# PY2013–2014 California Energy Efficiency and Demand Response Residential Behavior Market Characterization Study Report

## Volume II: Report Appendices

Prepared by

**Opinion Dynamics Corporation**

**DNV-GL**

For the

**California Public Utilities Commission**

**Energy Division**

**Final**

July 1, 2015

CALMAC Study ID: CPU0109.02

Opinion Dynamics

# Table of Contents

Opinion Dynamics

# Table of Tables

Opinion Dynamics

# Evaluator Contact Information

The Energy Efficiency and Demand Response Residential Behavior Market Characterization Study effort is covered under CPUC Contract 12PS5095 between DNV-GL and the CPUC. Opinion Dynamics is a subcontractor to DNV-GL for this work. The evaluation effort is being covered under work order ED_D_Res_1 and ED_D_Mkt_1.

The table below presents the various people involved in this effort.

| Firm/Agency | Name | Role | Email | Phone |
|---|---|---|---|---|
| CPUC Energy Division | Peter Franzese | Evaluation lead at the California Public Utility Commission - Energy Division (CPUC-ED) | Peter.Franzese@cpuc.ca.gov | 415-703-1926 |
| Ken Keating | Ken Keating | Consultant to the CPUC-ED during the study development period | Keatingk2@msn.com | 503-244-7204 |
| DNV-GL | Valerie Richardson | Overarching lead for the Residential Roadmap | valerie.richardson@dnvkema.com | 510-891-0446 |
| Opinion Dynamics | Mary Sutter | Director of this study | msutter@opiniondynamics.com | 510-444-5050 |
| Opinion Dynamics | Olivia Patterson | Project Manager of this study | opatterson@opiniondynamics.com | 510-444-5050 |

# Introduction

This is the second of two documents that comprise the results of the Energy Efficiency and Demand Response Residential Behavior Market Characterization Study. The first volume contains an executive summary, background of the study, findings, and recommendations.

# Appendix A. List of Acronyms

| Acronym | Definition |
|---|---|
| AB 32 | California Assembly Bill 32 |
| AC | Air Conditioning |
| ALCS | Advanced Load Control System |
| ALJ | Administrative Law Judge |
| AMI | Advanced Metering Infrastructure |
| B/C | Benefit-to-Cost |
| BayREN | Bay Area Regional Energy Network |
| BECC | Behavior, Energy, Climate Change Conference |
| BGE | Baltimore Gas and Electric |
| BKi | Bevilacqua Knight Inc |
| BYOT | Bring Your Own Thermostat |
| CAISO | California Independent System Operator |
| CEC | California Energy Commission |
| CLASS | California Lighting and Appliance Saturation Study |
| CPUC | California Public Utilities Commission |
| CPUC-ED | California Public Utilities Commission- Energy Division |
| CSS | Customer Service System |
| DMS | Distribution Management System |
| DOE | Department of Energy |
| DR | Demand Response |
| DTE | DTE Energy |
| E3 | Energy Environment Economic Calculator |
| EE | Energy Efficiency |
| ETP | Emerging Technologies Program |
| EM&V | Evaluation, Measurement, and Verification |
| EPRI | Electric Power Research Institute |
| ESPI | Energy Service Provider Interface |
| EUL | Effective Useful Life |
| EVSE | Electric Vehicle Supply Equipment |
| EWB | East West Bank |
| GBC | Green Button Connect |
| GHG | Greenhouse Gas |
| HAN | Home Area Network |
| HER | Home Energy Report |
| HVAC | Heating, Ventilation and Air Conditioning |
| IHD | In-Home Display |
| IOU | Investor-Owned Utility |
| kW | Kilowatt |
| kWh | Kilowatt-hour |
| LBNL | Lawrence Berkeley National Laboratories |
| LC | Load Control |
| MW | Megawatt |
| MWh | Megawatt-hour |
| NILM | Non-Intrusive Load Monitoring |
| OEC | Oklahoma Electric Coop |
| OIR | Order Instituting Rulemaking |
| PC | Personal Computer |
| PCT | Programmable Communicating Thermostat |
| PEV | Plug-in Electric Vehicle |

| Acronym | Definition |
|---|---|
| PG&E | Pacific Gas & Electric |
| PGS | Potential and Goals Study |
| PTR | Peak Time Rebate |
| PVRR | Present Value of Revenue Requirement |
| REA | Residential Energy Advisor |
| REN | Regional Energy Network |
| RD&D | Research, Development & Demonstration |
| SCE | Southern California Edison |
| SCG | Southern California Gas |
| SDG&E | San Diego Gas & Electric |
| SDP | Summer Discount Plan |
| SG | Smart Grid |
| SGDP | Smart Grid Deployment Plan |
| SMB | Small and Medium Business |
| T&D | Transmission & Distribution |
| TOU | Time-of-Use |

# Appendix B. Detailed Evaluation Methods

## Summary of Research Goals

Table 1 provides an overview of the research goals and tasks associated with the effort.

**Table 1: Overview of Research Goals, Tasks & Approach**

| Goal | Tasks | Research Question |
|---|---|---|
| 1. Document Smart Meter Business Case Decisions & Progress To Date | A. Describe Smart Meter business case Decisions and relevant EE conservation and DR costs and benefit assumptions. | How many feedback-based EE conservation savings were previously reflected in the EE Potential and Goals Study? How many Smart Meter business cases should be added as future EE residential behavior potential? |
| | B. Summarize current California IOU, third party (IOU) EE, HAN and DR behavior pilots and describe IOU progress to date implementing Smart Meter Decisions and realizing projected residential EE and DR benefits. | What types of EE, DR, HAN, ETP pilots are operating in California? What are their key elements and results? Are the IOUs on track with Smart Meter implementation and seeing the projected results? Have the anticipated benefits been realized, if not, how much has been? |
| 2. Document Market of Residential Behavioral Programs | A. Augment IOU findings by summarizing current California third party (non-IOUs) and U.S. residential EE, HAN and DR behavior pilots to help identify potential future program options. | Across the U.S., what types of EE, DR, HAN, ETP pilots and services are operating? What are their key elements and results? What is the range of demonstrated savings for different behavior program approaches or 3rd party services? Are there similar non-California efforts that could be used to project behavior savings potential in California? What are the barriers and trends in market? |
| 3. Integrated Analysis & Guidance | A. Identify barriers, gaps and opportunities for the known 3rd party and IOU EE/DR behavior pilots | Of the IOU existing behavior EE and DR pilots, which of the market and behavior program categories identified in the behavior whitepaper are represented? Is there a prioritization of behaviors to target? If so, which behaviors are most important? Has access for companies to participate in the EE programs improved? Are there program /pilot opportunities based on research of third party/U.S. market? |
| | B. Given above, how might the CPUC structure guidance to optimize EE/DR behavior programs and development of 3rd party market in CA? | Provide guidance that:<br>• Maximizes cost effective behavior savings<br>• Optimizes opportunities with Smart Meter data<br>• Does not re-fund activities or count savings funded already<br>• Provides for competition and innovation<br>• Adjusts for potential future residential rate increases / growth in behavioral programs |

## Summary of Evaluation Methods

Opinion Dynamics performed six distinct tasks within this study, shown in Table 2.

