PACIFIC GAS AND ELECTRIC COMPANY

SMART GRID ANNUAL REPORT – 2016

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SMART GRID TECHNOLOGIES

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CALIFORNIA PUBLIC UTILITIES COMMISSION

Contents

CHAPTER 1

SMART GRID ANNUAL REPORT

EXECUTIVE SUMMARY

1. Smart Grid Annual Report Executive Summary

Throughout the period of July 2015 to June 2016, Pacific Gas and Electric Company (PG&E or the Company or the Utility) continued to build capabilities to deliver on the Grid of Things™ vision. PG&E introduced this vision in 2014 to aid in the optimization of Distributed Energy Resources (DER). This vision integrates new energy devices and technologies with the grid and allows their owners to achieve greater value from their energy technology investments—rooftop solar, Electric Vehicles (EV), energy storage, Demand Response (DR) technologies, etc.—by virtue of their grid connectivity. PG&E is the key builder and enabler of this interconnected and integrated platform that will define California's future energy landscape. Innovative programs help PG&E achieve the vision while also maintaining a safe and reliable grid. These include:

- The Electric Program Investment Charge (EPIC), which covers the middle ground of testing and demonstration of pre-commercialized technologies. These projects span a number of PG&E's organizations from Customer Care to Energy Supply and from multiple departments within electric planning to operations.
- The Smart Grid Pilot Program, which is testing and piloting four smart grid technologies in a real-world, but controlled setting. The testing and fielding of these Smart Grid technologies will help determine their business cases for full-scale deployment.

As key components of the Grid of Things, the year 2016 will end as a milestone year as the Smart Grid Pilots and many of the EPIC First Triennial demonstrations are completed. While final reports with results will be filed at year end, this Executive Summary will provide some highlights.

As with last year, the trend in DERs growth is upwards. Potential projections for PG&E's territory:

- 98,000 EVs growing to over 220,000 by 2020
- 800,000 solar rooftop photovoltaic (PV) systems by 2020

- Continued growth in energy storage, including 580 megawatts (MW) contracted by 2020 under the energy storage mandate.

Growth in DERs can be a great benefit to customers, though it also introduces unique challenges in managing the grid such as those related to two-way power flow, voltage and power quality issues, as well as supply intermittency. Increased utilization of new grid technologies should allow PG&E to manage the increased complexity that DERs introduce to operating the grid, increasing the amount of information available for grid operations, allowing utilities better oversight and eventual control of DERs.

The Distribution Resources Plan (DRP) proceeding follows from a legislative requirement in Assembly Bill (AB) 327 (2014) for utilities to develop DRPs that identifies optimal locations for better integration of DERs into the distribution system. Additional DRP objectives include modernizing the distribution grid to support expected DER growth through two-way power flow, enabling customer choice of new DER technologies, and developing opportunities for DERs to provide grid benefits.

PG&E's DRP filing (July 2015) supports California's Clean Energy Vision, advocates for grid modernization, develops new analytics to estimate the impact of DER growth at a distribution feeder-level, and proposes various DER field demonstration projects. Within PG&E's DRP filing, PG&E noted the transformation of the electricity grid must ensure that electricity remains affordable for the millions of utility customers; at the same time, the future transformed grid will need to recognize the differentiated needs of customers and their flexibility to choose from various services. In the last year, PG&E and the other California investor-owned utilities (IOU) have participated in California Public Utilities Commission (CPUC or Commission) workshops to further progress on the DRP. Notably:

- In February 2016, the IOUs participated in a CPUC workshop to discuss locational net benefits analysis of DERs.
- In May 2016, the IOUs participated in a CPUC workshop on data access outlining principles emphasizing:

- Supporting facilitation of mutual data access between third parties and utilities to promote customer choice and integration of DERs into planning, operations and investments
    - Providing actionable data that supports intended use cases for furthering DRP goals
    - Maintaining appropriate levels of protection on customer privacy and confidential information (e.g., market-sensitive, proprietary, intellectual property, physical, cyber or security sensitive)
- In June 2016, the IOUs presented their revised field demonstration project proposals that aim to demonstrate DERs providing distribution services to the utility.

In its vision, PG&E outlined four key capabilities that form the foundation for implementation:

- Integrate clean and distributed energy resources
- Enhance decision making
- Automate and self-heal
- Enable customers

Through the Smart Grid pilots, EPIC program, Customer programs, and other projects across Distribution, Transmission and IT, PG&E continues to drive these capabilities forward.

Integrate Clean and Distributed Energy Resources

The first capability is to integrate clean and DERs. To enhance this capability, PG&E must determine ways to more efficiently to use DERs as a resource which can be dispatched to provide benefits to the DER owners and enhance the grid.

One example for how PG&E is planning for this future is the EPIC 2.02 Distributed Energy Resource Management Systems (DERMS) technology demonstration. This project will seek to demonstrate a DERMS system to coordinate the control of various types of DERs, which could include Distributed Generation (DG), EV, energy storage, DR and microgrids. Development, testing and demonstrations of DERMS will further California’s goals to adopt higher amounts of DERs on the grid while providing operators with the necessary control mechanisms to operate the grid safely, reliably and effectively. An effective DERMS could integrate customer-sited DG into grid operations to improve grid resiliency and reliability. However, due to the relative novelty of this technology, commercially tested and viable solutions do not currently exist.

As such, it is exciting that PG&E has partnered with General Electric to demonstrate a DERMS system under the EPIC program. In fact, given the relative trend of significant DER growth, the opportunities for utilities to partner with technology companies will continue to grow and be a key component of developing future capabilities.

Enhance Decision Making

As utilities have accumulated larger and larger data sets, and as the introduction of customer owned DERs will introduce new types of data and challenges, the importance of processing that data into actionable insights will be increasingly critical. This encompasses the following: building the capability to gather critical data; making data useful with visualization and analysis; and incorporating data into business processes to benefit customers.

The EPIC 1.08 System Tool for Asset Risk (STAR) was completed in 2015 and demonstrated a software application that calculates and displays (graphically and geospatially) safety, reliability and environmental risk scores for electric transmission, substation and distribution assets. The STAR project provided lessons on how to enable an automated, systemwide application to improve risk identification, prioritization, and investment decisions to support electric system safety. With the pilot complete, one of the key learnings was that the utility industry has opportunities to strengthen skillsets across data science, statistical analysis and machine learning. As data volumes grow and become an asset unto itself, utilities will need to continue building in these areas to extract value from the data.

Another key project in enhancing decision making is the Smart Grid Line Sensors pilot. This objective of the project is to pilot how line sensors can provide more accurate information about fault location area and provide accurate current flow information to operators and engineers to plan and reconfigure the system. Approximately 1,300 sensors on over 200 feeders are installed and as the pilot concludes PG&E will present a report with insights on how this new technology can help support reliability and utility operations for its customers.

Automate and Self-Heal

The third capability is to automate complex and high volume tasks. There are some areas where automation can provide value, such as situations where a human cannot react as fast as a machine or by automating repetitive tasks. This removes human error or ambiguity and allows operators to focus on higher order critical activities. One example of this relates to DER growth. As the distribution system grows from having a few to fleets of DERs, such as batteries, automation of various tasks will be ever more critical.

The EPIC 1.01 Energy Storage for Market Operations project examined the development of automated strategies and automation technologies for optimized bidding and scheduling of battery storage. This EPIC project successfully developed and deployed a technology platform that enables fully automated response of PG&E’s battery storage resources to California Independent System Operator (CAISO) market awards. The project demonstrated automated market participation for Battery Energy Storage Systems (BESS) and, in doing so, also helped developed organizational models and processes for utility operations going forward that will benefit customers.

Enable Customers

The final capability is to enable customers. For example, more customers are seeking increased choices and information about how they manage their energy consumption.

The EPIC 1.24 Demonstrate Demand-Side Management project successfully provided and tested the performance of a near real-time window of PG&E's Air Conditioning (AC) Direct Load Control (DLC) system, which utilizes one-way switch control devices. This allowed PG&E to improve its ability to estimate AC DLC impacts at the distribution system level to better understand the localized impact of AC DLC devices on meeting distribution feeder level reliability concerns. It also enabled near real-time visibility of AC DLC installations to support Transmission and Distribution (T&D) Operations and provided DR program administrators with near real-time feedback on any problems with DLC devices before, during or after an event is called, which supports T&D operational improvements. By improving performance of DR programs utilities enhance the customer experience and ensure that these types of programs continue to be a valuable resource for them to manage their consumption.

Although many of these projects are pilots and demonstrations, they have significant potential to enhance utility capabilities that will benefit PG&E's customers. Where proven, pilot technology can move into full deployment as part of future General Rate Cases (GRC) and begin delivering benefits to customers as early as 2017.

PG&E's Smart Grid Benefits Summary

This year, PG&E's Smart Grid benefits continue to grow, adding an estimated $68 million of incremental savings from July 2015 through June 2016. Another 49 million customer outage minutes were avoided as well.

Table 1-1: PG&E's Smart Grid Estimated Project Benefits – July 2015 to June 2016

	Annual Savings
Direct Customer Savings	$0.7 Million
Avoided Costs (Capital, Environmental, and Customer Energy Usage)	$5.1 Million
Customer Reliability Benefit[1]	$62.4 Million
Total Benefits	**$68.3 Million**
Reliability	Avoided 49.4 million customer outage minutes

[1] Reliability benefits will vary between the California IOUs due to differences between the projects included and calculated time period of accumulated benefits.

Projects that contribute to PG&E's Smart Grid project benefits include:

- PG&E's SmartMeter™ outage information improvement
- PG&E's Energy Alerts
- PG&E's Automated DR program
- PG&E's Fault Location and Service Restoration (FLISR) project
- PG&E's Modular Protection and Automation Control (MPAC) project

Smart Grid and Supplier Diversity

Through its nationally-recognized Supplier Diversity Program, PG&E has worked for over 30 years to bring more small-, women-, minority-, LGBT- and service-disabled veteran-owned business enterprises (collectively, Diverse Business Enterprises or "DBEs") into its supply chain.

Again in 2015, PG&E spent $2.5 billion with diverse businesses for a 44 percent total DBE spend. PG&E continues its demonstrated success in DBE outreach, development and partnership in all categories of procurement, including Smart Grid.

PG&E is testing a range of hardware, software and systems integration, communication infrastructure, and voltage management software from selected suppliers, and utilizing a variety of direct and subcontract DBEs in these efforts.

The remainder of this report is organized as follows:

Chapter 2 provides an update of the progress on PG&E's Smart Grid projects from July 1, 2015 through June 30, 2016.

Chapter 3 provides an update on the Smart Grid metrics approved by the Commission in Decision 12-04-025.

Chapter 4 provides PG&E's concluding remarks on this Annual Report.

Chapter 5 provides an appendix of PG&E's recorded project costs and closed projects.

CHAPTER 2

PG&E'S SMART GRID DEPLOYMENT PLAN AND PROJECT UPDATES

2. PG&E's Smart Grid Deployment Plan and Project Updates

Pursuant to Decision (D.) 10-06-047, Ordering Paragraph (OP) 15 and the Smart Grid Deployment Plan D.13-07-024, OP 4, PG&E provides this Smart Grid Annual Report with the following information included:

a) A summary of PG&E's deployment of Smart Grid technologies during the past year (July 2015 through June 2016) and its progress on its Smart Grid Deployment Plan.[2]

b) The costs and benefits of Smart Grid deployment to PG&E's customers during the past year, including a monetary estimate, to the extent possible, of the health and environmental benefits that may arise from the Smart Grid.

c) Current PG&E initiatives for Smart Grid deployments and investments.

d) Updates to PG&E's security risk assessment and privacy threat assessment; and PG&E's compliance with North American Electric Reliability Corporation (NERC) security rules and other security guidelines and standards identified by the National Institute of Standards and Technology (NIST) and adopted by the Federal Energy Regulatory Commission (FERC).

Consistent with PG&E's Smart Grid Deployment Plan, PG&E's Smart Grid Annual Report provides information on the status of its PG&E's Smart Grid investments, including Smart Grid Baseline Projects, Smart Grid-Related Customer Programs, and proposed Smart Grid Roadmap Projects.[3] For convenience of review, PG&E's Smart Grid investments are combined in this Annual Report.

2.1. Summary of Updates to PG&E's Smart Grid Deployment Plan

The Smart Grid Deployment Plan filed with the Commission in June 2011 and approved in July 2013, forms the foundation for PG&E's approach to modernizing the grid to support new

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[2] Unless otherwise specified, PG&E has provided cost and benefits for all projects for the period beginning July 1, 2015 through June 30, 2016.

[3] PG&E's Smart Grid Deployment Plan, Application (A.) 11-06-029, Chapters 4, 5 and 6.

customer demands on the grid. Since its initial preparation and review by the Commission, PG&E is increasing its Smart Grid program focus on integrating increasing levels of DERs, energy storage, and EVs into the grid. PG&E is leveraging the foundational investments in SmartMeter™ devices, distribution automation, and other technologies identified in PG&E's original Smart Grid Deployment Plan. While the focus of the plan is shifting to some extent to account for new and emerging grid needs, the plan continues to describe PG&E's goals and objectives and reflects PG&E's plans to modernize its grid, consistent with the Commission's goals and Senate Bill (SB) 17. As summarized earlier and described in more detail later in this report, PG&E has made progress implementing approved Smart Grid projects and initiatives and is seeking approval in various proceedings to further advance the plan and provide benefits to its customers.

2.2. Smart Grid Project Updates

PG&E continues to invest in Smart Grid related projects and initiatives with the objective of enhancing its grid infrastructure to provide safe, reliable and affordable energy services to its customers. Over the past year, PG&E has continued the implementation of key Smart Grid related projects outlined in its Smart Grid Deployment Plan. The projects that PG&E has implemented, or plans to implement, focus on areas such as customer engagement and empowerment, T&D automation and reliability, safety and operational efficiency, cybersecurity, and integrated and cross-cutting systems. As a result of these efforts, PG&E and the industry continued to gain additional information and knowledge, which enhances its understanding of the capability of its grid operations, the potential for deployment of new and innovative Smart Grid technologies, and customer expectations as they relate to the Smart Grid.

