 2014-2015 portfolio. These costs are lower than those for emerging technology and generic custom type measures, reflecting that SEM savings are O&M based and do not include rebate measures for large capital investments.

[91] Electric (GWh) and natural gas (therm) from the 2017 IEPR Forecast