**Table 2: Energy Efficiency and Demand Response Behavior Market Characterization Evaluation Tasks**

| Evaluation Task | Description |
|---|---|
| Exploratory with IOU and CPUC staff | Conducted seven interviews with CPUC experts and staff at three California IOUs (Pacific Gas & Electric (PG&E), Southern California Edison (SCE), and San Diego Gas & Electric (SDG&E) to discuss residential behavior efforts offered by the California IOUs, to understand the CPUC/IOUs' perspectives on the performance of residential behavior programs to date, and to highlight potential opportunities for new types of programs in the California residential behavior market. We conducted the interviews in Q3 2014–Q1 2015. |
| Document Smart Meter Business Case Decisions | Used secondary research (reviewed 28 documents) and four interviews with CPUC staff to document the AMI projects that have been approved by the CPUC, progress to date, how the IOUs calculate the EE and DR benefits from their AMI projects, and the status of Green Button Connect (GBC).[1] We conducted the secondary data review and interviews in Q3–Q4 2014. |
| Summarize Current California Residential Behavior Feedback Efforts | Used secondary research (reviewed more than 100 documents and websites), interviews with seven IOU and CPUC staff, and data requests to IOUs to develop a list of 95 California behavior programs/pilots ("efforts"); used this data to summarize IOU progress to date. We conducted the secondary data review and interviews in Q4 2014–Q1 2015. |
| Summarize Utility Behavior Efforts Outside of California | Used secondary research (reviewed 53 documents) to compile a list of 38 residential behavior feedback efforts in other parts of North America; used to understand the market outside of California and to identify potential gaps in California's IOU program offerings. We conducted the secondary data review in Q1 2015. |
| Vendor Interviews | Developed a list of 38 companies and organizations ("vendors") other than IOUs that offer services or technologies in California that use the behavior interventions we explored in this study; includes vendors that are affiliated or not affiliated with the California IOUs; conducted interviews with 16 vendors to better understand their products/services, barriers to participating in the California behavior market, and potential interventions from the CPUC or IOUs. We conducted the secondary data review and interviews in Q1 2015. |
| Subject Matter Expert Interviews | Conducted in-depth interviews with five experts in behavior energy efficiency to support our analysis of market trends and to assist in our identification of comparable efforts outside of California. We conducted the interviews in Q1 2015. |

We provide detailed descriptions of our approach below.

## Exploratory Depth Interviews with IOU and CPUC Staff

Between July and September 2014, the Team conducted three depth interviews with staff at the IOUs (one each for PG&E, SCE and SDG&E) and two interviews with four staff at the CPUC. The purpose of these interviews were three-fold:

1) Confirm that our current list of residential behavioral programs and pilots offered by the California IOUs is complete; if not, identify which are missing

[1] GBC is an offshoot of the GB initiative that provides utility customers the ability to automate the secure transfer of their energy usage data to an authorized third party.

2) Discuss smart meter project progress to date, smart meter energy efficiency/demand response (EE/DR) benefits calculations, and how these savings relate to the CA Energy Efficiency Potentials and Goals Study (PGS)

3) Discover additional secondary resources that can be leveraged for Objective 1 tasks and identify contacts at each of the IOUs regarding residential behavioral programs and pilots.

### Document Smart Meter Business Case Decisions

The Team conducted secondary research and leveraged information from the exploratory depth interviews with the CPUC (please refer to 0 above) to document the IOU Smart Meter/Advanced Metering Infrastructure (AMI) projects have been approved by the CPUC. Specifically, this research task sought to address the following research questions:

- What IOU AMI projects have been approved by the CPUC? What were their funding amounts and what were the projected costs and benefits of the projects? Is there any overlap between energy efficiency (EE) funding and AMI funding?
- How do the IOUs calculate the EE and DR benefits from their AMI projects? What assumptions are used? In what ways are they consistent or different across the IOUS? How does the AMI methodology compare to methods for estimating benefits from EE pilots?
- What is the status of Green Button Connect?
- Do the projected EE savings for AMI projects contribute to the current EE savings goals set forth in the Energy Efficiency Potential and Goals Study?[2] Should the projected savings be considered as separate or alternative savings goals?

To answer these questions, we reviewed a number of CPUC proceedings, business case studies, annual reports and other documentation. For a full listing of the documentation we reviewed for this effort, please refer to the Smart Grid Decision Review Memo embedded in Volume II, Appendix F.

### Summarize Current California IOU EE, HAN and DR Behavior Pilots

The Team used secondary research, the exploratory interviews with IOU and CPUC staff (please refer to 0 above), and a data request to the IOUs to develop a listing of California behavioral pilots and programs in California. The final count of programs was limited to those offerings that fall into the scope of the study, and to those that occurred in 2013.

Our final list includes 95 unique offerings in California: 86 from the IOUs, nine from select municipal utilities, and one from the Bay Area Regional Energy Network (BayREN). We opted to include a selection of ratepayer funded offerings, as well as municipal offerings, for the purposes of providing a more thorough picture of offerings available to California residential customers through their utilities. We also opted to include the BayREN, as it is a CPUC-funded program administrator (though technically independent of the IOUs). For each of these offerings we collected, where available, a description of the pilot, 2013 participation, budget, expenditures and savings data, and other program performance and descriptive information. Using this data, we categorized the offerings both in terms of program

[2] Navigant Consulting, Inc. November 2013. 2013 California Energy Efficiency Potential and Goals Study.

type (i.e., HAN, Home Energy Reports, Green Button) as well as behavioral interventions developed in the IOU-commissioned white paper "Paving the Way for a Richer Mix of Residential Behavioral Programs".[3]

### Summarize IOU EE, HAN and DR Behavior Pilots Outside of California

The Team performed a review of residential behavioral feedback programs and plots throughout North America, to summarize market trends outside of California and identify potential gaps in what California's IOUs offer. Through secondary research, the Team identified 38 efforts that fell within the scope of our study, and served as a comparison for California's IOU behavioral programs. Our list captures a snapshot of the types of residential feedback programs offered in North America, and does not provide a representative sample of the entire residential feedback market.

Our research was informed by interviews with subject matter experts, described in detail in section 0 below, and through our initial review of the programs offered by the California IOUs. The Team compiled our final list of programs primarily by searching through past evaluation reports, other studies that have been conducted in this space, and other resources that highlight the different types of residential feedback programs that utilities have deployed. Our team's secondary research focused on finding efforts comparable in scale to those offered by California's IOUs, and with adequate information to make comparisons across program type and intervention strategy. Additionally, this review focused on the most recent efforts available, in an effort to capture what is happening at the forefront of residential behavioral demand-side programing.

### Vendor Interviews

Through secondary research, we developed a list of 38 offerings by companies and organizations that provide technologies or services that fall within the scope of this study. After developing this list, we conducted interviews from November 2014 through January with 16 vendors. The purpose of these interviews was to understand their products/services, barriers to participating in the CA behavioral market, and potential interventions from the CPUC or IOUs that could help vendors participate in the California market. While we used a census approach for this effort, attempting to reach out to all vendors in our sample, we prioritized certain categories of vendors. Table 3 below presents our goals and number of completes by these categories for this effort.

**Table 3: Characteristics Vendor Interviews**

| Vendor | Target Number of Completes | Number of Interviews Completed* | Fielding Approach |
|---|---|---|---|
| Affiliated with IOU residential behavioral feedback program | 6-10 | 5 | Census Attempt |
| Offers applications for Green Button Connect | 4-6 | 8 | |
| Offers gaming services | 2-4 | 1 | |
| Other non-IOU-affiliated vendors | No goal | 6 | |
| **Total** | **12-15** | **16** | |
| *Vendors may belong to multiple categories | | | |

[3] P. Ignelzi, et al. May 2013. "Paving the Way for a Richer Mix of Residential Behavior Programs". CALMAC ID: SCE0334.01

### Subject Matter Expert Interviews

In addition to a review of secondary sources, compiling our list of residential feedback programs outside of California was informed by in-depth interviews with experts in the field. The four experts interviewed interact with behavioral energy efficiency and demand response programs in a variety of ways; coming from national laboratories, research institutes, third-party implementers, and industry groups. Our team sought out this group given their expertise and range of unique perspectives on the direction of the residential feedback market. Our discussions with these experts assisted our team in identifying programs for comparison with California's IOU offerings. These interviews also aided our team in focusing our search on specific types of programs.

## Data Cleaning and Assumptions

In Table 4 below, we describe our approach to developing the database of residential behavioral feedback programs that we have provided as a supplement to this study. Where applicable, we list the assumptions made to develop the variables included in that database.