2.3. Customer Engagement and Empowerment Projects

Over the past year, PG&E has made steady progress on a number of projects to provide customers with tools necessary to manage their energy usage and costs. PG&E considers its customers to be the primary driver of its Smart Grid program. Therefore, without an engaged and empowered customer population, many benefits offered by a Smart Grid would be difficult to realize. PG&E believes that continuing to leverage SmartMeter™ technology and data access technologies to provide customers with greater benefits and demonstrate the importance of utilizing customer demand-side programs is vital to support PG&E's efforts to help customers understand their energy use and manage their energy bills.

PG&E expanded its Energy Alerts program, which provides notifications to residential customers when their energy consumption crosses or is forecasted to cross into higher usage tiers. These customers are continuously being notified and educated about their energy consumption patterns, which will increase customer awareness and spur behavioral modifications and may lead to lower energy usage and customer bills. In 2016, improved its Energy Alerts program to provide customers with their forecasted bills. In addition, customers can set a monthly bill alert amount and PG&E will notify customers when their bill is projected to exceed the pre-set alert amount

The following sections provide an update on completed, in-progress or planned projects during the July 1, 2015 through June 30, 2016 time period. Throughout Section 2, the dollar amounts associated with the specific projects refer to the total amount spent from July 1, 2015 through June 30, 2016, unless otherwise noted.

2.3.1. Demand Response Projects

Supply-Side DR Pilot (Continuation of IRM Pilot Phase 2)	**$0.85 Million**
Description: The Supply-Side DR Pilot (SSP) is a continuation of the IRM Pilot Phase 2 (IRM2) and was approved as part of the 2015-2016 DR Bridge Funding (D.14-05-025). The IRM2 was originally proposed in PG&E's 2012-2014 DR application and approved by the Commission in D.12-04-045. The SSP has continued to explore the integration of DR resources into the CAISO market to help with renewable resource integration that was started in the IRM2 by expanding participation from large Commercial and Industrial (C&I) to smaller commercial and residential participants and enabling real-time and non-spin ancillary services) for commercial participants. Funding Source: Funding for this pilot was approved as part of the 2015-2016 DR Bridge Funding (D.14-05-025). Status: Bidding into the CAISO Day Ahead (DA) wholesale energy market started in April 2015, and bidding in the Real-Time (RT) energy market was enabled as part of the pilot in August 2015. In December 2015, the pilot started accepting applications for residential participation. Through June 2016, pilot participants have submitted over 4,550 bids and received over 660 awards in day-ahead market. In addition, there have been over 880 bids in RT market. Benefits Description: If proved viable, the SSP will be the gateway for more DR resources to be integrated into the CAISO wholesale market. PG&E is structuring the SSP as a bridge between the retail and wholesale market and also to allow for third-party DR providers' participation in the CAISO wholesale market. This step is vital in order to have a self-sustaining and fruitful third-party DR market in California. The SSP may also assist PG&E in future grid planning and operations, especially as	

more connected intermittent generations appears on the grid, potentially improving overall system reliability.

Benefit Category: Smart Market – PG&E is continuing to evaluate the value streams of enabling DR resources in a changing operations environment and to provide services to facilitate the reliable and cost-effective integration of renewable resources. PG&E is committed to discover the necessary program attributes that system operators will need in the future.

Demand Response Transmission & Distribution System Integration	**$0.33 Million**

Description: In T&D System Integration, PG&E will evaluate areas where existing DR programs can support PG&E's T&D planning and operations. In addition, this project will evaluate how future DR programs can be designed and implemented to support the needs and objectives of PG&E's T&D operations.

Funding Source: Funding for this project is provided under PG&E's 2012-2014 DR Proposal approved by the Commission in D.12-04-045. Funding was extended through 2015-2016 program cycle in D.14-05-025.

Status: This project is currently in progress. The first phase of the pilot was concluded in Q1 2015. The first phase included a study of the required DR resource characteristics to meet distribution needs. The pilot expects to conduct field demonstration projects as part of 2015-2016 DR Bridge Funding Activities (D.14-05-025). Demonstration projects will include the deployment of local DR resource zones that can be called by Distribution Operations to maintain local system reliability, development of behavioral DR resources that can be locally called by Distribution Operations and testing the feasibility of automated calling of DR resources linked to Supervisory Control and Data Acquisition (SCADA).

Benefits Description: In the long run, the benefits of this project would include the use of DR resources to improve grid reliability, especially as more intermittent resources are connected on the grid.

Benefit Category: Smart Utility – PG&E is continuing to evaluate the value streams of enabling DR resources and to provide new services to support T&D operations. PG&E is committed to determining the necessary program attributes that transmission and distribution operators will need now and in the future.

AC Cycling Next Generation Technology Assessment	$0.55 Million
Description: Under its direct installation program, PG&E has deployed over 200,000 one-way paging air conditioner direct load control receivers (LCR) since 2007. In order to leverage its investment in the Advanced Metering Infrastructure (AMI) network, PG&E has been testing two-way LCR's that communicate either through SmartMeter™ devices or direct to the AMI network and could be deployed in 2018 on its AC cycling DR program for the residential segment. In 2013, PG&E conducted a targeted technology assessment of a ZigBee based LCR that connected through a SmartMeter™. In 2014, PG&E conducted a Request for Quote (RFQ) and subsequent laboratory test of Zigbee, direct to grid (SSN) and cellular LCRs. In 2015, PG&E worked with manufacturers of these devices to offer features that provide greater benefits, real time monitoring, than what was previously available. PG&E field deployed 100 devices of three different models on residential AC cycling participant premises in April through June of 2016. These premises will undergo load control events to assess each model's ability to offer load reduction values. PG&E will assess the cost effectiveness of this new technology and may include it in its DR application for 2018-2020. Funding Source: Funding for this project is provided under PG&E's 2015-2016 Bridge Funding Budget for DR as approved by the Commission in D.14-05-025. Status: On July 1, 2014 PG&E issued an RFQ for two-way direct LCRs for central air conditioners. Eleven models were assessed in the laboratory in 2014. In total, five devices passed the 2013 and 2014 laboratory tests and were assessed with a new feature set in 2015. Two of those models were eliminated and PG&E focused attention on devices that communicated through the AMI network. PG&E is in the midst of conducting a field test of three devices that proved viable from the final laboratory test. With the benefit of DR events in 2016, PG&E will analyze the results and determine whether or not the new technology is cost effective to be deployed and may include it in its DR application for 2018-2020. Benefits Description: By installing two-way direct load control devices, PG&E will have near RT visibility to an individual premise and the air conditioner's actual response to a load control event signal. This will facilitate early detection of device malfunction in either under- or over-performance circumstances and lost load can be recaptured quicker. Additionally, costs can be avoided related to unnecessary truck rolls to retrieve internal programming and operational history. Currently, PG&E uses SmartMeter™ data to determine an estimate of the number of non-performing devices in its maintenance program. With a disconnect alarm on a two-way LCR, unnecessary truck rolls can be avoided to sites. Benefit Category: Smart Utility – The two-way technology will provide greater visibility into device behavior, which will be used in more accurate forecasting of load reduction during events, increase the load reduction value per customer, and subsequently as a resource, and provide efficiencies in program management operations.	

2.3.2. Electric Vehicle Integration Projects

Demand Response Plug-In Electric Vehicle (DR PEV) Pilot	**$1.6 Million**

Description: The DR PEV Pilot aims to demonstrate the technical feasibility as well as the value of managed charging of EVs as a flexible and controllable grid resource. The main goal of this project is to understand the potential of using EVs for grid services, which can result in cost savings associated with operating and maintaining the grid as well as owning and operating a vehicle. The pilot requires BMW provide a minimum of 100 kilowatts (kW) of capacity at any given time, regardless of how many BMW i3 EVs are charging. BMW is required to provide this capacity in the form of existing grid services as defined by the CAISO. To date, BMW has elected to provide DA and RT energy services. To meet the managed charging component, BMW has enrolled 95 BMW i3 drivers located within the South Bay Area (PGP2 SubLAP) to participate in this pilot. Once an event is called, BMW utilizes proprietary aggregation software to delay charging of participating customers (via telematics embedded in the vehicle) in order to reduce load on the grid. The algorithm prioritizes the reduction of electricity consumption from charging without interfering on customers' mobility needs; however, drivers can opt-out of event participation at any time. To address uncontrollable fluctuations regarding managed charging capacity, BMW developed a stationary battery system made up of eight used MINI E batteries (100 kW/225 kilowatt-hours (kWh)) as back-up storage to fill the gap between available load drop from managed charging and the required DR capacity.

Funding Source: Funding for the project is provided under the 2012-2014 DR Program.

Status: On April 2, 2013, this project was approved, per Advice Letter 4077-E-B. Upon approval of the pilot, PG&E initiated work on the pilot, as detailed in Advice Letter 4077-E-B. On August 16, 2013, PG&E released a Request for Information (RFI) to automakers and received responses from various parties. Building off of the RFI, PG&E released a Request for Proposal (RFP) on April 30, 2014 to automakers, selecting BMW in August of 2014. PG&E and BMW executed contracts in December 2014 and officially launched the pilot in January 2015. From January to July, BMW focused on customer enrollment, receiving. Significant interest in the pilot with over 500 applications for 100 available spots. Between July 2015 and the end of June 2016, BMW has been participating in DR events. Over the course of this period, the BMW resource has reliably provided grid services for both DA and RT events. In total, BMW has participated in 134 DR events. BMW met the performance requirements for 94% (126) of the events called. Throughout this period, there were 98 DA events, in which BMW met the performance requirement for 97% (95) of these events. With respect to RT events, BMW met the required target for 89% (31) of the events called. Overall satisfaction with the pilot is very high, with 92% indicating they are satisfied (a 4 or 5 rating on a 5 point scale). In terms of advocacy for the program, 86% would likely recommend the program to family/friends.

Benefits Description: As part of this project, PG&E will be able to evaluate the capabilities and willingness of EV owners and automakers to participate and provide grid services to the utility. Providing these services may result in cost savings associated with operating and maintaining the grid as well as owning and operating a vehicle. Added grid services can potentially reduce the need to increase California's electricity generation capacity and is aligned with the State's loading order for resources, effectively reducing energy procurement costs.

Benefit Category: Smart Market – PG&E will be able to assess the development of the DR - PEV market to provide grid services to the utility.

2.3.3. SmartMeter™ Enabled Tool Projects

Energy Diagnostics and Management (includes, Home Energy Reports, Business Energy Reports, My Energy Portal)	**$9.75 Million**
Description: The Energy Diagnostics and Management (ED&M) Project is the implementation of a comprehensive strategy for customer self-service demand-side management. The project is enhancing the online My Energy platform and launching new tools to help customers understand their energy bills, how they use and generate energy, rate options, and savings opportunities. In addition to launching new versions of existing online tools, the current Home Energy Report program is being scaled to 1.5 million residential customers, and a new Business Energy Report Emerging Technology project is being evaluated in a scaled field test. Funding Source: This project was funded through the Energy Efficiency (EE) and DR Balancing Accounts and GRC. Status: The project was launched in May 2015 and development will continue through December 2016. It replaces the existing contract to provide Home Energy Reports and existing My Energy portal functionality. Benefits Description: This project provides residential and small and medium non-residential customers with actionable information and personalized recommendations on how they can save energy find the best rate for them and explore distributed generation and EV options. Benefit Category: Engaged Consumer – the project increases customer awareness and engagement in managing their energy usage in an environmentally sustainable and economically efficient manner.	

Energy Alerts	**$0.135 Million**
Description: The PG&E Energy Alerts program allows customers to personalize a monthly bill alert amount of their choice and then sends a notification alert to the customer when their bill is projected to exceed the set alert amount. This program is currently being offered to residential customers with electric SmartMeter™ devices who are on electric rate schedules E1, E6, EVA, EVB, ETOUA, ETOUB, and Non-NEM. Funding Source: This project was originally funded under PG&E's SmartMeter™ Upgrade program and received additional funding under GRC's capital fund and expense. Status: The Energy Alerts program was updated in April 2016. The original Energy/Tier Alerts program that originated in June 2010 officially concluded on March 1, 2016. This alert program was updated due to tier collapse and tier restructuring. PG&E also received customer feedback that the previous alert program did not allow personalization and that customers had confusion regarding the effect of tiers on their total bills. To alleviate the confusion, we provided information and tips on the updated alerts program web page on how to set an alert to mirror the tier structure. On April 1, 2016, the updated Energy Alerts program was launched with over 113,000 customers that transitioned from the previous Energy/Tier Alert program. Benefits Description: Energy Alerts provides enrolled customers with a monthly projected bill amount notification when their current usage pattern is expected to exceed their personalized Energy Alert amount. This alert will help customers adjust their consumption patterns to avoid paying higher energy bills. Nearly all of the savings for the Energy/Tier Alerts program in 2015 was attributable to participants receiving five or fewer alerts. In these segments, we saw consistent positive savings estimates	

across nearly all the months of 2015. During calendar year 2015, enrolled Energy Alerts participants saved a total of 6,189 megawatt-hours (MWh) or 177 kWh per participant, for an average annual impact of 2.2%. Energy Alerts participants who were also enrolled in PG&E's online MyEnergy account saved a total of 4,761 MWh or 92 kWh per participant, for an average annual impact of 1.13%. Benefit Category: Engaged Consumer – the program increases customer awareness and engagement in managing their energy usage in an environmentally sustainable and economically efficient manner.

Share My Data (Customer Data Access) Project	**$6.2 Million**
Description: Under the Customer Data Access (CDA) project, now known as "Share My Data," PG&E developed a platform that provides authorized and secure data to customer-authorized third parties. With the release of CDA Phase 1 functionality, customers could share electric energy usage data with third parties. With the release of the CDA Phase 2 functionality in December 2015, customers could also opt to share one or more categories of information, including usage (e.g., interval usage data for gas consumption), billing (e.g., rate schedules, billing history) and account (e.g., service address). Funding Source: This project is funded through the CDA D.13-09-025 and starting January 2017 will be funded purely by GRC. Status: On September 19, 2013, the CPUC approved PG&E's CDA Application (D.13-09-025). PG&E launched Phase 1 of the Share My Data project in March 2015 and Phase 2 on December 18, 2015. Benefits Description: This platform provides PG&E's customers and their selected third-party service providers with a robust means of accessing their energy data in a standardized manner. It also supports the evolution of the energy services industry by providing the data necessary for third parties to develop applications that will help customers manage their energy usage and reduce their monthly energy bills. Benefit Category: Engaged Consumer – the program increases customer awareness and engagement in managing their energy usage in an environmentally sustainable and economically efficient manner.	

Energy Data Access	$0.3 Million
Description: In Commission D.14-05-016 ("Decision"), the Commission adopted rules to provide access to energy usage and usage-related data to local governments, academic researchers, and state and federal agencies for specific use cases, while protecting the privacy of customers' personal data. The Decision ordered the utilities to create a Data Request and Release Program to facilitate this access, and instructed the utilities to submit an updated data catalog in the Smart Grid Annual Report.[4] Funding Source: PG&E is tracking the incremental costs associated with implementing this decision in a memorandum account and is in the process of seeking authorized recovery of such costs through its GRC proceeding. Status: In December 2014, PG&E implemented the Decision requirements, which includes the development of an Energy Data Request Program portal, creation of a Data Request and Release Process, publishing of a data request log (referred to as data catalog in the Decision), publishing of a quarterly energy consumption report by ZIP code and customer class, and the formation of a statewide Energy Data Access Committee (EDAC) that meets quarterly to discuss IOUs' data sharing programs. An updated data request log (data catalog) is provided below and summarizes the requests received or fulfilled for period July 1, 2015 through June 30, 2016. The complete log can be viewed on PG&E's website at pge.com/energydatarequest. The EDAC held quarterly meetings through June 2016. Minutes from each meeting are posted on the CPUC's EDAC website: http://www.cpuc.ca.gov/General.aspx?id=10151. Benefits Description: This program provides energy consumption and energy-related customer data to qualified academic researchers for research purposes, local governments for their climate action plans, and state and federal agencies to fulfill statutory obligations, including low income participation in EE programs. The data provided is intended to promote EE, DR, and greenhouse gas (GHG) reductions, and advance Smart Grid policy goals. Benefit Category: Engaged Consumer – this program facilitates access to energy data for local governments, academic researchers, and state and federal government entities needing data to fulfill statutory requirements.	

[4] D.14-05-016, pp. 91-92.

Energy Data Access – Data Request Log Update 7/1/2015 – 6/30/2016

Complete Request Received	Requestor Name	Request Description	Status	Date Closed
6/27/2016	City of Berkeley	Monthly aggregated residential and commercial electric and gas consumption by census block group or rolled up to census tract, for the City of Berkeley for period 6/1/2013 – 5/31/2016.	In Review	
3/30/2016	Sonoma County Economic Development Board	2015 Renewables Capacity.	Canceled	4/8/2016
3/15/2016	University of California, Davis CWEE	Five years monthly billing data, monthly and interval usage data, meter address and lat/long, EE program participation, and billing start and stops dates for all agricultural customers in certain ZIP codes in Monterey and Fresno counties.	Canceled	6/8/2016
2/24/2016	City of Cupertino	Five years annual community electricity and gas usage by ZIP plus 4; or if not possible, then ZIP plus 2, or just ZIP code. Census block data if possible.	Canceled	3/7/2016
2/2/2016	University of Illinois	5.5 years gas and electric residential usage by ZIP+2, billing dates and amounts, indicator for master meter, open/close account date, premise street address and lat/long, baseline territory, indicator for net metering (no usage data).	Completed	6/29/2016
2/1/2016	Town of Los Altos Hills	Residential aggregated interval and monthly billing gas usage for the Town of Los Altos Hills by TOT code for 2005, 2012 and 2015.	Completed	3/2/2016
1/13/2016	United States Geological Survey	All agricultural specific rate schedules in the Pajaro Valley (zip code 95076) including AG-1B, AG-RB and AG-RE, AG-VB and AG-VE, AG-4B and AG-4E, AG-4C and AG-4F, AG-5B and AG-5E, and AG-5C and AG-5F.	Denied	3/15/2016
12/17/2015	Town of Los Altos Hills (via HEA)	Residential interval gas usage for the Town of Los Altos Hills for 2005 and 2015.	Canceled	12/24/2015
10/28/2015	San Francisco Planning Department	2013-2014 monthly aggregated gas and electric usage by U.S. Census Block Group or tract level data for residential, commercial and industrial customers in the City and County of San Francisco.	Completed	3/11/2016
2/18/2015	City of Fremont	2013/14 residential electric and gas usage by ZIP, plus quarterly updates through 2016. Q1 2016 quarterly update.	Completed	4/28/2016
2/18/2015	City of Fremont	2013/14 residential electric and gas usage by ZIP, plus quarterly updates through 2016. Q4 2015 quarterly update.	Completed	1/27/2016
2/18/2015	City of Fremont	2013/14 residential electric and gas usage by ZIP, plus quarterly updates through 2016. Q3 2015 quarterly update.	Completed	10/30/2015
2/18/2015	City of Fremont	2013/14 residential electric and gas usage by ZIP, plus quarterly updates through 2016. Q2 2015 quarterly update.	Completed	8/10/2015

Stream My Data aka Home and Business Area Network (HAN)	$196,512

Description: PG&E's Stream My Data helps customers save energy and money by providing real-time electricity data through an energy monitoring device. The device helps a customer understand how and when they are using electricity, as well as the related costs—allowing them to take actions to save energy and money. By connecting an energy monitoring device to the electric SmartMeter™ for the home or a small medium business, the customer is able to do the following:

- Monitor your Real-Time Electricity Usage (kW)
- See your Real-Time Price ($/kWh)
- Get an Estimated Costs to Date and Estimated Electric Bill This Month
- Receive Demand Response Event Alerts (SmartRate™ and Peak Day Pricing (PDP) event alerts)

Funding Source: The funding source for those ongoing operations was split between GRC and DREBA until the end of 2015. From 2016 on, the funding source was based solely from GRC.

Status: The HAN platform was renamed "Stream My Data" to be more customer-friendly, and the suite of functionality is available to all eligible customers, based on rate and meter type. This project was completed and was declared used and useful in November 2014 to provide. Current usage, current price, current energy rate, estimated costs to date, estimated bill this month, and DR event alerts.

Benefits Description: Customers are able to use validated HAN devices/technologies to receive RT usage, RT price, and DR signals via their SmartMeter™. This improves their energy awareness and helps them adapt their energy consumption or load shifting behaviors to lower their monthly energy bills, and makes it easier for customers to participate in DR programs.

Benefit Category: Engaged Consumer – HAN enablement allows customers with SmartMeter™ interoperable devices/ technologies to synchronize with PG&E's SmartMeter™.

Time Varying Pricing (TVP) Rates	$7.86[5] Million

<u>Description</u>: TVP products, such as PDP, Time-of-Use (TOU), and SmartRate take advantage of SmartMeter™ capabilities that are now largely available across PG&E's service territory. Charging customers different rates based on varying system conditions is intended to more closely align retail and wholesale electric prices for generation, as well as create economic incentives for customers to actively manage their energy costs by shifting electricity use from when it costs more to when it costs less. PDP provides between 30-45 MW of load reduction on the hottest days of summer, equaling the load of almost two peaker power plants. The SmartMeter™ has enabled PG&E to cost-effectively offer all customers these types of rate programs which provide significant customer and societal benefits.

<u>Funding Source</u>: This project is funded as part of PG&E's Rate Design Window (D.10-02-032, D.11-05-018, and D.11-11-088 – $97.05 million), 2011 GRC (2011 Phase 1 – $12.61 million) and AMI Cases (D.06-07-027– $2.07 million).

<u>Status</u>: PG&E continues to administer and offer TVP Rates to all PG&E bundled residential and nonresidential customer classes. Beginning in November 2012, small and medium business (SMB) customers with 12 months of SmartMeter™ data began a mandatory transition to TOU rates and two years later, in 2014, began transitioning to default opt-out PDP. Small Agricultural customers began transitioning to mandatory TOU rates annually starting in March 2013. There is currently no decision that requires the default of Residential customers to TVP, but they may enroll in to the SmartRate™ program, and enrollment in SmartRate has grown to over 147,000 residential customers who provide an average of 35-45MW of load reduction on event days. Over 400,000 SMB Service Agreements have transitioned to TOU rates in the past four years. Over 245,000 Service Agreements have transitioned to a PDP rate in the past two years. In 2016, PG&E expanded the In Season Support program for PDP customers to all customers who have provided email addresses. This program increased load contribution for participants in 2015 – In Season Support participants provided an average load reduction of 1.3% during PDP events, while non-participants reduced load by 0.5%.[6] In Season Support provides customers additional event notifications via email and customized reports on their facility's event performance shortly after the event. In 2016, PG&E also introduced a pilot program to provide the same customized reporting and analytics via SMS messaging.

<u>Benefit Description</u>: Time Varying Pricing reduces demand during peak summer time periods, lowering system-wide costs, by enabling customers to save money by shifting load to off-peak times of day. Customers can still use the same amount of energy and reduce their bill by shifting some of their usage to times of lower cost generation.

<u>Benefit Category</u>: Engaged Consumer and Smart Utility – the program increases customer awareness and engagement in managing their energy usage in an environmentally sustainable and economically efficient manner while at the same time allowing PG&E greater control and flexibility over its transmission and distribution.

[5] 7/1/15-7/30/16 TVP actuals (GRC and DPMA, only for TVP).

[6] Source: PG&E 2015 Ex Post Load Impacts – CPP, provided by Nexant.

2.3.4. Emerging Customer Side Technology Projects

Automated Demand Response (AutoDR) Program	$5 Million
Description: PG&E's Automated Demand Response (AutoDR) program offers small, medium and large commercial, industrial and agricultural customers an incentive to install automated equipment that enhances their ability to reduce load during DR program events. Specifically, AutoDR is an automation-based communication infrastructure that links PG&E's designated third-party hosted solution servers to customer-owned Energy Management Control Systems. PG&E helps its customers to develop pre-programmed energy management and curtailment strategies to automate their facilities when PG&E calls a DR event day. Funding Source: Since its inception, PG&E's Auto DR program has been funded under PG&E's DR activities and budgets, which have been authorized by the Commission. Status: PG&E's AutoDR program is currently in progress. PG&E's AutoDR program provides incentives to large commercial and industrial customers. Starting in 2017, SMB customers will be eligible for AutoDR incentive. Benefits Description: PG&E's AutoDR program has recruited 594 customers who will provide PG&E with up to 108 MW of dispatchable load during the DR seasons. During the past year, 2,600 MWh were shed reducing GHG emissions by 3,242,450 pounds. Benefit Category: Engaged Consumer – PG&E offers AutoDR to the customers with a way to automate their DR load shed strategies. This two-way communication and technology provides PG&E with operational status of the customer that is valuable in a smarter grid.	

Smart Thermostat Study	$1.3 Million
Description: PG&E is conducting an Emerging Technologies field assessment to evaluate gross energy savings and effectiveness of EE facilitating features in multiple smart thermostats—Nest, EcoBee3 and Radio Thermostat of America CT50 with EnergyHub service provider—with focus on learning/optimization software, occupancy sensing and geo-location. Smart thermostats professionally installed at no cost to up to 2,207 residential customers in in the North Valley, Stockton and Fresno areas. Behavioral messaging and DR are out of scope. Both billing data and manufacturer thermostat usage data will be collected over the 12 months period and used for analysis. Funding Source: PG&E funded this project using funds authorized under the 2013 – 2015 EE program as part of Emerging Technology activities. Status: This project is currently in progress and with a final report expected in Q4 of 2016. PG&E initially recruited approximately 14,000 customers who agreed to participate in the Study and finalized control and treatment assignment based on eligibility criteria. Installation was completed in December 2015. Benefits Description: PG&E will be leveraging key learnings from this Study to add Smart Thermostats to EE portfolio in 2017. Benefit Category: The latest generation of Smart Thermostat products offers customers easier and more convenient ways to manage their HVAC with improved functionality and integration to other connected devices. Moreover smart thermostat as the first connected system in line is a way to enable customers to have insight and control over their energy usage pattern.	

2.4. Distribution Automation and Reliability Projects

Projects in the Distribution Automation and Reliability category provide capabilities and associated technology enablement to monitor and control the electric distribution system. PG&E continues to focus on technology capabilities to increase the visibility and control enabled by Substation SCADA in the distribution system, continues to deploy FLISR technology projects first introduced by the Cornerstone project, implemented technologies to support the effective consolidation of Distribution Control Centers, and piloted and deployed Smart Grid technologies to improve distribution performance and outage response.

The following section provides an update on completed in-progress or planned projects through June 2016 unless otherwise noted.

Distribution Substation Supervisory Control and Data Acquisition (SCADA) Program	**$42 Million**
Description: The Distribution SCADA program focuses on increasing SCADA penetration to support future Distribution Control Center consolidation and improve reliability for PG&E customers. PG&E's goal is to achieve 100% visibility and control of all critical distribution substation breakers over the next few years, adding or replacing SCADA for approximately 393 substations and approximately 1,107 breakers. Funding Source: This project is funded under PG&E's 2011, 2014 and 2017 GRC. Status: This project is currently in progress. PG&E currently anticipates the conclusion of this project in December 2019. Implementation of this project began on March 2011. This project has upgraded or replaced SCADA in 173 substations and added SCADA on 578 breakers between 2011 through June 2016. Benefits Description: Increasing SCADA penetration enables improvements in reliability, grid planning, and operations. Benefit Category: Smart Utility – PG&E's goal of 100% visibility using SCADA is expected to reduce outage time, personnel travel and operations time managing the system and provide data to better operate and plan and design the distribution system.	

Distribution Management System (DMS) Project	$2.25 Million

Description: The DMS Project implements electronic wall maps to assist in distribution operations control center consolidation. This project is a key strategic system implementation for the electric distribution system to provide increased grid visibility and control capability.

Funding Source: This project is funded under both PG&E's 2011 and 2014 GRCs.

Status: This project is currently in progress. PG&E commenced implementation activities in February 2012 and anticipates concluding implementation of activities under this project in November 2016. This project has two phases. The project has completed its first phase and went live in October 2013. Phase 2 has been deployed in the consolidated distribution control centers. Minor enhancements are in progress to improve network grid visibility.

Benefit Description: This project will enable operational improvements that yield safety, reliability, and operational benefits.