**Table 4: Data Cleaning and Assumptions**

| Variable | Description of Cleaning and Assumption |
|---|---|
| **ODC ID** | ID unique to each row captured in the database created by Opinion Dynamics |
| **Program ID** | ID that is specific to each overarching program (where applicable) created by Opinion Dynamics. This ID is not unique in cases where we have separated different offerings for a single pilot or program. For example, we identified several sub-activities of PG&E's Residential Energy Advisor Program. All sub-activities have the same Program ID, but unique ODCIDs. |
| **IOU ID** | Where applicable, program identifier created by CA IOUs |
| **AMI Enabled (Y/N)** | A "Y" means program documentation explicitly mentioned that the program was made possible through the installation of a smart meter or leverages smart meter data. |
| **Funding Source** | Combination of funding information from Smart Grid Annual reports and other sources. Entries for projects within the Smart grid Annual Reports typically identified the funding source. When information was found on EE stats website, it was considered EE funding. When program was found in DR monthly reports it was considered DR funded. Programs with an ETP ID, found in the ETP database, were considered funded through ETP. Non-IOU funded programs are either municipal programs or REN. For programs marked as funding source "other," we were either unable to find funding source information or we found less common funding sources (i.e. GRC or shareholder funds) |
| **Program Administrator** | This refers to either the IOU, the municipal utility, or other entity responsible for the program's design and administration, not necessarily its implementation. |
| **Program Name** | This is the program name as defined by the administrator, and is not always the customer facing name. |
| **Description** | Descriptions were generally taken verbatim from PIP, DR funding decisions, the ETP database, Smart Grid Annual Reports, or another secondary source. In some cases, Opinion Dynamics paraphrased to include relevant and important information about the specific program. |
| **Implementer** | This generally refers to the organization responsible for delivering service. Where blank, the implementer is the program administrator. |
| **Case Study** | Indicates if the program is referred to in the report in the case study section. |
| **Pilot?** | Similar to AMI enabled, if there was explicit evidence in the source that it was a pilot program it is marked as "Y". |

| Variable | Description of Cleaning and Assumption |
|---|---|
| **Savings Reported as DR** | This variable notes when energy impact information is reported as a percent of consumption reduced over a specific period of time (i.e. use reduced over a peak period) |
| **Program Year** | The year to which the information captured in this sheet refers |
| **Beginning Year** | The year of the offering's inception |
| **Opt-In/Opt-Out Model** | We made our best estimate based on offering design/materials reviewed. In some cases we looked at website enrollment information to determine whether customers were required to sign-up (suggesting the offering was opt-in). If the materials we reviewed did not make it explicitly clear that an offering was opt-out, we assumed it was opt-in. In some cases, such as research studies, this categorization is not applicable (marked as "n/a"). |
| **Impact Data** | Impact information was pulled from a variety of sources--such as, evaluation reports, annual reports, monthly reports, IOU data requests, case studies, websites, and third-party studies of specific types of behavioral programs. Information was reported in a variety of forms and our team reported information as it was presented. As such, columns were added throughout the project to capture all of the different ways that impacts were reported. Information listed as "part of..." meant that data was rolled up in another overarching program and our team was unable to separate by individual activity. When information is listed as "not tracked" it was not explicitly collected and reported in the sources referenced. Information listed as "n/a" typically meant that a certain field was not relevant to that program, and information listed as "not found" was not available in any of the sources referenced for this review |
| **Program Type and Technology Offered** | We based these variables on secondary information and made reasonable assumptions, when appropriate, about the nature of the program and our staff's knowledge of residential behavior feedback programs. Where a certain technology or other type of offering was explicitly mentioned in the secondary literature, it was flagged as such. |
| **Intervention Strategies** | Similar to the program type and technology offered category, we leveraged secondary literature and in-house knowledge on feedback-based intervention strategies to make reasonable assumptions about which strategies were leveraged by each program. In addition, our team referenced the program-specific sources, such as PIPs, to inform our understanding of which intervention strategies were employed. See Appendix E for a complete list of secondary sources |

## Definitions of Product Offerings

We categorized each of the 95 California efforts according to the type of product or information they offer. Table 5 provides a definition for each product offering.

**Table 5: Overview of Product Offerings**

| Product Offering | Definition | Examples |
|---|---|---|
| DR | Demand Response; attempts to shift customers' usage away from peak hours and days, in some cases, by providing different rates for higher and lower-use periods; also includes signaling to in-home devices (such as thermostats and IHDs) during demand response events | SCE Peak Time Rebate (aka Save Power Day) |
| HAN | Pilots or studies exploring technologies that offer connectivity to other energy-using appliances in the home; includes automation | PG&E HAN Enablement Program |
| Prepay | Opt-in programs that allow participants to pay for their energy before they use it; typically paired with a web-platform, or | DTE SmartCurrents |

| Product Offering | Definition | Examples |
|---|---|---|
| | other feedback device, that allows customers to track their energy use | |
| In-home display | Displays that provide customers with information on energy use or cost; some IHDs also provide tips and other messaging | SDG&E Reduce Your Use IHD Pilot |
| Green Button | Refers to each IOUs Green Button/Green Button Connect roll-out efforts; also refers to any offerings that include technologies that use GBC | SDG&E Green Button Connect My Data |
| Reports | Provide home energy report (electronic or paper) with peer comparisons | PG&E Home Energy Reports |
| Game-Based | Provides feedback via computer or mobile phone games; that incorporate competitions or challenges designed to reduce participants' energy consumption | SCE Game Based Energy Efficiency Programs |
| Thermostat | Programs, pilots, or studies exploring PCTs or smart thermostats | SCG Advanced Thermostat Scaled Field Testing with EPRI |
| Analysis/ Self-Audit Tool/Survey | A web or mobile tool for analyzing energy use and providing feedback or energy savings tips | SCE Home Energy Advisor (Universal Audit Tools) |
| Electric Vehicles | Projects that support sub-metering and time-of-use rates for electric vehicle charging | Statewide Plug-in Electric Vehicle Submetering Pilot |
| Alerts | Send messaging to customers that alerts them of peak periods, DR events, or if they are approaching a billing tier. | PG&E Energy Alerts |

# Appendix C. Research Questions

In this appendix , we provide answers to the study research questions, or refer to the relevant sections of Volume I of the report.

| ***Goal 1a: Document Smart Meter Business Case Decisions Progress to Date*** |
|---|
| **What IOU Smart Meter/AMI projects have been approved by the CPUC?**<br>Please refer to Volume I, Chapter 3: Background on Building a Smart Grid and Using It to Provide Customer Feedback |
| **What were their funding amounts and what were the projected costs and benefits of the projects?**<br>Please refer to Volume I, Chapter 3: Background on Building a Smart Grid and Using It to Provide Customer Feedback. |
| **Is there any overlap between EE funding and Smart Meter/AMI funding?**<br>Please refer to the Smart Grid Decision Review Memo embedded in Volume II, Appendix F |
| **How do the IOUs calculate the EE and DR benefits from their Smart Meter/AMI projects? What assumptions are used?**<br>Please refer to the Smart Grid Decision Review Memo embedded in Volume II, Appendix F |
| **In what ways are they consistent or different across the IOUS?**<br>Please refer to the Smart Grid Decision Review Memo embedded in Volume II, Appendix F |
| **How does the Smart Meter/AMI methodology compare to methods for estimating benefits from energy efficiency pilots?**<br>Please refer to the Smart Grid Decision Review Memo embedded in Volume II, Appendix F |
| **Do the projected EE savings contribute to the current EE savings goals set forth in the Energy Efficiency Potential and Goals Study?**<br>Please refer to Volume I, Chapter 3.3: Realizing Engagement Benefits |
| **Should the projected savings be considered as separate or alternative savings goals?**<br>Please refer to Volume I, Chapter 3.3: Realizing Engagement Benefits |
| **What is the status of Green Button Connect?**<br>Please refer to the Smart Grid Decision Review Memo embedded in Volume II, Appendix F |
| **Are the IOUs on track with Smart Meter implementation and seeing the projected results?**<br>Overall, our team found it difficult to determine how the residential feedback efforts are contributing to California's EE, DR, and GHG reductions goals. This was primarily due to a paucity of data that limited our ability to draw conclusions about the relative benefits and costs of these efforts. |
| **What progress have the IOUs made in implementing these Smart Meter/AMI projects?**<br>While our review is not comprehensive due to the data limitations mentioned above, please refer to Volume I, Chapter 3.3: Realizing Engagement Benefits |
| **Have the anticipated benefits (energy savings, reduced costs, etc.) for 2013-14 been realized, if not how much has been?**<br>Overall, our team found it difficult to determine how the residential feedback efforts are contributing to California's EE, DR, and GHG reductions goals. This was primarily due to a paucity of data that limited our ability to draw conclusions about the relative benefits and costs of these efforts. |
| **Have there been labor/operational cost savings from remote disconnection of meters and eliminating meter reader positions?**<br>We did not answer this research question at the direction of the CPUC. |

| *Goal 1b: Document IOU Offering Progress To-Date* |
|---|
| **What IOU EE, DR, HAN, and Emerging Technology Program (ETP) behavioral pilots exist in the California residential market?**<br>Please refer to Volume I, Chapter 4: California Residential Behavior Feedback Efforts. Please also refer to our Behavioral Master List embedded in Volume II, Appendix F. |
| **Who implements them (i.e. vendors) and what types of services do these pilots offer?**<br>Please refer to Volume I, Chapter 4: California Residential Behavior Feedback Efforts. Please also refer to our Behavioral Master List embedded in Volume II, Appendix F. |
| **How are these pilots marketed to raise customer awareness of behavioral pilots?**<br>We were unable to determine how these pilots were marketed due to limited data available. |
| **What intervention strategies are used by these programs/pilots?**<br>Please refer to Volume I, Chapter 4: California Residential Behavior Feedback Efforts. Please also refer to our Behavioral Master List embedded in Volume II, Appendix F. |
| **How are the IOU Behavioral Pilots performing to date?**<br>Please refer to Volume I, Chapter 4: California Residential Behavior Feedback Efforts. Please also refer to our Behavioral Master List embedded in Volume II, Appendix F. |

| *Goal 2: Characterize the Market of Residential Behavioral Programs Beyond the IOU Programs* |
|---|
| **What third party (non-IOU) EE, DR, HAN, ET, and Smart Appliances behavioral pilots/programs ("Third Party Behavioral Programs") exist in the California residential market?**<br>Please refer to Volume I, Chapter 7: Fostering a Competitive Marketplace. Please also refer to our list of vendors reviewed in Volume II, Appendix E. |
| **Who implements them (i.e. vendors) and what types of services do these programs offer?**<br>Please refer to Volume I, Chapter 7: Fostering a Competitive Marketplace. |
| **Do vendors of these programs also participate in IOU Behavioral Pilots?**<br>Please refer to Volume I, Chapter 7: Fostering a Competitive Marketplace. |
| **How are the IOU Third Party Programs performing to date?**<br>Please refer to Volume I, Chapter 7: Fostering a Competitive Marketplace. |
| **Are there similar non-California pilots/programs that could be used to project behavior savings potential in California?**<br>Please refer to Volume I, Chapter 6: National Residential Behavior Feedback Efforts |
| **From the viewpoint of third-party implementers, what are the barriers and trends in the residential behavioral program market?**<br>Please refer to Volume I, Chapter 7: Fostering a Competitive Marketplace. |

| *Goal 2b: How are the non- IOU US programs performing to date?* |
|---|
| **How many customers have participated to date in the pilots (and if available participation propensity based on opt-in or opt-out model)** |

| *Goal 2b: How are the non- IOU US programs performing to date?* |
|---|
| Please refer to Volume I, Chapter 6: National Residential Behavior Feedback Efforts. Please also refer to our Behavioral Master List embedded in Volume II, Appendix F. |

| *Goal 3: Identify Opportunities to Develop Improved Interventions* |
|---|
| **What are the barriers, gaps and opportunities for the known third party and IOU EE/ DR behavior pilots?**<br>Please refer to Volume I, Chapter 7: Fostering a Competitive Marketplace. |
| **Based on the behavioral framework described in "Paving the Way for a Richer Mix of Behavioral Programs," what types of behavior program categories are represented by California offerings and which are not?**<br>Please refer to Volume I, Chapter 4: California Residential Behavior Feedback Efforts. |
| **How much potential energy/demand savings could be realized by addressing these gaps in the residential behavioral market?**<br>Please refer to Volume I, Chapter 4: California Residential Behavior Feedback Efforts. |
| **Should programs that encourage certain types of behavior be prioritized? If so, which behaviors are "most important" either based on their ability to obtain durable savings or have substantial program adoption?**<br>The Team did not have enough information available to answer this question. However, please refer to our recommendations on improved data tracking in Volume I, Chapter 8: Realizing AMI Investments and Guiding Future Behavior Efforts. |
| **Do firms interested in participating in the residential behavioral market still face barriers? If so, what?**<br>Please refer to Volume I, Chapter 7: Fostering a Competitive Marketplace. |
| **Describe the status of Green Button Connect (and any obstacles faced regarding connectivity or validation issues for third-party market)**<br>Please refer to Volume I, Chapter 7: Fostering a Competitive Marketplace. |
| **Describe technical difficulties (such as hooking up aggregation services with the IOUs)**<br>Please refer to Volume I, Chapter 7: Fostering a Competitive Marketplace. |
| **Describe current reception and ease of participating in HAN enabled California-based third party programs**<br>We did not answer this research question at the direction of the CPUC. |
| **Describe possible IOU obstacles to future growth in third party HAN market**<br>We did not answer this research question at the direction of the CPUC. |
| **Determine vendor access to EE programs**<br>Please refer to Volume I, Chapter 7: Fostering a Competitive Marketplace. |
| **Considering these gaps and opportunities, how can the CPUC guide IOUs and third party program implementers?**<br>Please refer to our detailed recommendations in Volume I, Chapter 8: Realizing AMI Investments and Guiding Future Behavior Efforts. |
| **How can the CPUC maximize cost effective behavior savings – including prioritizing certain target behaviors/intervention over others?**<br>Please refer to our detailed recommendations in Volume I, Chapter 8: Realizing AMI Investments and Guiding Future Behavior Efforts. |
| **How can the CPUC leverage new Smart Meter interval data to augment their behavioral programs?** |

| *Goal 3: Identify Opportunities to Develop Improved Interventions* |
|---|
| Please refer to our detailed recommendations in Volume I, Chapter 8: Realizing AMI Investments and Guiding Future Behavior Efforts. |
| **How can the CPUC ensure that savings for behavioral programs that leverage smart meter interval data are not double-counting savings already counted in the Smart Meter Decisions**<br>Please refer to our detailed recommendations in Volume I, Chapter 8: Realizing AMI Investments and Guiding Future Behavior Efforts. |
| **How can the CPUC provide competition and innovation in the residential behavioral program market?**<br>Please refer to our detailed recommendations in Volume I, Chapter 8: Realizing AMI Investments and Guiding Future Behavior Efforts. |
| **How can the CPUC adjust for potential future residential rate increases/growth in behavioral programs?**<br>We did not answer this research question at the direction of the CPUC. |

# Appendix D. Additional Data to Support Findings on AMI Status

In this appendix, we highlight several tables and data sources for our findings on the status of AMI. Many of the tables in this appendix originally appeared in the Smart Grid Decision Review Memo embedded in Volume II, Appendix F.

## Summary of AMI and SG Decisions

This attachment provides supporting data for the findings presented in the memo. Specifically, we reviewed the eight CPUC documents shown in Table 6. These included the initial Decisions approving funding for each of the four California IOUs' Advanced Metering Infrastructure (AMI; i.e., smart meter) projects, as well as Rulings and Decisions adopting frameworks for cost-effectiveness analysis and metrics for measuring the success of these projects.