Benefit Category: Smart Utility – The project installs electronic wall map capability in centralized distribution operations control centers. The electronic wall map is a new smart technology that assists operations personnel in managing and making operational decisions regarding the distribution system. The DMS will also be a foundational system for future Smart Grid projects.

Battery Energy Storage System (BESS) Demonstration Projects	$1.6 Million

Description: In these projects, PG&E will utilize energy storage for Market and Distribution Operations with the benefit of gaining "real world" experience and data from participation in the CAISO market (EPIC 1.01) and using energy storage to mitigate overload conditions on distribution system equipment (EPIC 1.02).

> EPIC Project 1.01 uses two Sodium Sulfur (NaS) battery sites to gain "real world" experience and data from participation in the California Independent System Operator's (CAISO) new Non-Generator Resource (NGR) market model created specifically for Limited Energy Storage Resources (LESRs) such as batteries. The project will develop and deploy an automated communications and control solution to enable battery resources to automatically respond to CAISO market awards and thus make full use of their fast-response functionalities. Based on the data collected, the project will also quantify financial performance from participation in CAISO markets.

> EPIC Project 1.02 will use a 0.5MW/2 MWh Li-Ion batteries to demonstrate energy storage on the distribution system by deploying a system to address a projected overload condition (500kW to 1MW) and reliability concerns.

Funding Source: The NaS batteries were originally forecasted for cost recovery in the GRC and were subsequently approved as an EPIC project. Project 1.02 is EPIC funded.

Status: EPIC 1.01 is nearing completion with the expectation of final report being issued this year. The Vaca Dixon facility (2 MW/14 MWh NaS Battery) became a CAISO market participant in August 2014 while the Yerba Buena facility (4 MW/ 28 MWh NaS battery) started market operations in January 2016. PG&E developed the automation necessary for the resources to automatically respond to CAISO market awards and has been testing out the new NGR market model developed specifically for Energy Storage.

EPIC 1.02 project is in progress – PG&E selected the project site, ran the RFP, selected the winning bidder, completed the engineering design and started construction.

Benefit Description: EPIC 1.01, Energy Storage for Market Operations has significantly improved PG&E's capabilities in operating Energy Storage in the CAISO market. The project setup the Information Technology infrastructure necessary for automated bidding and has methodically explored the use of Vaca and Yerba Buena BESS for providing Energy and Ancillary Services in the CAISO markets. EPIC 1.02 project, if viable will demonstrate how BESS can be successfully used on the distribution grid to address a projected overload condition.

Benefit Category: Smart Market and Smart Utility – PG&E is testing the operational and integration capabilities of grid-scale storage batteries to better understand the benefits to the utility of integrating storage and usage in the overall supply market and distribution system.

Smart Grid Fault Location, Isolation, and Service Restoration (FLISR)	**$14 Million**

Description: This project continues the installation of FLISR systems work that was funded in the Cornerstone Decision (D.10-06-048). Smart Grid FLISR will expand the implementation of the FLISR system to approximately 80 circuits per year across the PG&E system to improve customer service reliability.

Funding Source: This project is proposed to be funded in PG&E's 2017 GRC.

Status: This project has been approved. The Smart Grid FLISR project has begun in 2014 and is expected to continue through 2019.

Benefit Description: When installed, FLISR can reduce the impact of outages by quickly opening and closing automated switches to reduce what may have been a one- to two-hour outage to less than five minutes.

Benefit Category: Smart Utility – the Smart Grid FLISR project improves customer service reliability, provides RT load and voltage data which supports distribution operations and DER/distribution resource integration.

Install Smart Grid Line Sensors Pilot	**$4.2 Million**

Description: This objective of the project is to pilot how line sensors can: (1) provide more accurate information about the fault location area, allow faster outage restoration by reducing outage response time, and improve customer satisfaction; (2) provide accurate current flow information to operators and engineers to plan and reconfigure the system without overloading equipment based on actual current measurements instead of models; and (3) provide more accurate current flow information to engineers to support better planning of the distribution system rather than relying exclusively on models.

Funding Source: This project is funded under Smart Grid Pilot Deployment Project D.13-03-032.

Status: This project is in flight and has installed approximately 1,300 sensors on over 200 feeders. Installations include both overhead and underground distribution lines. This project began in August 2013 and is anticipated to end December 2016. The CPUC approved this project in March 2013 (D.13-03-032; A.11-11-017).

Benefit Description: This pilot project may demonstrate safety, reliability, and operational benefits through reducing outage time and improving system operations and planning. This project is expected to deliver the following benefits: • Customer Cost Savings: reduced operations and maintenance (O&M) from more efficient outage response and restoration • Reliability Benefits: improved CAIDI and SAIDI A forecast of these potential benefits was submitted as part of A.11-11-017. Benefit Category: Smart Utility – The Smart Grid Line Sensor project improves reliability and increases the capability of the distribution system for operations and planning engineering personnel to operate and effectively run the distribution system.

Voltage and Reactive Power (Volt/Var) Optimization System Pilot	**$16.64 Million**

Description: This project is piloting a voltage and reactive power (Volt/Var) optimization technology to evaluate its ability to reduce customer energy usage and reduce utility system losses by managing the distribution voltage from the substation to the customer's service point (distribution primary, secondary and service systems). This project will also demonstrate the benefit of this technology in managing voltage with higher levels of DER penetration.

Funding Source: This project is funded under Smart Grid Pilot Deployment Project D.13-03-032.

Status: This project began in August 2013 and is anticipated to conclude December 2016. The CPUC approved this project in March 2013 (D.13-03-032; A.11-11-017). The project is presently in the Phase 2: Field Trial phase. PG&E began commissioning VVO in Fresno Division beginning in June 2015, and ending in January 2016, with 12 feeders going live in the summer of 2015, and 2 additional feeders going live in the winter of 2016. PG&E has engaged a third party to perform Measurement & Verification (M&V) of VVO benefits. Preliminary benefits M&V results show that VVO can deliver in upwards of 2% EE savings on certain feeders. PG&E has actively been engaging with piloted VVO vendors to drive enhancements to their VVO algorithms, and to develop an understanding of how Smart Inverter autonomous settings can be coordinated with VVO software to improve VVO's benefits. PG&E has performed extensive testing of certain Smart Inverter autonomous functions in preparation for a Smart Inverter Field Trial which places approximately Smart Inverters at customer premises on a subset of VVO Pilot feeders. Voltage visualization dashboards developed for the VVO Pilot is driving learnings of how to use SmartMeter™ voltage data to adjust VVO software settings perform physical modifications to circuits to further flatten voltage profiles, both driving improved benefits.

When the pilot ends, PG&E will provide a report on the project with a specific focus on costs and benefits associated with a full system deployment and a recommendation on if a deployment is in the best interests of PG&E's customers.

Benefit Description: This pilot project may demonstrate the ability to enable more efficient procurement and supply of electricity, and potentially enable increased penetration of distributed renewable generation and reducing GHG emissions. This project is expected to deliver the following benefits:

- Grid Reliability: mitigate voltage issues caused by high penetration of DG through better voltage regulation
- Customer Energy Savings: avoided cost savings from reduced energy consumption (MWh) and peak demand (MW)
- Environmental Savings: avoided GHG emissions

A forecast of these potential benefits was submitted as part of A.11-11-017. The project will perform M&V of actual benefits throughout the Field Trial (Phase 2).

Benefit Category: Smart Utility – The Volt/Var Optimization project is a smart utility project that seeks to improve the operating efficiency of distribution circuits and customer equipment by managing the voltage and power factor devices improving the overall operating efficiency of the distribution circuit and voltage at the customer metering point. Additionally managing the distribution voltage and power factor reduces the need for generation which in turn reduces GHG emissions.

Detect and Locate Faulted Circuit Conditions Pilot	**$6.2 Million**

Description: This project will install and evaluate a fault-finding software system or systems that will assist in more precisely locating failed equipment that caused an outage and determine if there are additional benefits of providing a more accurate location to utility first responders to outages.

Funding Source: This project is funded under Smart Grid Pilot Deployment Project D.13-03-032.

Status: The project continues to evaluate several fault finding analytic approach's and vendor products. The project is anticipated to be complete the end of 2016.

Benefit Description: This pilot project may demonstrate safety, reliability, and operational benefits through reducing outage time and improving system operations and planning. This project is expected to deliver the following benefits:

- Customer Cost Savings: reduced O&M from more efficient outage response and restoration
- Reliability Benefits: improved CAIDI and SAIDI

A forecast of these potential benefits was submitted as part of A.11-11-017.

Benefit Category: Smart Utility – The Smart Grid Detect and Locate Faults project improves reliability by improving information to find the likely location of the damaged equipment that caused the distribution outage. The distribution operations personnel will be better equipped to operate and efficiently run the distribution system. Additionally, this project will explore enhancing the utilities ability to locate and mitigate high impedance faults.

2.5. Transmission Automation and Reliability Projects

Projects included in the Transmission Automation and Reliability category provide capabilities and associated technology enablement to monitor and control the electric transmission system. Over the past year, PG&E has focused on technology capabilities to improve wide-area monitoring, protection, and control enabled by SCADA in the transmission system, equip operators with the tools necessary to enhance bulk system reliability in coordination with the CAISO and neighboring utilities, and pilot and deploy digital substation technology and other Smart Grid technologies.

The following section provides an update on completed, in-progress or planned projects through June 2015 unless otherwise noted.

Compressed Air Energy Storage (CAES) Demonstration Project	**$4.13 Million**
Description: The purpose of this demonstration project is to determine the technical and economic feasibility of an approximately 300 MW CAES plant using a porous rock structure for up to 10 hours of air storage at a location within California. CAES technology will compress air into an underground porous rock formation during periods of excess generation and then will release the stored air to generate electricity during periods of peak demand. Funding Source: The project is funded under the Department of Energy (DOE)/American Recovery and Reinvestment Act grant of $25 million and matching funds approved by the CPUC and California Energy Commission (CEC) of $24 million and $1 million, respectively. Status: This project is currently in progress. The project started January 2012 and is expected to be completed in December 2016. PG&E selected two reservoirs for core extraction and analysis. Preliminary core analysis showed that both sites have the permeability and porosity suitable for a CAES project. One of the sites was chosen as the preferred site for the air injection/withdrawal test. The DOE drafted an Environmental Assessment for the preferred site as part of its National Environmental Policy Act review; the DOE issued a Finding of No Significant Impact in May 2014 which allowed the project to move forward with ground disturbance activities associated with the air injection test. PG&E also prepared and submitted an Underground Injection Control permit application to the Energy Protection Agency; this permit, which is required prior to construction of the injection/withdrawal well as part of the air injection test, was issued to PG&E on August 20, 2014. PG&E drilled and completed the injection/withdrawal well and completed the construction of the air compression test facility in Q4 of 2014 and Q1 of 2015. The test commenced on February 14, 2015, with the injection of approximately 550 Management Measures (MM) SCF of depleted air and ambient air and series of withdrawal tests to replicate the operation of a full scale CAES facility. The test results have been analyzed and implemented in model updates to the preliminary conceptual design of a commercial facility. The site was substantially decommissioned by June 30, 2015. A Request for Offers (RFO) for third-party bids to build, own, and operate a CAES facility was released in October 2015 and initial bids were received in May 2016. PG&E is currently evaluating bids and, if appropriate, will develop a short-list for negotiations. Upon completion of the RFO, a "Go/No-Go" decision will be made to pursue Phase II of the program; the development, application and construction of a	

commercial facility.

Benefit Description: If demonstrated to be economically and technologically viable, CAES technology may facilitate the integration of renewable generators and help attain clean energy policy goals.

Benefit Category: Smart Market – This project seeks to evaluate the feasibility of a large energy storage facility that can be used to manage renewables and other generation.

Transmission Substation SCADA Program	**$25.9 Million**

Description: Under the Transmission Substation SCADA program, PG&E is in the process of installing new SCADA on the transmission system to provide PG&E's Electric Operations and the CAISO with full visibility into the transmission system, significantly improving efficiency and operational flexibility. PG&E's current goal is to achieve 100% visibility and control of all transmission substations by 2019, adding or replacing SCADA for approximately 230 substations and approximately 673 breakers.

Funding Source: This project is funded under PG&E's Transmission Owner (TO) cases.

Status: This project is currently in progress. The project started in July 2010 and is expected to be completed in December 2019. PG&E has added or replaced SCADA at 162 substations and 580 breakers from 2010 through June 2016.

Benefit Description: Increasing SCADA penetration enables improvements in reliability, grid planning, and operations.

Benefit Category: Smart Utility – PG&E's goal of 100% visibility using SCADA is expected to reduce outage time, personnel travel and operations time managing the system and provide data to better operate and plan the transmission system.

Modular Protection Automation and Control (MPAC) Installation Program	**$24.3 Million**

Description: The multi-year MPAC program aims to deploy pre-engineered, fabricated, and standardized control buildings in transmission substations. These activities are performed in an integrated manner with other PG&E projects such as capacity expansion projects, bus conversions, deficiency and aging asset replacement, control room condition improvements, reliability, and control center consolidation efforts.

Funding Source: This project is funded under PG&E's TO cases.

Status: This project is currently in progress. This is an ongoing program, and doesn't have a defined end date, the project began in 2005. PG&E has installed and completed 102 MPAC buildings.

Benefits Description: The program will help improve reliability of the transmission system by replacing aging infrastructure and modernizing facilities. Over the past year, the MPAC Installation Program has avoided $3.9 million in capital costs over traditional upgrade methods and has avoided a cumulative total of $58.1 million.

Benefit Category: The program is a Smart Utility project designed to improve reliability of the transmission system by replacing aging infrastructure and modernizing facilities.

Synchrophasor Project Realization	$2.31 Million

Description: Synchrophasor technology realization will build on the foundation of the original PG&E Synchrophasor Investment project, to provide additional functionality to the Energy Management System and integration into RT operations. The initial Synchrophasor Project allowed PG&E (and others within Western Electricity Coordinating Council (WECC)) to install the technology. Data flow into control centers (Disaster Recovery Infrastructure) has been validated and several components of the project have transitioned into stages that transmission system operation will activate for PG&E business use. Examples include, Post Event Analysis, selected Angle Pairs, and Phasor based Dispatch Training simulator.

Funding Source: PG&E Electric Transmission Operation/Transmission System Operations.