**Table 6: Smart Meter Business Case Decisions and Other Documents Reviewed**

| Phase | Proceeding Number | IOU/Org | Decision/Report Date | Title | Purpose of Document |
|---|---|---|---|---|---|
| AMI Deployment | R. 02-06-001 | | July 2004 | Ruling Adopting a Business Case Analysis Framework for Advanced Metering Infrastructure | Establishes an analysis framework for estimating the costs/benefits of AMI projects |
| AMI Deployment | Filed in Compliance with R.02-06-001 | | January 2005 | Advanced Metering Infrastructure Revised Preliminary Business Case Analysis – Volumes 1 through 4 | Business case analysis of SCE's AMI project |
| AMI Deployment | Filed in Compliance with R.02-06-001 | SDGE | January 2005 | Advanced Metering Infrastructure AMI Business Case Supplemental Filing | Business case analysis of SDG&E's AMI project |
| AMI Deployment | Filed in Compliance with R.02-06-001 | PG&E | March 2005 | Updated Preliminary AMI Business Case Analysis of PG&E, U-39E, March 15, 2005 | Business case analysis of PG&E's AMI project |
| AMI Deployment | D. 06-07-027 | PG&E | July 2006 | Final Opinion Authorizing Pacific Gas and Electric Company to Deploy Advanced Metering Infrastructure | Approves PG&E's AMI project |
| AMI Deployment | A. 05-03-015 | SDGE | February 2007 | Settlement Agreement Regarding San Diego Gas & Electric Company's Advanced Metering Infrastructure Application | Settlement Agreement revising SDG&E's AMI business case |
| AMI Deployment | D. 07-04-043 | SDGE | April 2007 | Opinion Approving Settlement on San Diego Gas & Electric Company's Advanced | Approves SDG&E's AMI project |

| Phase | Proceeding Number | IOU/Org | Decision/Report Date | Title | Purpose of Document |
|---|---|---|---|---|---|
| | | | | Metering Infrastructure Project | |
| AMI Deployment | A. 07-07-026 | | July 2007 | Edison SmartConnect Deployment Funding and Cost Recovery: Exhibit 3: Financial Assessment and Cost Benefit Analysis | Presents the financial assessment and cost benefit analysis of SCE's AMI project |
| AMI Deployment | A. 07-07-026 | | July 2007 | Application for Approval of Advanced Metering Deployment Activities -- Appendix A Settlement Agreement | Settlement Agreement revising SCE's AMI business case |
| AMI Deployment | D. 08-09-039 | | September 2008 | Decision Approving Settlement on Southern California Edison Company Advanced Metering Infrastructure Deployment | Approves SCE's AMI project |
| AMI Deployment | R. 08-12-009 | | December 2008 | OIR to Consider Smart Grid Technologies Pursuant to Federal Legislation and on the Commission's own Motion to Actively Guide Policy in California's Development of the Smart Grid System | Initiates proceeding to consider strategies for IOUs to enhance the ability of the electric grid to support California's energy-related policy goals |
| AMI Deployment | D. 09-03-026 | PG&E | March 2009 | Decision On Pacific Gas And Electric Company's Proposed Upgrade to The Smartmeter Program | Approves additional funding to PG&E's AMI program |
| AMI Deployment | D. 10-04-027 | Southern California Gas Company | April 2010 | Decision on Application of Southern California Gas Company for Approval of Advanced Metering Infrastructure | Approves SCG's AMI project |
| Smart Grid Development | D. 10-06-047 | | June 2010 | Decision Adopting Requirements for Smart Grid Deployment Plans Pursuant to Senate Bill 17 (Padilla), Chapter 327, Statutes of 2009 | Outlines the information that must be provided in Smart Grid Annual Reports |
| Smart Grid Development | Filed in compliance with R. 08-12-009 | PG&E | June 2011 | PG&E's Smart Grid Deployment Plan | Comprehensive description of smart grid deployment strategy |
| Smart Grid Development | Filed in compliance | SDG&E | June 2011 | SDG&E's Smart Grid Deployment Plan 2011-2020 | Comprehensive description of smart grid deployment strategy |

| Phase | Proceeding Number | IOU/Org | Decision/Report Date | Title | Purpose of Document |
|---|---|---|---|---|---|
| | with R. 08-12-009 | | | | |
| Smart Grid Development | Filed in compliance with R. 08-12-009 | SCE | July 2011 | SCE's Application for Approval of Smart Grid Deployment Plan | Comprehensive description of smart grid deployment strategy |
| Smart Grid Development | D. 11-07-056 | CPUC | July 2011 | Decision Adopting Rules to Protect the Privacy and Security of the Electricity Usage Data of the Customers of PG&E, SCE, and SDG&E | Adopts rules for IOUs and third parties regarding the privacy and security of customer usage data; orders IOUs to make CAISO wholesale price information available to customers |
| Smart Grid Development | n/a | CPUC | December 2011 | CPUC 2011 Smart Grid Report | Annual update on the status of the California smart grid |
| Smart Grid Development | D. 12-04-025 | CPUC | April 2012 | Decision Adopting Metrics to Measure the Smart Grid Deployments of Pacific Gas and Electric Company, Southern California Edison Company and San Diego Gas & Electric Company | Adopts the metrics for measuring the progress of PG&E, SCE and SDG&E smart meter projects |
| Smart Grid Development | n/a | PG&E | October 2012 | PG&E's Smart Grid Annual Report | Annual update on AMI-enabled pilots and programs |
| Smart Grid Development | n/a | SCE | October 2012 | SCE Annual Update – Smart Grid | Annual update on AMI-enabled pilots and programs |
| Smart Grid Development | n/a | SDG&E | October 2012 | SDG&E Smart Grid Deployment Plan Annual Report | Annual update on AMI-enabled pilots and programs |
| Smart Grid Development | n/a | PG&E | April 2013 | 2012 Program Year Smart Meter Program Enabled Demand Response and Energy Conservation Annual Report | Report on demand response, energy efficiency, and other financial benefits from 2012 AMI-enabled programs |
| Smart Grid Development | n/a | PG&E | October 2013 | PG&E's Smart Grid Annual Report | Annual update on AMI-enabled pilots and programs |
| Smart Grid Development | n/a | SCE | October 2013 | SCE Annual Update – Smart Grid | Annual update on AMI-enabled pilots and programs |
| Smart Grid Development | n/a | CPUC | May 2014 | Annual Report to the Governor and the Legislature, California Smart Grid | Annual update on the status of the California smart grid |
| Smart Grid Development | n/a | SDG&E | October 2013 | SDG&E Smart Grid Deployment Plan Annual Report | Annual update on AMI-enabled pilots and programs |

## Costs and Benefits of AMI Deployment Business Case Decisions

The table below present the final budget allotments approved by the CPUC for each of the IOUs.

**Table 7: Approved Phase 1: Building AMI Infrastructure Budgets, by IOU**

| IOU | Budget (millions) |
|---|---|
| PG&E[1] | $2,256.6 |
| SCE | $1,633.5 |
| SDG&E | $1,050.7 |
| SCG | $572.0 |
| (1) Includes initial budget of $1,684.6 plus an additional $572 approved later for AMI upgrades | |

The IOUs estimate costs and benefits for AMI projects in 2004 present value revenue requirement (PVRR). The table below presents estimated savings for each of the IOUs' projects.