Status: Active. Communication protocol and transport layer enhancements underway to support data availability and data quality. Synchrophasor test lab under development. Working with WECC to improve Synchrophasor data sharing capability.

Benefit Description: Synchrophasor technology provides high resolution grid measurement and more accurate and synchronized measurements in real-time. Benefits include:

- Improvements in PG&E' system models (the basis for the EMS used by Operators) – Accurate model allows identifying true system constraints (voltage, system instability, thermal), improved transmission system performance, evaluating true limits due to better results for on-line EMS applications supporting state estimation and dynamic line rating
- More accurate Control Center understanding of the state of the Grid (Situational Awareness)
- Faster operator alerts and improved visibility of the fast, dynamic grid conditions
- Prompt identification of un-damped grid oscillations to prevent outages
- Quick identification of the location of a grid disturbance for faster response
- More cohesive system restoration amongst transmission owners and reliability coordinators

Benefit Category: System Reliability and Operational Efficiency

2.6. Asset Management and Operational Efficiency Projects

Projects included in the Asset Management and Operational Efficiency category provide capabilities and associated technology enablement to track and manage asset information (e.g., location, maintenance history, specifications/characteristics), as well as assess and plan asset maintenance, replacement, and capacity enhancements. Over the past year, PG&E has focused on technology capabilities to leverage industry-standard technologies (e.g., integrated GIS/SAP system) to capture and provide access to accurate, traceable, and verifiable asset information for all stakeholders to support the Electric Operations business.

The following section provides an update on completed in-progress or planned projects through June 2016 unless otherwise noted.

SmartMeter™ Outage Management Integration Project	**$0.15 Million**
<u>Description</u>: The SmartMeter™ Outage Management Integration project integrates the SmartMeter™ "Last Gasp" and Restoration messages into PG&E's Outage Management System for outage notification to operators and dispatchers and improved outage restoration. Phase I project will deliver: (1) the capability to create trouble reports from AMI alarms when an associated customer call has been received; (2) the capability to ping a transformer to determine if an outage is larger than it was inferred to be; and (3) the capability to ping individual meters to determine whether they have been restored. Phase 2 of the project will identify and isolate downstream outages that have occurred prior to a larger upstream outage. Additionally, it will enhance the capability introduced in Phase 1 by removing the requirement for an associated customer call and automatically creating trouble reports using AMI only reports. <u>Funding Source</u>: This project is funded within PG&E's SmartMeter™ Project, D.06-07-027. <u>Status</u>: Phase 1 of this project was started in May 2008 and completed in September 2011. The functionality of Phase 2 has been deployed systemwide as of Q4 2015. <u>Benefits Description</u>: This project is expected to deliver reliability and operational benefits through leveraging SmartMeter™ data to better understand and resolve customer outages. The program this past year saved more than 6,500 "truck rolls" eliminated approximately 61,000 pounds of GHG emissions and saving the utility more than $733,000. <u>Benefit Category</u>: Smart Utility – this project integrates SmartMeter™ outage last gasps into PG&E's outage management system and allows for pinging customers to make sure they are back in power after the outage restoration work was completed.	

Electric Distribution Geographic Information System and Asset Management (ED GIS/AM) Project	$117.7 Million (costs since inception)

Description: The ED GIS/AM project is a continuation of and enhanced approach to the Automated Mapping and Facilities Management (AM/FM) Project, where PG&E upgraded hardware and software components from 2008-2010 and completed alignment of electric and gas maps to a common coordinate scheme or "land base," to prepare the maps for migration and conversion into a new enterprise GIS solution.

While the purpose and scope of the ED GIS/AM project is consistent with and leverages work completed as part of the predecessor AM/FM project, key enhancements are being made to drive increased business value with the integrated GIS and enterprise asset management system (SAP) data. A significantly more rigorous approach to assure data quality and implement data governance processes is included as part of the new ED GIS/AM project. In addition, the scope of the ED GIS/AM project has been expanded to include web based analytics for multiple ED functions. These and other capabilities are more fully detailed and scoped in the GIS/AM project as compared to the 2011 GRC AM/FM forecast, resulting in a more comprehensive and longer duration project.

Funding Source: This project is funded from PG&E's 2011 and 2014 GRCs.

Status: This project has been completed. The development of the enterprise-wide data repository commenced in October 2011 and was completed in December 2015.

Benefits Description: PG&E has estimated cost savings including $0.8 million in 2016, $2.9 million in 2017 and $2.9 million in 2018 based on efficiencies gained from implementing the ED GIS/AM solution. These savings would result from back office efficiencies as well as improved productivity by applying ED GIS/AM technology in conjunction with other initiatives to streamline processes that are currently manual or less efficient.

Benefit Category: Smart Utility – this project is expected to deliver safety, reliability, and operational benefits through enhanced visualization of PG&E's electric distribution system.

Network Supervisory Control and Data Acquisition (SCADA) Monitoring Project	$7.0 Million in 2016

Description: The project is installing new monitoring and control systems on the downtown San Francisco and Oakland secondary network systems including full remote control on network protectors (including remote setting of relays), and primary switches. The monitoring itself includes voltages, currents, temperature, oil level, and chamber pressures. For vaults, the monitoring system includes SCADA battery, water detection and may include others such as distributed generation monitoring depending on future needs and feasibility. Real time data collected from the equipment is used for triggering of alarms, and for equipment condition assessment as part of the Condition Based Maintenance (CBM) system for operation and maintenance activities. The data is also used for asset management decisions on maintenance and replacement of network equipment. The new SCADA system has remote operating capabilities that include network protector open/close and station transfer trip of the network protectors for feeder clearances.

Funding Source: This project is funded by PG&E's 2014 GRC.

Status: This project is currently in progress. PG&E has a total of twelve network groups. Four network groups are complete

(Z-34-1, Z-34-2, Z-1 and Y-4) with a fifth network group (Y-3) to be completed in 2016. These completed network groups have been added to the PI Historian system which is the data accumulator for all of the SCADA information. This data in turn is coupled with the CBM system described above which allows PG&E to transition from time based to condition based replacement and maintenance. This results in a safer system while at the same time generating savings through deferring work until the condition of the equipment warrants.

Benefit Description: The new control features included as part of this project will improve personnel safety and overall system operability.

Benefit Category: Smart Utility – this project provides information for PG&E to better manage its assets and make informed maintenance, repair and upgrade decisions.

Smart Grid Short-Term Demand Forecasting Pilot Project	**$2.64 Million**

Description: The objective of the proposed Project is to evaluate if more granular sources of data can be acquired and used to improve the accuracy of PG&E's short-term electricity demand forecasts for retail load. The Project will follow a three-phase approach to analyze, build, and pilot the systems that incorporate more granular sources of data for local pilot areas within PG&E's service territory.

Funding Source: This project is funded under Smart Grid Pilot Deployment Project D.13-03-032.

Status: The CPUC approved this project in March 2013 (Advice Letter 4227-E, D.13-03-032; A.11-11-017) and the continuation of the project to Phase 2 and 3 (Advice Letters 4429-E and 4770-E, respectively). In Phase 1, PG&E identified the local areas and data sources to test the new forecasting methodology. In Phase 2, PG&E built the infrastructure and systems to process the new granular data sources into a central repository for input into the demand forecasting model for the local pilot areas. In Phase 3, PG&E is forecasting hourly loads for the local areas on 7 x 24 basis, analyzing the model performance, and evaluating the new forecasting methodology for system-wide deployment. Phase 3 is anticipated to be complete in 2016.

Benefit Description: This pilot project seeks to demonstrate if more granular sources of data can improve the accuracy of PG&E's demand forecast within the selected areas and if the implementation to PG&E's entire service area would be cost effective.

Benefit Category: Smart Market and Smart Utility – this project uses SCADA data and SmartMeter™ usage data to determine if there is an improvement to the accuracy of PG&E's short-term electric demand forecasts to meet PG&E's retail load obligations.

2.7. Security (Physical and Cyber) Projects

Since the publication of the Smart Grid Deployment Plan, PG&E completed the Advanced Detection and Analysis of Persistent Threats (ADAPT) cybersecurity project that was primarily focused on increasing the utility's capability to effectively anticipate, prevent, and respond to a new and emerging class of cyber and physical threats. Following the conclusion of the ADAPT project, PG&E has undertaken the implementation of a second project, the Identity and Access Management (IAM) project. This is a multi-year investment focused on improving PG&E's core access control capabilities. Additional detail on these two projects has been provided in the following section, and discussion of PG&E's overall Cybersecurity Risk Management Program is provided in Section 2.12 to 2.16 of this report.

The cybersecurity projects have multiple goals and provide regulatory compliance benefits (SOX, NERC Critical Infrastructure Protection (CIP), and other standards and regulations), significant risk reduction benefits, and alignment to PG&E's Risk Management Framework (RMF) as described later in this document.

Identity and Access Management Project	**$10.4 Million**
Description: The IAM Program is a multi-year, multi-project enterprise level investment that will strengthen authorized PG&E system access controls and reduce the risk of unauthorized access. The Program will improve centralized control over access to PG&E's key systems, provide role based access control to those systems, provide a central authoritative source for identity attributes of authorized individuals, and provide enhanced auditing capabilities to achieve enterprise wide visibility and control of employee access to systems. Through the IAM Program, PG&E will implement key technologies and services in the areas of identity management, credential administration, provisioning, entitlements, access management, and audit and compliance. Funding Source: This Program is funded in PG&E's 2011 and 2014 GRCs and TO funds for the NERC CIP program. Status: The Program started in March 2012, is expected to complete in 2019, and is in progress. Benefit Description: As of July 2016, PG&E has decreased the risk of unauthorized physical and logical access through: automated creation of network login credentials for approved and authorized users; automated removal of access from up to 231 separate facility access control systems for decommissioned users; centralized server access provisioning/de-provisioning, monitoring and reporting; improved governance processes for enterprise user access functions contributing to a reduction in Segregation of Duties violations by 91%; deployment of controls to restrict and better monitor privileged accounts; deployment of a centralized logical and physical access management portal called My Access; and retirement of the legacy provisioning system for SOX systems. Benefit Category: Engaged Consumer, Smart Market, and Smart Utility – The IAM Program, enhances controls across the entire PG&E infrastructure and is not limited to the Smart Grid. Each of the Engaged Consumer, Smart Market, and Smart Utility areas benefit from these improved controls that protect key processes and systems across the enterprise. For example, the infrastructure that allows customers to log in to PG&E's My Energy will be enhanced with increased security and control mechanisms to validate that only customers and their approved designees can access customer energy information online.	

2.8. Integrated and Cross-Cutting Systems Projects

Integrated and cross-cutting systems refer to projects that support multiple smart grid domains, such as grid communications, application platforms, data management and analytics, advanced technology testing, and workforce development and technology training. An integrated approach for this type of projects will ensure that investments are managed efficiently while creating the platform to deliver a stream of benefits across the IOU operations and to customers.

Integrated communications systems will provide solutions to connect and enable sensors, metering, maintenance, and grid asset control networks. In the mid-to-long term, integrated and cross cutting systems would enable information exchange with the IOU, service partners and customers using secure networks. Data management and analytics projects will improve the IOU's ability to utilize vast new streams of data from T&D automation and SmartMeters™ for improved operations, planning, asset management, and enhanced services for customers.

Advanced technology testing and standards certification are a foundational capability for the IOUs to evaluate new devices from vendors and test them in a demonstration environment prior to deployment onto the electric system. This reduces the risks associated with new technology projects, and helps the IOUs maximize technology performance and interoperability prior to deployment.

Workforce development and advanced technology training enables the successful deployment of new technologies, ensuring that the IOUs' workforces are prepared to make use of new technologies.

The integrated and cross-cutting systems group is driven by several state and federal laws and regulatory orders including SB 17, Energy Independence and Security Act, CPUC D.10-06-047, AB 32 and Executive Order S-305, SB 078 and SB X1-2.

The following section provides an update on completed in-progress or planned projects through June 2016 unless otherwise noted.

Telecommunications Architecture	$16.5 Million

Description: Telecommunications Architecture allows PG&E to meet near term and long term telecommunications needs by developing and implementing a multi-tier, multi service telecommunications infrastructure architecture, consisting of a core and an edge network. Smart Grid projects require an exponential increase in the ability for customers, markets and utilities to securely and reliably communicate on a near real time basis. New communication models include customer to utility, customer to market, and smart "equipment to equipment." PG&E's telecommunication infrastructure must be enhanced to facilitate this increased communications and also developed in a systematic, economic manner that allows for re use of communications infrastructure.

A blend of technologies will be needed to address the diverse performance needs and geography of the PG&E service territory. Increased SCADA density, Phasor Measurement Units (PMU), cyber security, and network management requirements will drive capacity, latency, and quality of service requirements that must be built into future networks.

Funding Source: This project is being funded in PG&E's 2011 and 2014 GRCs.

Status: This project is currently in progress and is expected to be completed in 2017. PG&E has completed implementation of the core and aggregation layer of the Multi-Protocol Label Switching network and has begun the network consolidation. Multiple Virtual Routing and Forwarding Domains have been constructed enhancing security and availability of critical applications. Pilot installations of wireless edge technologies have begun to verify cost models associated with the technology and ensure system meets desired increases in capacity and coverage, and reductions in latency.

Benefits Description: Benefits are estimated at $10 million in lifecycle asset replacement avoidance.

Benefit Category: Engaged Consumer, Smart Markets and Smart Utility – Cross-cutting initiatives apply across all three segments.

California Energy Systems for the 21st Century (CES-21) Program	$4.3 Million

Description: The CES-21 Program is a public-private collaborative research and development project between PG&E, Southern California Edison Company (SCE), San Diego Gas & Electric Company (SDG&E), and Lawrence Livermore National Laboratory (LLNL). The objective of the CES-21 Program is to address challenges of cyber security and grid integration of the 21st century energy system for California. The CES-21 Program utilizes a team of technical experts from the Joint Utilities and LLNL, who leverage and extend ongoing research in grid cyber security. LLNL will combine data integration with advanced modeling, simulation, and analytical tools to provide problem solving and planning necessary for the challenges of grid integration.

In D.14-03-029, which modified D.12-12-031 to comply with SB 96, the Commission authorized the three utilities to recover up to $35 million over five years for the CES-21 Program and limited research areas to cyber security and grid integration. On April 25, 2014, the three utilities filed a joint Advice Letter (PG&E AL 4402-E) requesting approval for two research projects and the Cooperative Research and Development Agreement (CRADA), which was approved in October 2014.