**Table 8: Potential Costs and Benefits Phase 1: Building AMI Infrastructure, by IOU**

| IOU | Estimated Cost (PVRR millions) | Estimated Benefits (PVRR millions) | Net Benefits (Benefits-Cost) (PVRR millions) | Estimated Benefits to Cost (B/C) Ratio |
|---|---|---|---|---|
| PG&E | $2,258 | $2,258 [1] | $0[1] | 1.00[1] |
| SCE | $1,981 | $1,990 | Between $9 and $304[3] | Between 1.00 and 1.11[2] |
| SCG | $1,040 | $1,067 | $27 | 1.03 |
| SDG&E | $652 | Between $692 and $703 | Between $40 and $51 | Between 1.06 and 1.08[2] |

(1) Number are assumed based on our review; in D. 06-07-027, the CPUC agreed that 90% of the project cost would be recouped in operation benefits, with the remaining 10% recouped with demand response benefits
(2) Calculated by the Team
(3) $9 million is without societal benefits; $304 is inclusive of $295 in societal benefits

## Costs and Benefits Associated with AMI-enabled Customer Empowerment and Engagement Projects

**Table 9: Costs and Benefits of Customer Empowerment and Engagement Projects in AMI Deployment Business Case Decisions**

| Document | IOU | Customer Engagement Project C/B Item | Cost Amount (Million $)* | Benefit Amount (Million $)* | Decision Page |
|---|---|---|---|---|---|
| D.06-07-027 | PG&E | No relevant projects associated with this Decision | No associated costs | No associated benefits | n/a |
| D.09-03-026 | PG&E | HAN Retrofits | $25 | No associated benefits | 151-152 |
| | | IT | $50 | No associated benefits | 151-152 |
| | | EE Conservation | No associated costs | $ 269 | 151- 152 |
| | | PTR | $28 | $ 263 | 151-152 |
| | | PCT | $26 | $83 | 180, 193 |
| | | A/C Cycling | No associated costs | $129 | 24 |
| D.08-09-039 (Settlement Agreement) | SCE | Near Real Time Technology/SCE Web Portal | $4 | $164 | 7, A-1 |
| | | PCT | $58 | $32 | 11, B-2 |
| D.07-04-043 | SDG&E | DR | No associated costs | $33 | 70 |
| | | PCT | No associated costs | $13 to 24 | 73 |
| | | Information Feedback | No associated costs | $19 | 70 |
| **Total Costs and Benefits** | | | **$191** | **$1,005 to $1,016** | **n/a** |

*PG&E and SCE estimate costs and benefits in PVRR (discounted) terms. While it is likely that SDG&E also uses PVRR (per the AMI Deployment analysis framework stipulated by the CPUC), we could not confirm this with certainty.

**Table 10: Costs and Benefits of Customer Empowerment and Engagement Projects in Smart Grid Deployment Plans**

| Document | Customer Engagement Project C/B Item | Cost Amount (Nominal Million $) | Benefit Amount (Nominal Million $) | Plan Page |
|---|---|---|---|---|
| PG&E Smart Grid Deployment Plan | Integration of Enhanced DR Forecasting | $5-9 | Total customer engagement benefits ranged from $596 to $1,404* | 161, 176-177 |
| | Demand Response Optimization | $10-18 | | 161, 176-177 |
| | HAN Phase II -- Pricing and Load Control Signals | $27-51 | | 161, 176-177 |
| | Enable Access to Smart Meter data via Open Automated Data Exchange | $8-15 | | 161, 176-177 |
| SCE Smart Deployment Plan | Metering Capital Requirements (2nd Meter for PEV) | $11 | No associated benefits | 129 |
| | EE Conservation (HAN) | No associated costs | 250,000 MWh/year** | 129, 133 |
| | Dynamic Pricing | $33 | 370 additional MW/year** | 129, 132 |
| | Alerts and Notification Projects | $20 | No associated benefits | 129 |
| | PEV Support Systems | $8 | No associated benefits | 129 |

| Document | Customer Engagement Project C/B Item | Cost Amount (Nominal Million $) | Benefit Amount (Nominal Million $) | Plan Page |
|---|---|---|---|---|
| | HAN Support and Troubleshooting | $8 | No associated benefits | 129 |
| | SDP Transition | $27 | No associated benefits | 129 |
| | ALCS System Enhancements | $2 | No associated benefits | 129 |
| | Other Load Control System Enhancements | $3 | No associated benefits | 129 |
| | Smart Charging Plug-In Electric Vehicle Pilot | $1 | No associated benefits | 129 |
| | Workplace Charging Pilot | $1 | No associated benefits | 129 |
| | DR System Enhancements | $3 | No associated benefits | 129 |
| SDG&E Smart Grid Deployment Plan | Customer Empowerment Programs | $1.26-1.27 | $0.81 to $1.01 | 273, 303 |
| **Total Costs and Benefits** | | **$168 to $211** | **$597 to $1,405** | **n/a** |

Note: Across the SGDP's, cost and benefits are estimated in nominal (non-discounted) terms. However, estimates may not be comparable across IOUs given differing timeframes.

* Benefits were bundled with non-Customer Engagement projects, and thus these amounts may not reflect benefits solely attributable to Customer Engagement projects.

**Benefits were not quantified into monetary values. Benefits were also bundled, and thus may include benefits from non-Customer Engagement projects.

## Costs and Benefits Assumptions

In Table 11 below, we present the inputs used in benefits calculations for Phase 1: Building AMI, for each IOU.

**Table 11: Phase 1 Benefits Inputs to Benefits Calculations, by IOU**

| Assumptions | PG&E | SCE | SCG | SDG&E |
|---|---|---|---|---|
| **Assumptions for Benefit Calculations** | | | | |
| Benefits presented as 2004 present value dollars | ✓ | ✓ | ✓ | ✓ |
| Demand response savings based on weighted average of savings under average hot weather conditions | ✓ | ✓ | ✓ | ✓ |
| Discount rate=utility cost of capital | ✓ | ✓ | ✓ | ✓ |
| Avoided peak demand cost: $85/kW-year | ✓ | ✓ | ✓ | ✓ |
| Avoided energy cost: $63/MWh | ✓ | ✓ | ✓ | ✓ |
| Avoided capacity generation cost: $52/kW-year | ✓ | ✓ | ✓ | ✓ |
| 2006-2021 analysis period | ✓ | ✓ | ⬢ (1) | ✓ |
| Effective Useful Life (EUL) of AMI: 20 years | ✓ | ✓ | ✓ | ⬢ (2) |

**Legend:**

✓: Included
⬢: Included, but slightly different from other IOUs
×: Not included
Notes:
**(1)** SCG uses an analysis period of 2016-2034
**(2)** SDG&E uses a useful life value of 17 years

In Table 12 below, we present the types of costs included in determining the cost-effectiveness of Phase 2: Deploying Smart Grid Projects.

**Table 12: Phase 2 Costs, by IOUs**

| Type of Costs Included | PG&E | SCE | SDG&E |
|---|---|---|---|
| Asset Management, Safety and Operational Efficiency | ✓ | ✓ | ✓ |
| Customer Empowerment and Engagement | ✓ | ✓ | ✓ |
| Distribution Automation and Reliability | ✓ | ✓ | ✓ |
| Integrated and Cross-Cutting Systems | ✓ | ✓ | ✓ |
| Security | ✓ | ✓ | ✓ |
| Transmission Automation and Reliability | ✓ | ✓ | ✓ |
| **Legend:**<br>✓: Included<br>×: Not included<br><br>**Source:** May 2014. CPUC. Annual Report to the Governor and the Legislature, Smart Grid. | | | |