Funding Source: In D.14-03-029, the Commission authorized the three utilities to recover up to $35 million over five years for the CES-21 Program.

Status: The CPUC approved the Advice Letter (PG&E AL 4402-E) and CRADA in October 2014 allowing the IOUs and LLNL to initiate the cyber security and grid integration projects at the beginning of 2015. The cyber security project is in the staging phase while the grid integration project in the design/engineering phase. Note that the CES-21 initiative files a comprehensive annual report. Benefit Description: The CES-21 Program has the potential to deliver significant benefits to California's electric customers. California customers will benefit greatly from avoided or shortened outages due to cyber-attacks. Automated response capabilities may reduce the number of outages, minimize their impact, and improve recovery times. The grid integration project may reduce operating and capital costs and improve reliability by reducing uncertainty around appropriate metrics to gauge reliability and the adequacy of planned resources as adoption of intermittent renewables increases Benefit Category: Engaged Consumer, Smart Markets and Smart Utility – Cross-cutting initiatives apply across all three segments.

Electric Program Investment Charge (EPIC) Program	**$18.7 Million**
Description: As a result of the CPUC's Phase 2 EPIC D.12-05-037, PG&E, SCE, SDG&E, and the CEC are executing on the approved 2012-2014 Triennial Investment Plan and program framework to provide ongoing support for the development and deployment of next generation clean energy technologies. Upon approval of the EPIC 2 Final D.15-04-020, the California IOUs, and the CEC are also executing on the approved 2015-2017 Triennial Investment Plan. The EPIC program demonstrates promising new Smart Grid technologies focused on four key areas: Renewables and DER Integration; Grid Modernization and Optimization, Customer Service and Enablement; and Cross-Cutting and Foundation Strategies. Project specific information about EPIC 1 and 2 can be found in PG&E's EPIC 2015 Annual Report, which was filed on February 29, 2016, and can be found on PG&E's website at www.pge.com/epic. Funding Source: This EPIC 1 program is funded in D.12-05-037. The Commission authorized the three IOUs to collect funding for the EPIC program in the total amount of $162 million annually beginning January 1, 2013 and continuing through December 31, 2020. The total collection amount shall be adjusted on January 1, 2015 and January 1, 2018 to commensurate with the average change in the Consumer Price Index. PG&E's share is 50.1%. The EPIC 2 program is funded in D.15-04-020, and follows the annual funding amount of $162 million as previously stated. Status: In November 2013, the CPUC approved PG&E's 2012-2014 Triennial Investment Plan filed on November 1, 2012. Seventeen projects have been underway and are in various phases: 1 project in Design/Engineering phase; 3 projects in Staging phase, 8 projects in Build/Test phase; 3 projects in Closeout; and 3 projects complete.[7] Additionally, CPUC approved 31[8] projects for PG&E's 2015-2017 Triennial Investment Plan on April 9, 2015. Of the 31 projects approved by the CPUC,	

[7] The final reports for the EPIC projects can be found on the EPIC webpage at www.pge.com/epic.

[8] In the EPIC 2 Plan Application (A.14-05-003), PG&E originally proposed 30 projects. Per the CPUC D.15-04-020 to include an assessment of the use and impact of EV energy flow capabilities, Project 2.03 was split into two projects, resulting in a total of 31 projects.

14 projects have been internally approved through the initial two waves of the prioritization process. The remainder are being further assessed through PG&E's prioritization process to assign the remaining EPIC 2 funding. Of the 14 active EPIC 2 projects, the projects are in various phases of deployment: 9 projects in Planning Phase, 3 projects in Design/Engineering phase, 2 projects in Build/Test. Note that the EPIC program files a comprehensive annual report. Benefit Description: EPIC projects are expected to improve the safety, reliability and affordability of the electric system in California while supporting state energy policy goals. Benefit Category: Engaged Consumer, Smart Markets and Smart Utility – Cross-cutting initiatives apply across all three segments.

Workforce Development and Technology Training	**N/A**
Description: PG&E is committed to developing a Smart Grid workforce. Enhanced workforce skills and knowledge are required for successful support of smarter grid design, deployment, operation, maintenance, safety, and customer care. PG&E develops internal training programs through experience, including with demonstration pilot projects, and scales them for broader deployment. Funding Source: This work is funded through PG&E's GRCs. Status: PG&E is continuing to enhance workforce skills to support a smarter, more integrated grid. Benefit Description: Improved access to a skilled workforce necessary to implement the Smart Grid deployment to benefit grid reliability, increasing grid complexity, and technology integration that will help PG&E meet its energy goals in the state of California. Benefit Category: Engaged Consumer, Smart Markets and Smart Utility – Cross-cutting initiatives apply across all three segments.	

Supplier Diversity	N/A
Description: Throughout the process of identifying qualified suppliers to participate in the initial testing and limited pilots, PG&E emphasized the criticality of diverse supplier inclusion. PG&E continues to highlight the importance of education, mentoring and careful planning for the full participation of DBEs as business solution partners and subcontractors over the life of this program. In the initial and current phases of the Smart Grid evaluation, PG&E has hired over a dozen DBE firms providing technical consulting, legal services, computer systems, staff augmentation, and office and electrical supplies. As a result, at mid-year 2016, as in 2015, PG&E Smart Grid supplier spending is in-line with the company's year-to-date supplier diversity goals. As part of the advance planning and education effort, PG&E provided specific Smart Grid and general business opportunities to DBEs, including: • PG&E's sponsorship of DBE firms in the University of California Advanced Technology Management Institute executive management training for companies poised for growth in emerging technologies like Smart Grid. • PG&E's sponsorship of DBE firms in the UCLA Anderson School of Business, Management Development for Entrepreneurs executive business management training. • DBE supplier development opportunities through PG&E's Technical Assistance Program, which include ISO 9001 and ISO 14001 certification training scholarships, DBE sponsorships to select industry trade shows, invitations to matchmaking events and other educational workshops.	

2.9. Customer Roadmap

In its March 2012 Smart Grid Workshop Report, CPUC Staff requested the following information to be included in the IOUs' Smart Grid Annual Reports:

1. Timeline that connects specific projects with specific marketing and outreach efforts
2. Specific steps to overcome roadblocks, as identified in the workshops and included in this report[9]

As requested by CPUC Staff, PG&E is providing marketing and outreach information using the sample template in Appendix 1 to the Smart Grid Workshop Report as follows:

Timeline: PG&E has adapted the CPUC Staff's template (Appendix 1) to reflect the existing and planned work that is related to the Smart Grid, including approved initiatives in place that meet the customer objectives outlined in SB 17 and D.10-06-047. Since the Marketing, Education, and Outreach proposal in the Smart Grid pilot deployment A.11-11-017 was denied, the only

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[9] See Smart Grid Workshop Report: Staff Comments and Recommendations, March 1, 2012, page 10.

outreach that provides support to the Smart Grid initiative is conducted through funding approvals of individual program and their initiatives as listed in Table 2-1.

Initiative Detail: For each of the project areas identified in the Customer Engagement timeline, PG&E has provided detail on existing or proposed outreach in accordance with the proposed template from the Commission's Smart Grid Workshop Report.

Table 2-1 below provides an annual illustration of PG&E's customer engagement timeline.

Customer Engagement Timeline - Table 2-1	2014	2015	2016*	2017*	2018*
Energy Management Enablement Tools:					
PG&E Online Account Web Tools (including rate comparisons)	X	X	X	X	X
Universal Audit Tools	X	X	X	X	X
Energy Usage Alerts	X	X	X	X	X
Business and Home Energy Reports	X	X	X	X	X
Third-Party Customer Data Access Tools (e.g., green button connect, customer data access)	X	X	X	X	X
SmartMeter™	X				
Electric Program Investment Charge*				X	x
Behind-the-Meter (Customer Premise) Devices:					
SmartAC™**	X	X	X	X	
Distributed Generation (Solar Water Heating, Solar PV, etc.)	X	X	X	X	
Business and Home Area Network; Local Area Network; Smart Thermostat, etc.	X	X	X	X	
Electric Vehicle Supply Equipment**	X	X	X	X	X
Rates Options:					
SmartRate and Related Residential Time Varying Rates**	X	X	X	X	
Time-of-Use	X	X	X	X	X
Peak Day Pricing	X	X	X	X	X
Electric Vehicle Rates	X	X	X	X	X
* Various EPIC pilots have some component of customer outreach/marketing. ** These forecasts are based on the best knowledge PG&E has at the current time; however, future regulatory decisions or other business developments may alter these forecasts.					

2.10. Overview of Customer Engagement Plan

PG&E's had sought approval for a plan to more broadly educate customers on longer-term benefits of Smart Grid technology beyond these immediate offerings, to provide context for future technologies and customer-facing benefits that will be available in the coming years in PG&E's Customer Outreach and Education Pilot. However, since the Outreach proposal in A.11-11-017 was denied, the outreach that supports the Smart Grid initiative can only be conducted through marketing of individual programs if they are approved in new cycles with outreach funds allocated. PG&E's outreach efforts over the reporting period have been focused on meeting goals of each program.

PG&E's effort to ensure that customers have the tools and knowledge to benefit from the Smart Grid have included customer education on:

- Available tools designed to help customers understand their energy use;
- Choices for rate options and new technology that will help customers manage their energy bills; and
- Communicating with customers through communication methods they prefer, including online and by mail.

2.11. Smart Grid Engagement by Initiative Area

In the following section PG&E describes the customer engagement elements for each initiative area identified in Table 2-1 above, as requested by CPUC Staff in its March 1, 2012 Smart Grid Workshop Report.

Enablement Tool: Energy Management	
Project Description	Marketing, Education and Outreach (ME&O) to educate customers about the various tools available to evaluate and manage their energy use and to develop a more interactive and engaged relationship with PG&E services
Target Audience	Focused on Residential and SMB Customers
Sample Message	"PG&E offers a number of ways to help you evaluate your energy use and learn about ways to save energy"
Source of Message	Utility
Current Customer Engagement Road Block(s)	• Low engagement category • There is a low baseline incentive for customers to be interested in incremental savings on their power bill given the low engagement level of the utility category • While customers are increasingly interested in digital communications, not all customers prefer communications through online channels
Strategy to Overcome Roadblocks	• Continue to use a variety of outreach methods to ensure highest penetration possible of relevant and targeted information with residential customers • Continue to market energy enablement tools • Demonstrate available energy savings by highlighting customer case studies • Conduct frequent customer communication, including through the Small Business and residential e-newsletters

Enablement Tool: Behind the Meter (Customer Premises) Devices	
Project Description	ME&O to educate customers about available home or businesses devices that: 1) Provide interval energy usage data like SmartMeter™, Home Area Networks (HAN) Local Area Networks (LAN) 2) Allow customers to participate directly in grid operations with tools like SmartAC 3) Facilitate distributed generation
Target Audience	Residential and SMB customers
Sample Message	"PG&E offers devices that provide information to help customers manage energy use and costs"
Source of Message	Utility
Current Customer Engagement Road Block(s)	• Concerns about ceding control of customer premises to utility through installed devices • Immediate economic impact (i.e., cost savings) is not always easily seen • Long payback periods on technology investments can make the Investment unfeasible
Strategy to Overcome Roadblocks	• Provide customers with factual information about devices, focusing on: o The benefits and energy management tools it serves o The potential to positively impact the customer's economic bottom line with cost savings o Positive impact on grid stability and reliability • Continue to market customer premise device rebates available

Rate Options	
Project Description	ME&O to educate customers about rate options. Includes opt-in for residential customers and default rates for SMB customers.
Target Audience	Residential and SMB customers
Sample Message	"Rate options offer customers new ways to conserve energy and to choose the rate that is best for them"
Source of Message	Utility
Current Customer Engagement Road Block(s)	• Lack of customer understanding about how they can benefit financially from various rate options available • TOU and critical peak pricing requires action from the customer on event days • Changes to rate structures for residential and businesses
Strategy to Overcome Roadblocks	• Sustained, ongoing outreach about default rates for SMB (prior to and after default) and how to participate in opt-in residential rates • Provide customers examples of how to benefit from rate options on peak event days and how to prepare for a an event day, including developing an action plan • For SMB customers, this is achieved with education about the PDP program both before and after their automatic transition onto the rate, so that they understand how PDP works, what the potential benefits are for the customer, and what specific actions a customer should take on an event day to be successful. • For residential customers, cross promotion of enablement tools so that customers gain understanding of how various options available to them work together to save them money (SmartAC and SmartRate) • Promote SmartRate program that offers bill protection for the first year after signup for and highlight a maximum of 15 "Smart Days" will be called each year; Once enrolled continuous communication to keep customers engaged by highlighting ways they can continue to save on SmartRate and remind them that their regular day (non-Smart Day) rates are lower when on the SmartRate program.

2.12. Key Risks

As part of the continuous review of its key risks, PG&E has concluded that there has been no appreciable change to those risks over the past year.

PG&E initially laid out its strategy for measuring, managing and mitigating both cybersecurity technology risks and physical security risks in its June 2011 Smart Grid Deployment Plan filing. The strategy described in June 2011 highlighted PG&E's fundamental cybersecurity approach at that time. The Utility business continues to evolve. New operational models depend more and more on converged Information and Operations Technologies to perform advanced business functions such as those proposed for the Smart Grid. Many of these functions are automated and will be implemented through information-rich applications or grid automation with "smart" devices. New technologies change the risk and threat landscape. New threats continue to put pressure on and change the risk posture of the Utility requiring more protective measures and safeguards to prevent, detect, respond, and recover in a resilient manner that does not jeopardize the safe, reliable, and cost-effective delivery of energy to customers. Since June 2011, PG&E's cybersecurity strategy has evolved, with the implementation of a more quantitative approach to risk management through the newly developed and deployed RMF that blends current efforts for managing compliance with this new method for proactively managing risk. This approach is emphasized in the CPUC September 19, 2012 Policy Paper: *Cybersecurity and the Evolving Role of State Regulation: How it Impacts the California Public Utilities Commission.* As recognized by the CPUC, "Compliance is an important component of addressing cybersecurity, but it is not enough to ensure that the rapidly evolving risks are adequately considered and acted upon effectively. … A broader risk management-based approach is needed to move beyond minimal compliance and mitigate cybersecurity risks as they arise." PG&E recognizes that focusing solely on compliance management without a holistic risk management framework will not achieve the desired optimal outcome to adequately protect the Utility and the Smart Grid. This philosophy also extends to PG&E's physical security strategy, which is driven by the Corporate Security department and plays an important role in protecting PG&E's Smart Grid assets. From a cybersecurity perspective, physical security is leveraged as part of the overall defense-in-depth strategy; a critical protection layer for the widely distributed systems and devices planned for the evolving Smart Grid.