## List of Green Button Connect Applications Developed for California IOUs

**Table 13: Green Button Connect Applications Available in California as of August 2014**

| Third Party Application | IOU | Description | Web Link |
|---|---|---|---|
| Active Energy by Power TakeOff | SDGE | ■ Energy data analysis and reporting web-based application that allows customers to track their energy consumption | http://www.powertakeoff.com/ |
| Bidgely | SDGE | ■ Energy management application that monitors energy use of appliances in customers' homes and is capable of comparing energy usage between or among similar homes close to each other | https://www.bidgely.com/ |
| BuiltSpace | PG&E | ■ Provides detailed, up-to-date information on energy usage to customers | www.builtspace.com |
| EEme by EEme, LLC | SDGE | ■ Provides personalized energy-efficiency recommendations based on each customer's home profile through analyzing meter data | http://www.energyefficiency.me/ |
| EnACT (Beta) by enACT Systems, Inc | SDGE | ■ Free application that provides cost-saving energy solutions for customer homes | http://www.enact-systems.com/ |

| Third Party Application | IOU | Description | Web Link |
|---|---|---|---|
| Energy Independence Program - Action Plan Tool | PG&E | ■ An energy analysis tool that allows home owners to maximize cost savings, minimize carbon footprint, improve comfort and health conditions, and evaluate home projects through upgrade recommendations and energy saving tips | http://sonoma.planetecosystems.com/?url=action-plan |
| Energy Usage Management by IncentForce | SDGE | ■ Monitors and provides information to help customers understand their energy use and consumption costs, the application also alerts customers by email, mobile application or text messaging<br>■ Features a social energy application that encourages behavioral changes in energy consumption by promoting energy conservation as positive behavior that helps the community | http://www.incentforce.com/index.html |
| EnergyAI™ | SDGE | ■ Provides users with information on how to save energy by analyzing historical energy use data from meters and identifying usage patterns and abnormalities | http://www.energyai.com/EAIWeb/ |
| EnergyElastics by San Diego State University | SDGE | ■ Forecasts future energy consumption, predicted energy expenses and provides information on the best times to run household appliances | |
| EnergyHub | SDGE | ■ Cloud-based application that allows customers to monitor and manage their thermostat/s either within the home or remotely | http://www.energyhub.com/ |
| ERA CPP by Joule Assets, Inc. | SDGE | ■ Market analysis tool that performs billing analysis under current rate schedule and compares to bill under CPP rate schedule | http://www.jouleassets.com/joule-assets-openadr-partnership/ |
| Ergy by Echo Labs | SDGE | ■ Allows two-way communication between retail customers and energy products and analyzes data to enable customers to | http://www.echolabs.net/energy-management |

| Third Party Application | IOU | Description | Web Link |
|---|---|---|---|
| | | monitor and manage their resources more efficiently | |
| Gridium | PG&E | ■ Monthly subscription to smart meter data that provides non-residential customers with demand forecasting, fault detection, cost forecasting and variance analysis, performance tracking and energy savings calculations | http://www.gridium.com/. |
| Leafully | PG&E | ■ Monitors how customers use energy and sends information to customers on their energy usage weekly<br>■ Notifies customers of unusual energy usage behavior via alerts | https://leafully.com/ |
| MRPRO™ by Papro's, Inc | PG&E SDGE | ■ Gathers energy data allowing customers to track their energy usage, which can be used to control energy consumption and cost<br>■ Calculates carbon footprint | http://www.papros.com/ |
| PEV4Me by True Labs | PG&E SDGE | ■ Calculates the cost of electricity to charge electric vehicles and cost savings on gas | http://www.pev4me.com/ |
| PowerTools by Candi Controls | SDGE | ■ Application that allows customers to view energy usage data and provides energy saving tips | https://www.candicontrols.com/powertools.html |
| SCP™ - Smart Customer Portal by Smart Utility Systems | SDGE | ■ Application that provides customers tools and relevant information to manage individual energy needs | http://smartusys.com/smart-solutions/scp.aspx |
| Smart leak detector™ by PowWow Energy | SDGE | ■ Software for farmers and ranchers that monitors leaks in irrigation systems to minimize water loss, energy use and cost by tracking water pumps | https://www.powwowenergy.com/ |
| Stem | PG&E | ■ Cloud-based predictive software for non-residential customers that lowers energy bill by reducing peak loads, predicting patterns in energy use, and deploying stored energy at precise time periods | http://www.stem.com/ |

| Third Party Application | IOU | Description | Web Link |
|---|---|---|---|
| UnPlug Stuff by Home Energy Analytics | PG&E SDGE | ■ Informs residential customers with regard to how much energy is wasted when idle. | http://www.unplugstuff.com/pge.html |
| WeatherBug Home | SDGE | ■ Provides reliable information on home energy use as it correlates to weather data in real-time and predicts how much heating or cooling energy is needed in a timely manner to help customers save money and energy | http://weatherbughome.com/ |

## AMI Metrics

The table below describes the metrics tracked for AMI in the SGDPs.

**Table 14: AMI Metrics**

| Data Category | Type of Data Tracked |
|---|---|
| AMI Metrics | Percent of DR that is Auto-DR enabled |
| AMI Metrics | Meter functionality metrics (i.e., complaints, replacements, requested field tests) |
| AMI Metrics | MW peak load reduction from smart-meter enabled DR programs |
| AMI Metrics | Advanced meters with HAN or comparable devices |
| AMI Metrics | Customers on time-variant or dynamic pricing tariffs |
| AMI Metrics | Customers using a utility web-based portal to access energy usage information . |
| AMI Metrics | Customers using a utility web-based portal to enroll in energy information programs |
| AMI Metrics | Customers who have authorized utility to provide a third-party with energy usage data |
| AMI Metrics | MW and MWh per year of utility-owned or operated energy storage |
| AMI Metrics | System outage metrics |
| AMI Metrics | System load factor |
| AMI Metrics | Customer-owned distributed generation metrics |
| AMI Metrics | Distribution circuits equipped with automation or remote control equipment |
| **Sources:** Smart Grid Deployment Plan Updates | |

# Appendix E. Bibliography and Data Sources

In Table 15 below, we present the data sources used to develop the database of California residential behavioral offerings. In Table 16 we present the data forces for the other U.S. offerings. Please note that these sources represent data actually used to develop the database. Thus, these lists may not include some data sources we reviewed but ultimately did not use.

**Table 15: Data Sources for California Residential Behavioral Offerings**

| Category | Abridged Name | Estimated Number Reviewed |
|---|---|---|
| CPUC Proceedings/Documents | CPUC Decisions/Rulemakings | 13 |
| CPUC Proceedings/Documents | CPUC California Smart Grid Annual Reports | 2 |
| CPUC Proceedings/Documents | CPUC 2013-14 Residential Fact Sheet (March 2013) | 1 |
| IOU documentation | Demand Response Monthly Reports | 30 |
| IOU documentation | IOU Smart Grid Annual Updates | 9 |
| IOU documentation | CALSPREE Program Implementation Plans | 8 |
| IOU documentation | EESTATS Monthly Reports | 8 |
| IOU documentation | AMI Business Case Decisions | 3 |
| IOU documentation | Smart Grid Deployment Plans | 3 |
| IOU documentation | SCE Emerging Technology Demand Response (DR) Projects Semi-Annual Reports (September 2013, March 2014) | 2 |
| IOU documentation | Residential Energy Advisor Monthly Metrics Report (October 2014) | 1 |
| IOU documentation | 2013 IDSM Program Implementation Plan | 1 |
| IOU documentation | Joint IOU IDSM Quarterly Summary and Compliance Tracking Report (November 2013) | 1 |
| IOU documentation | SDG&E Smart Grid Roadmap | 1 |
| Other Study | SGIG Consumer Behavior Study Analysis (LBNL-6248E) | 1 |
| Other Study | SMUD's Communicating Thermostat Usability Study (SMUD Contract No: 4500071792) (February 2014) | 1 |
| Other Study | PG&E Findings from the Opower/Honeywell Smart Thermostat Field Assessment (ET11PGE3074) | 1 |
| Other Study | SCE 2010-12 Universal Audit Tools Evaluation (SCE0339.02) (September 2014) | 1 |
| Other Study | SDG&E Residential Disaggregation Final Report (ET13SDG1031) | 1 |
| Other Study | PG&E HAN Pilto Final Report (PGE0332.01) (January 2014) | 1 |
| Other Study | Emerging Technologies Program Aggregate Spreadsheet (Opinion Dynamics) | 1 |
| Presentation | ETCC Q3 Quarterly Meeting: "Cutting Edge Residential Efficiency" (July 2014) | 1 |
| Presentation | "Residential Behavior: IOU Program Perspective" (June 2013) | 1 |
| Presentation | SCG "Local Government Commission SoCalGas Emerging Technologies Program" (Nov 2014) | 1 |
| Presentation | SDG&E "The PEV Rate and Technology Experiment" (March 2014) | 1 |
| Presentation | "CEIVA Homeview Frame: A Quantitative Study" (July 2013) | 1 |
| Presentation | BECC 2014: "Final Savings Estimates and Key Learnings from a Behavioral Messaging Thermostat Trial" | 1 |

| Category | Abridged Name | Estimated Number Reviewed |
|---|---|---|
| Website | www.greentechmedia.com | 1 |
| Website | www.pge.com | 1 |
| Website | www.burbankwaterandpower.com | 1 |
| Website | www.glendaleca.gov | 1 |
| Website | mcecleanenergy.com | 1 |
| Website | smud.org | 1 |
| Website | www.cpuc.ca.gov | 1 |
| Website | www.esource.com | 1 |
| Website | www.alarm.com | 1 |
| Website | www.sce.com | 1 |
| Website | www.sdg&e.com | 1 |
| Website | www.nest.com | 1 |
| Website | www.earthnetworks.com | 1 |
| Website | www.burbankleader.com | 1 |
| Website | www.smartgrid.gov | 1 |
| Website | www.ohmconnect.com | 1 |
| Website | www.opower.com | 1 |
| **Total** | | **113** |

**Table 16: Data Sources for Other U.S. Residential Behavioral Offerings**

| Category | Abridged Name | Estimated Number Reviewed |
|---|---|---|
| Annual/Quarterly Report | 2011 Milton Hydro DSM Annual Report | 1 |
| Annual/Quarterly Report | 2010 Nevada PUC DSM Annual Report | 1 |
| Annual/Quarterly Report | 2014 City of Boulder Energy Smart Q3 Report | 1 |
| Evaluation | 2012 PeakSaver Plus Evaluation | 1 |
| Evaluation | 2013 June Cross-Cutting Behavioral Program Evaluation Final Integrated Report June 2013 | 1 |
| Evaluation | 2012 AEP Ohio Home Energy Reports Evaluation | 1 |
| Evaluation | 2012 Arizona Public Service DSM Report | 1 |
| Evaluation | 2009 BGE Smart Energy Pricing Pilot Impact Evaluation | 1 |
| Evaluation | 2012 CL&P Home Energy Report Evaluation | 1 |
| Evaluation | 2013 CLC Smart Home Energy Manager Evaluation | 1 |
| Evaluation | 2014 DTE SmartCurrents Fact Sheet SmartGrid.gov | 1 |
| Evaluation | 2014 DTE Pre-Pay Pilot Evaluation | 1 |
| Evaluation | 2014 DTE SmartCurrents Evaluation | 1 |
| Evaluation | 2013 ECW Cool Choices Evaluation | 1 |
| Evaluation | 2013 Brattle OPA's Time of Use First Year Analysis | 1 |

| Category | Abridged Name | Estimated Number Reviewed |
|---|---|---|
| Evaluation | 2010 Salt River Project MPower Program Review | 1 |
| Evaluation | 2014 Puget Sound Energy Home Energy Reports Evaluation | 1 |
| Evaluation | 2014 Seattle City Light Home Energy Reports Evaluation | 1 |
| Evaluation | 2014 BGE Smart Energy Savers Evaluation | 1 |
| News Article | 2014 Metering.com Article "Efficiency Vermont's New Online Energy Tool for Utility Customers" | 1 |
| News Article | 2014 Opower Article "Opower Reinvents Residential Demand Response, Changes Economics of Smart Grid" | 1 |
| News Article | 2015 Washington Post Article "Why 50 Million Smart Meters Still Haven't Fixed America's Energy Habits" | 1 |
| Other Study | 2014 CEE Behavior Program Summary Public | 1 |
| Other Study | 2009 OEC Pre-Pay Case Study | 1 |
| Presentation | 2013 Austin Energy Web Portal Presentation | 1 |
| Presentation | 2013 CEE Beyond California Presentation | 1 |
| PUC Filing | 2014 BGE Quarterly Report | 1 |
| PUC Filing | 2013 BGE Smart Energy Rewards Program Description | 1 |
| Website | Illinois Power Agency Website | 1 |
| Website | Milton Hydro peakSaver Plus Website | 1 |
| Website | Peak Rewards Website | 1 |
| Website | DTE SmartCurrents Fact Sheet SmartGrid.gov | 1 |
| White Paper | 2013 ACEEE "A Field Guide to Utility-Run Behavior Programs" | 1 |
| White Paper | 2010 ACEEE Case Studies of Behavioral Programs | 1 |
| White Paper | 2011 Bonneville Power Association Behavioral Program Profiles | 1 |
| White Paper | 2012 CPUC Review of Pre-Pay Programs | 1 |
| White Paper | 2015 ACEEE Gamified Energy Efficiency Programs | 1 |
| White Paper | 2012 NBER Working Paper "Knowledge is (Less) Power" | 1 |
| White Paper | 2013 DEFG "The Effect of Prepayment on Energy Use" | 1 |
| White Paper | 2013 BECC "Persistence of EE Behaviors Over Time" | 1 |
| White Paper | 2012 Opower White Paper No. 03 "Successful Behavioral EE Programs" | 1 |
| **Total** | | **41** |

**Table 17: List of Third Party Vendor Offerings Reviewed**

| Company Name | Offering |
|---|---|
| Planet Ecosystems | P-ECOSYS3 (focus on Consumer Outreach and Self_Service Web Tools) |
| Bidgely | Bidgley app |
| Ceiva Energy | Homeview |
| EnergyHub | EnergyHub app |

| Company Name | Offering |
|---|---|
| Earth Networks | WeatherBug Home |
| Echo Labs | Ergy 2.0 |
| True Labs | PEV4Me |
| EcoFactor | 3 services: Proactive Energy Efficiency, Optimized Demand Response, and HVAC Performance Monitoring services |
| IncentForce | 1) Consumer Energy Management and 2) Social Energy Applications |
| Leafully | Leafully app |
| EEme | Eeme app |
| Blueline Innovations | POWERCOST Monitor |
| Rainforest Automation | EMU-2, RAVEn, EAGLE |
| Honeywell | Tuxedo Touch with Total Connect |
| Genability | Genability CONDUCT™ |
| Home Energy Analytics | UnPlug Stuff |
| WattzOn | EnergyCenter |
| NEST | NEST Learning Thermostat |
| Wattvision | Wattvision App and Energy Rewards |
| Alarm.com | Alarm.com Energy Management |
| OhmConnect | OhmConnect App |
| Opower | Thermostat Management Platform |
| Plotwatt | Plottwatt.com |
| Thinkeco | Thinkeco "modlet platform", smartAC thermostat kit |
| Simple Energy | Energy Insights Dashboard, Energy Community, Energy Rewards |
| Sonoma County Energy Independence Program | My Energy Tool |
| ENERGATE | Pioneer Smart Thermostat; MyEnergate |
| Tendril | Tendril ESM Platform (incl. Home Energy Reports, Mobile and Web Platforms, Energy Savings Calculators and Assessment Tools) |
| The Energy Detective | TED 5000/TED Pro Series; TED Footprint |
| Chai Energy | Chai Energy App |
| PeoplePower | Presence Pro Energy |
| SolarCity | PowerGuide |
| Eyedro Green Solutions | Eyedro Home Electricity Monitor |
| INSTEON | INSTEON Energy Display |
| Vergence Entertainment (ASK Platform) | Ringorang |
| GE, Center For Science, National Geographic | Plan It Green |
| Leviton | Omnistat2, Leviton Energy Usage Display |
| Zema | Zema Good |

# Appendix F. Supporting Files

For the Smart Grid Decision Review Memo, submitted to the CPUC in September 2014, please see Volume III of this report (CALMAC Study ID: CPU0109.03).

For the Behavior Master List, which includes all in-scope behavior efforts reviewed for this study, please see Volume IV of this report (CALMAC Study ID: CPU0109.04).

# Appendix G. IOU Comments on Study Report

For IOU comments, please see Volume V of this report (CALMAC Study ID: CPU0109.05).

## For more information, please contact:

**Olivia Patterson**
**Behavioral Research Manager**

510 444 5050 tel
510 444 5222 fax
opatterson@opiniondynamics.com

1999 Harrison St.
Suite 1420
Oakland, CA 94612