2.13. Key Risks and Actions Taken to Address Them

PG&E takes a risk-based, all-hazards approach to protecting the resilience, reliability, and recovery of the computers, control systems, and other cyber infrastructure that operates the electric grid. G&E ensures executive support for cyber and physical risk management activities, and that risks are understood and managed throughout the enterprise. PG&E also maintains collaborative relationships with government, regulatory, and industry bodies to collectively protect the cybersecurity of the bulk electric power system, prioritize assets, address vulnerabilities, manage emerging risks, and maintain open lines of communication.

While the next sections primarily focus on managing cybersecurity, physical security remains critical for controlling risk within the Smart Grid. PG&E's Corporate Security department remains abreast of changes in the regulatory landscape and continues to closely follow all Critical Cyber Assets outlined in the NERC Cyber Security Standards, CIP 006 as well as industry standards from NIST, such as those outlined in the industry guideline NISTIR 7628, Guidelines for Smart Grid Cyber Security.

2.13.1. Managing Cyber Security Risk Through Control Baseline

Controls are the system safeguards that mitigate various types of risk, and PG&E has developed a set of standardized, baseline controls that align to multiple best practice governing bodies and regulations.

PG&E has established the following thirteen control families as part of its baseline controls:

- Security Leadership
- Audit and Risk Management
- Privacy Protection
- Records Management
- Configuration Management
- Operational Management
- Human Resource Management
- Monitoring and Measurement
- System Design, Build, and Implementation

- Physical Security
- System Continuity
- Acquisition of Facilities, Technologies, and Services
- Technical Security

These control families provide a baseline for risk measurement and inform controls implementation across people, process, and technology.

2.14 PG&E's Compliance With NERC Security Rules and Other Security Guidelines and Standards as Identified by NIST and Adopted by FERC

PG&E has developed and established formal standards that form the foundation for controls implementation and adherence. Examples of those standards include password management, user access management, information classification, information security, training, and privacy. PG&E's standards leverage industry best practice standards such as NIST. PG&E also participates in industry peer groups to understand changes in technology and regularly updates applicable standards. PG&E has implemented a Guidance Document Management initiative in order to make standards more intuitive and easy to understand. This helps improve compliance with both the spirit and intent of the guidance.

PG&E's risk management framework enables compliance with multiple state and federal regulations and is aligned to leading industry practices and standards including the following:

- NERC Critical Infrastructure Protection (NERC CIP)
- Industry Guidelines
- Privacy
  - CPUC Privacy D.11-07-056
  - California SB 1476
  - California SB 1386
- SCADA System Security
  - International Electro Technical Commission 62351

- Others
  - International Organization for Standardization/IEC 27000 Series
  - Federal Communication Commission Regulations
  - Sarbanes Oxley
  - Health Insurance Portability and Accountability Act

PG&E participates in multiple forums to ensure that its control design is current, comprehensive and remains in alignment with the standards and industry groups mentioned above. PG&E also engages with external partners related to cybersecurity and cyber risk management, including industry bodies, government-related security forums, and academia.

2.15. Key Risks Conclusion

PG&E continues to improve upon its ability to measure, manage, communicate, and mitigate potential cybersecurity, privacy, and technology risks that could impact the systems that PG&E depends on to deliver safe and reliable electric and gas services to its customers. PG&E's risk management approach is focused on ensuring that risks are well understood at all levels of the Company and that there is executive support for mitigating and managing operational risks, physical security risks as well as cyber security risk. PG&E's risk management efforts are focused on continuous improvement to effectively predict and proactively manage risk by integrating risk management strategies, plans and practices into everyday business activities.

CHAPTER 3

SMART GRID METRICS AND GOALS

3. Smart Grid Metrics and Goals

In this section, PG&E provides an update on the 19 consensus Smart Grid metrics approved by the Commission in D.12-04-025. PG&E continues to support the Commission's position that these consensus metrics will provide parties and the Commission with information that will allow for better understanding of PG&E's Smart Grid investments and provide the foundation for moving forward with Smart Grid investments.

3.1. Customer/Advanced Metering Infrastructure Metrics

Metric 1: Number of advanced meter malfunctions where customer electric service is disrupted, and the percentage this number represents of the total of installed advanced meters.

Number of PG&E Advanced Meter Malfunctions Where Customer Electric Service is Disrupted; Percentage of Total Installed Advanced Meters	
Metric	Value
Number of Meter Malfunctions	178 meters
Percentage of Total Meters	0.00338%
Note: Reporting date: July 1, 2015 through June 30, 2016.	

Metric 2: Load impact in MW of peak load reduction from the summer peak and from winter peak due to smart grid-enabled, utility administered DR programs (in total and by customer class).

Load Impact in MW of Peak Load Reduction From the Summer Peak and From Winter Peak Due to Smart Grid-enabled, Utility Administered Demand Response Programs	
Metric	Value
From the Summer Peak (May – October 2014:	
Residential	0 MW
Non-Residential < 200 kW	0 MW
Non-Residential ≥ 200 kW	63 MW
Other (Agricultural)	7 MW
Total	70 MW
From the Winter Peak (November 2014 – April 2015):	
Residential	0 MW
Non-Residential < 200 kW	0 MW
Non-Residential ≥ 200 kW	0 MW
Other (Agricultural)	0 MW
Total	0 MW
Note: Includes load reduction from DR programs and time-varying rates that is enabled by automated technologies.	

Metric 3: Percentage of DR enabled by AutoDR in each individual DR impact program.

Percentage of PG&E Demand Response Enabled by AutoDR in Each Individual DR Impact Program (2015)	
Metric	Value
Percentage of DR enabled by AutoDR – Demand Bidding Program (DBP)	8%
Percentage of DR enabled by AutoDR – Peak Day Pricing (PDP) program	2%
Percentage of DR enabled by AutoDR – Capacity Bidding Program (CBP)	4%
Percentage of DR enabled by AutoDR – Aggregator Managed Portfolio (AMP)	5%
Note: Percentage represents the Verified kW load reductions (engineering analysis) available for DR programs in 2015, divided by total DR portfolio kW, with the resulting number multiplied by 100.	

Metric 4: The number and percentage of utility-owned advanced meters with consumer devices with HAN or comparable consumer energy monitoring or measurement devices registered with the utility (by customer class, California Alternate Rates for Energy (CARE) status, and climate zone).

Number and Percentage of PG&E Owned Advanced Meters With Consumer Devices With HAN or Comparable Consumer Energy Monitoring or Measurement Devices Registered With PG&E		
Metric	Number	Percentage
Residential	3,806	<1%
Non-Residential < 200 kW	67	<1%
Non-Residential ≥ 200 kW	0	0%
Other	0	0%
Total	3874	<1%
CARE	0	0%
Non-CARE	3874	<1%
Total (CARE and Non-CARE)	3874	<1%
Climate Zone P	73	<1%
Climate Zone Q	20	<1%
Climate Zone R	121	<1%
Climate Zone S	283	<1%
Climate Zone T	931	<1%
Climate Zone V	18	<1%
Climate Zone W	36	<1%
Climate Zone X	2302	<1%
Climate Zone Y	18	<1%
Climate Zone Z	4	<1%
Total by Climate Zone	3874	<1%
Note: Percentage is defined as the number of advanced meters with consumer devices with HAN or comparable consumer energy devices registered with the utility divided by the number of advanced meters installed for the group of concern, with the resulting number multiplied by 100.		

Metric 5: Number and percentage of customers that are on a time-variant or dynamic pricing tariff (by type of tariff, by customer class, by CARE, and by climate zone).

Number and Percentage of Customers on a Time-Variant or Dynamic Pricing Tariff		
Metric	Number	Percentage
Residential	326,306	7%
Non-Residential < 200 kW	515,329	77%
Non-Residential ≥ 200 kW	10,153	2%
Total	851,788	16%
CARE	51,119	4%
Non-CARE	800,669	19%
Total (CARE and Non-CARE)	851,788	16%
Climate Zone P	32,842	18%
Climate Zone Q	955	25%
Climate Zone R	115,409	19%
Climate Zone S	163,193	18%
Climate Zone T	161,849	13%
Climate Zone V	9,395	16%
Climate Zone W	55,802	19%
Climate Zone X	302,760	15%
Climate Zone Y	8,918	14%
Climate Zone Z	665	3%
Total by Climate Zone	851,788	16%
Note: Percentage is defined as the number of customers that are on a time-variant or dynamic pricing tariff divided by the number of customers in the group of concern, with the resulting number multiplied by 100.		

Metric 6: Number and percentage of escalated customer complaints related to (1) the accuracy, functioning, or installation of advanced meters; or (2) the functioning of a utility-administered HAN with registered consumer devices.

Number and Percentage of Escalated PG&E Customer Complaints Related to (a) Accuracy, Functioning or Installation of Advanced Meters; or (b) Functioning of a PG&E-Administered Home Area Network With Registered Consumer Devices		
Metric	Number	Percentage
Escalated customer complaints related to the accuracy, functioning or installation of advanced meters	8	17%
Escalated customer complaints related to the functioning of a PG&E-administered HAN with registered consumer devices	0	0%
Note: Percentage is defined as the number of escalated complaints related to (1) the accuracy, functioning, or installation of advanced meters; or (2) the functioning of a utility-administered HAN with registered consumer devices divided by the number of escalated complaints in total, with the resulting number multiplied by 100.		

Metric 7: The number and percentage of advanced meters replaced before the end of their expected useful life during the course of one year, reported annually, with an explanation for the replacement.

Number and Percentage of Advanced Meters Replaced Before the End of Their Expected Useful Life During the Course of One Year, Reported Annually, With an Explanation for the Replacement		
Metric	Number	Percentage
Advanced meters replaced	23,900	0.45%
Explanation for the replacements: These advanced electric meters were replaced due to a malfunction before the end of their expected useful life (e.g., damaged meter, etc.).		
Note: Percentage is defined as the number of advanced meters replaced before the end of their expected useful life during the course of one year, reported annually, divided by the number of advanced meters installed, with that resulting number multiplied by 100.		

Metric 8: Number and percentage of advanced meters field tested at the request of customers pursuant to utility tariffs providing for such field tests, and the number of advanced meters tested measuring usage outside the Commission-mandated accuracy bands.

Number and Percentage of Advanced Meters Field Tested at the Request of Customers Pursuant to Utility Tariffs Providing for Such Field Tests, and the Number of Advance Meters Tested Measuring Usage Outside the Commission-Mandated Accuracy Bands		
Metric	Number	Percentage
Advanced meters field tested at the request of customers [A]	2,858	0.05%
Advanced meters tested measuring usage outside the Commission-mandated accuracy bands [B]	6	0.21%
[A] Percentage is defined as the number of advanced meters field tested divided by the number of advanced meters installed, with that resulting number multiplied by 100.		
[B] Percentage is defined as the number of advanced meters field tested found outside of the Commission-mandated accuracy bands divided by the number of advanced meters tested at the request of the customer between 7/1/15 and 6/30/16 with that resulting number multiplied by 100.		

Metric 9: Number and percentage of customers using a utility web-based portal to access energy usage information or to enroll in utility energy information programs or who have authorized the utility to provide a third-party with energy usage data.

Number and Percentage of Customers Using a PG&E Web-based Portal to Access Energy Usage Information or to Enroll in PG&E Energy Information Programs or Who Have Authorized PG&E to Provide a Third-Party with Energy Usage Data		
Metric	Number	Percentage
Customers using a PG&E web-based portal to access energy usage information [A]	1,819,552	34%
Customers using a PG&E web-based portal to enroll in PG&E energy information programs	148,521	2.8%
Customers who have authorized PG&E to provide a third-party with energy usage data	109,206	1.7%
[A] This number represents the unique number of customers who have clicked on the “My Usage” tab within My Energy at least one time during the reporting period (July 1, 2015 through June 30, 2016).		

3.2. Plug-In Electric Vehicle (PEV) Metric

Metric 1: Number of customers enrolled in time-variant EVs tariffs.

Number of PG&E Customers Enrolled in a Time-Variant Electric Vehicle Tariffs	
Metric	Value
Number of EV-A Customers	26,253 customers
Number of EV-B Customers	435 customers
Note: Utilities currently have limited ability to determine which customers have EVs. As methods for acquiring this information are determined in that proceeding, this metric should be updated. Metrics related to metering arrangements should be deferred until after PEV metering policy is set in Alternative Fueled Vehicles OIR (Rulemaking 09-08-009).	

3.3. Energy Storage Metric

Metric 1: MW and MWh per year of utility-owned or operated energy storage interconnected at the transmission or distribution system level. As measured at the storage device electricity output terminals. The measure is for January 1, 2015 through December 31, 2015. Data is unavailable for any other time frame.

MW and MWh of PG&E-Owned or Operated Energy Storage Interconnected at the Transmission or Distribution System Level	
Metric	Value
Energy Storage Interconnected At The Transmission System Level	1,212 MW
	599,072 MWh
Energy Storage Interconnected At The Distribution System Level	6 MW
	42 MWh
Note: As highlighted in this Smart Grid Project Update, a 2 MW/14 MWh battery storage system was commissioned at a PG&E substation near Vacaville in August 2012 and a 4 MW/28 MWh battery storage system on a distribution circuit in San Jose California in May 2013.	

3.4. Grid Operations Metrics

Metric 1: The system-wide total number of minutes per year of sustained outage per customer served as reflected by the System Average Interruption Duration Index (SAIDI) Major Events Included and Excluded for each year starting on July 1, 2015 through June 30, 2016. There were seven major events in this time period.

PG&E's System Average Interruption Duration Index, Major Events Included and Excluded	
Metric	Value
SAIDI – Major Events Included	137.3
SAIDI – Major Events Excluded	110.6

Metric 2: How often the system-wide average customer was interrupted in the reporting year as reflected by the System Average Interruption Frequency Index (SAIFI), Major Events Included and Excluded for each year starting on July 1, 2015 through June 30, 2016. There were seven major events in this time period.

PG&E's System Average Interruption Frequency Index Major Events Included and Excluded	
Metric	Value
SAIFI – Major Events Included	1.139
SAIFI – Major Events Excluded	1.008

Metric 3: The number of momentary outages per customer systemwide per year as reflected by the Momentary Average Interruption Frequency Index (MAIFI), Major Events Included and Excluded for each year starting on July 1, 2015 through June 30, 2016. There were seven major events in this time period.

PG&E's Momentary Average Interruption Frequency Index Major Events Included/ Major Events Excluded	
Metric	Value
MAIFI – Major Events Included	1.806
MAIFI – Major Events Excluded	1.638

Metric 4: Number and percentage of customers per year and circuits per year experiencing greater than 12 sustained outages for each year starting on July 1, 2015 through June 30, 2016.

Number and Percentage of PG&E's Customers Per Year and Circuits Per Year Experiencing Greater Than 12 Sustained Outages Per Year		
Metric	Number	Percentage
Customers Experiencing Greater Than 12 Sustained Outages Per Year	1,640	0.030%
Circuits Experiencing Greater Than 12 Sustained Outages Per Year	10	0.333%
Note: (Percentage of customers experiencing greater than 12 sustained outages per year equals [(the number of customers experiencing greater than 12 sustained outages in a year) divided by (the total number of customers)] with the resulting number multiplied by 100. Percentage of circuits experiencing greater than 12 sustained outages per year equals (the number of circuits experiencing greater than 12 sustained outages in a year).		

Metric 5: System load factor and load factor by customer class for each year starting on January 1, 2015 through December 31, 2015. Data is unavailable for any other time frame.

PG&E's Load Factors	
Metric	Value
System Load Factor	57.19%
Residential Load Factor	38.84%
Non-Residential < 200 kW Load Factor	Small L&P: 48.49% Medium L&P: 46.24%
Non-Residential ≥ 200 kW Load Factor	Large L&P: 65.46%
Other (agriculture) Load Factor	52.67%
Note: Until advanced meters are fully deployed for residential, small commercial and industrial, and small agriculture customers, load factors will be calculated using estimates, rather than measured directly.	

Metric 6: Number of and total nameplate capacity of customer-owned or operated, grid-connected distributed generation facilities. The data are cumulative through June 30, 2016.

Number and Total Nameplate Capacity of PG&E's Customer-Owned or Operated Grid Connected Distributed Generation Facilities		
Metric	Number of Facilities	Capacity (MW)
Distributed generation facilities (solar PV)	251,754	2,161
Distributed generation facilities (non-solar)	1,013	769
Distributed generation facilities (solar PV and non-solar)	252,767	2,930

Note: Information and estimates about production of distributed generation facilities that serve on-site customer load is produced annually by the CEC in their California Energy Demand Forecast.

D.12-04-025 defines Distributed Generation as "Customer-owned or operated generating systems that are enrolled with a utility in the Self Generation Incentive Program (SGIP) or the California Solar Initiative (CSI) or otherwise operating under a Feed In Tariff (FIT)." Significant customer-side Distributed Generation capacity has been interconnected outside of the CSI and SGIP programs. Therefore, data includes all NEM and non-export Rule 21 interconnected facilities.

For Rule 21 facilities, capacity for solar generating facilities is reported as the PV CEC-AC rating, while for non-solar facilities, capacity is reported as the maximum inverter capacity. Please note that in last year's annual report, PV capacity was reported as the maximum inverter capacity of the system.

Metric 7: Total electricity deliveries from customer-owned or operated, grid-connected distributed generation facilities, reported by month and by ISO sub-Load Aggregation Point. This information is for July 1, 2015 through June 30, 2016.

Year	Month	Exports (GWh)*
2015	Jul	144.58
2015	Aug	136.96
2015	Sept	111.73
2015	Oct	99.79
2015	Nov	91.81
2015	Dec	65.71
2016	Jan	70.01
2016	Feb	131.22
2016	Mar	165.73
2016	Apr	201.07
2016	May	218.36
2016	Jun	219.37

Note: Information and estimates about production of distributed generation facilities that serve on-site customer load is produced annually by the CEC in their California Energy Demand Forecast.

*In previous annual reports, net generation was reported. In this annual report and moving forward, the total generation figure by month will be provided.

Metric 8: Number and percentage of distribution circuits equipped with automation or remote control equipment, including SCADA systems. The measure is for July 1, 2015 through June 30, 2016.

Number and Percentage of PG&E's Distribution Circuits Equipped With Automation or Remote Control Equipment, Including SCADA		
Metric	Number	Percentage
PG&E Distribution Circuits Equipped With SCADA at the Breaker	2,316	70.7
Note: Percentage of distribution circuits equipped with automation or remote control equipment equals the number of distribution circuits equipped with automation or remote control equipment) divided by the total number of distribution circuits with the resulting number multiplied by 100.		

CHAPTER 4

CONCLUSION

4. Conclusion

As growth in DERs continues, PG&E continues to build the capabilities for a platform for a new energy landscape, one filled with customer choice and cleaner, renewable, and distributed energy.

The remainder of 2016 will be an exciting year as PG&E begins to complete the Smart Grid pilots and projects from the first EPIC triennial program. The lessons learned from these pilots and demonstrations will be invaluable in guiding the industry in making smart investments for the future.

PG&E will also continue to advance its Distributed Resource Plan in order to better integrate the growing number of DERs onto the distribution system.

With the investments made, Customers continue seeing benefits. For the period, customers enjoyed an estimated $68.3 million in benefits, inclusive of several key programs such as Cornerstone and the SmartMeter™ deployment.

Lastly, PG&E continues to maintain a strong commitment to supplier diversity and its aspiration exceed the Commission's supplier diversity goals set forth in General Order 156. PG&E intends to continue its successful track record and will review strategies related to its Smart Grid Pilot Projects, which were approved by the Commission in D.13-03-032.

CHAPTER 5

APPENDIX

5. Appendix

2015 Annual Smart Grid Report
Recorded Smart Grid Project Costs From July 1, 2015 Through June 30, 2016

Project Name	Recorded Amount
Customer Engagement and Empowerment Projects	
Supply-side DR Pilot (Continuation of IRM Pilot Phase 2)	$0.85 Million
Demand Response Transmission and Distribution System Integration	$0.33 Million
AC Cycling Next Generation Technology Assessment	$0.55 Million
Demand Response Plug-In Electric Vehicle Pilot	$1.6Million
Energy Diagnostics and Management	$9.75 Million
Energy Alerts	$0.135 Million
Share My Data (Customer Data Access) Project	$6.2 Million
Energy Data Access	$0.43 Million
Home Area Network Demand Response Integration Pilot Project	$0.2 Million
Time Varying Rates	$7.86 Million
Automated Demand Response Program	$5 Million
Smart Thermostat Study	$1.3 Million
Distribution Automation and Reliability Projects	
Distribution Substation Supervisory Control and Data Acquisition Program	$142.4 Million[10]
Distribution Management System Project	$2.25 Million
Battery Energy Storage System Demonstration Projects	$1.6 Million
Smart Grid Fault Location, Isolation, and Service Restoration	$14 Million
Install Smart Grid Line Sensors Pilot	$4.2 Million
Voltage and Reactive Power Optimization System Pilot	$16.64 Million
Detect and Locate Faulted Circuit Conditions Pilot	$2.72 Million
Transmission Automation and Reliability Projects	
Compressed Air Energy Storage Demonstration Project	$4.13 Million
Transmission Substation SCADA Program	$25.9 Million
Modular Protection Automation and Control Installation Program	$24.3 Million
Synchrophasor Project Realization	$2.31 Million
Asset Management and Operational Efficiency Projects	
SmartMeter™ Outage Management Integration Project	$0.15 Million
Electric Distribution Geographic Information System and Asset Management Project	$117.7 Million[11]

[10] Cost since project inception.

[11] Cost since project inception.

2015 Annual Smart Grid Report
Recorded Smart Grid Project Costs From July 1, 2015 Through June 30, 2016
(Continued)

Project Name	Recorded Amount
Network Supervisory Control and Data Acquisition Monitoring Project	$7.0 Million[12]
Smart Grid Short-Term Demand Forecasting Pilot Project	$2.64 Million
Security (Physical and Cyber) Projects	
Identity and Access Management Project	$10.4 Million
Integrated and Cross-cutting Systems Projects	
Telecommunications Architecture	$16.5 Million
Information Management Architecture	$3.3 Million
California Energy Systems for the 21st Century Program	$4.3 Million
Electric Program Investment Charge Program	$18.7 Million

[12] Cost recorded in 2016.

2015 Annual Smart Grid Report
Closed Smart Grid Projects

Project Name	Completion Date
Customer Engagement and Empowerment Projects	
Intermittent Renewable Resource Management (IRRM) Pilot Phase 1 In the IRRM Pilot Phase 1, PG&E leveraged work performed under the C&I DR Participating Load Pilot to provide regulation services to the CAISO. The objective of the IRRM Pilot Phase 1 was to demonstrate whether customers can provide second by second frequency-regulation service needs to the CAISO.	2011
Proxy Demand Resources (PDR) Program Phase 1 As part of the Commission's vision of integrating retail-wholesale DR programs, in the PDR Program Phase 1, PG&E is in the process of enabling its retail DR programs to directly participate in the CAISO's wholesale market – PDR product. Phase 1 of this project was focused on assembling the proper tools (i.e., telemetry, forecasting) and integrating interfaces (procurement back-end systems to schedule, notify and settle) that PG&E needs to operate when bidding available DR resources in the CAISO market.	2013
Plug-In Hybrid Electric Vehicle/Electric Vehicle (PHEV/EV) Smart Charging Pilot In the PHEV/EV Smart Charging Pilot, PG&E and the Electric Power Research Institute tested baseline functionalities of PEV charging hardware by conducting an end-to-end system connectivity to evaluate potential residential smart charging capabilities utilizing the load management software over the SmartMeter™ network.	December 2011
SmartMeter™ Program PG&E's SmartMeter™ Program launched the deployment of foundational technology to help PG&E's customers understand how and when they use energy, including through automated home energy management. The SmartMeter™ system improved infrastructure integrity, helped PG&E manage energy demand, and also enabled PG&E to provide more reliable service. Through these broad system-wide enhancements, the SmartMeter™ Program has served the vital foundational step to enable creation of the Smart Grid, which in turn fosters a clean energy economy and sustainable economic expansion.	December 2013
The Green Button Initiative In PG&E's Green Button Initiative, the Green Button tool provides customers with a means of easily accessing and downloading their energy use online in a standardized format that can be shared with energy service providers.	October 2012
Green Button Connect (GBC) Beta GBC is a software interface that allows PG&E customers to easily share their SmartMeter™ enabled energy usage data with other energy service providers. These developers can then "mash up" the data in unique ways to provide valuable insights to customers. GBC was retired when PG&E launched its Share My Data platform.	March 2015
Energy and Carbon Management System (ECMS) In the ECMS, PG&E has developed tools specifically for PG&E's large C&I customer account representatives to identify opportunity customers and enable a consultative energy discussion with those customers using advanced usage analytics and financial metrics for proposed EE projects.	December 2013
My Energy Web Tools PG&E's customer website – My Energy – allows residential, small and medium business, and small agricultural customers to view usage, price and cost, and take advantage of various rate analysis tools. The usage information is displayed in a variety of formats including year to year comparison, peak/off peak, hourly and 15 minute interval data (depending on the granularity of the SmartMeter™ data), bill to date and monthly bill forecast. The "My Energy" website will also include a rate calculator which will calculate the customer bill under a variety of available rate plans.	November 2012

2015 Annual Smart Grid Report
Closed Smart Grid Projects
(Continued)

Project Name	Completion Date
Universal Audit Tools (UAT) PG&E provides the Home Energy Checkup and Business Energy Checkup (also known as Universal Audit Tools) for residential and small and medium business customers through My Energy. These tools utilize SmartMeter™ data along with other customer insights to make it easy for our customers to find energy savings ideas that are particular to how they use energy. The tools are progressive in nature, continually learning based on the information the customer provides, and include recommendations across EE, DR, DG, and behavioral changes.	September 2012
HAN Enablement Program – Phase 1 & Phase 2 PG&E's HAN Enablement program is an infrastructure that allows customers to register and commission a standards compliant device with PG&E's AMI network to receive near RT data from their SmartMeter™. In HAN Phase 1 (Initial Deployment), which ran from March 1, 2012 through April 30, 2013, PG&E installed and supported 430 in-home displays with residential customers. Starting in January 2013, PG&E launched HAN as a platform, making the capability to register a device and received near real time usage information from a customer's electric SmartMeter™ available to all eligible customers across its service territory.	April 2013 and February 2014
Opower/Honeywell Smart Thermostat Assessment Pilot PG&E conducted a Smart Thermostat field assessment with Opower and Honeywell to evaluate the energy benefits that accrue to customers who utilize internet-enabled thermostats, when exposed to behavioral energy saving messaging. This effort was a component of the Energy Efficiency Portfolio's Emerging Technologies Program. PG&E successfully installed Honeywell Smart Thermostats in 505 residential homes in the San Francisco Bay Area and the Central Valley in February 2013. Opower and PG&E monitored usage differences between the test and control groups for a 12-month period.	July 2014
Distribution Automation and Reliability Projects	
Cornerstone Improvement Project – Feeder Automation The Cornerstone Improvement Project includes the installation of distribution feeder fault locating, isolation and service restoration (FLISR) systems on select urban and suburban circuits. The project is expected to result in reliability improvements for PG&E customers. The Feeder Automation component of Cornerstone Improvement Project involves implementing feeder automation on approximately 400 distribution circuits. The project scope includes automating mainline protection equipment utilizing FLISR schemes to restore unaffected customers within five minutes.	December 2013
Transmission Automation and Reliability Projects	
Regional Synchrophasor Investment Project As part of this project, PG&E installed or upgraded Synchrophasor technology, also known as Phasor Measurement Units (PMU), throughout its service territory, has networked them together, and provided the data in a secured interface to PG&E's electric transmission operators, WECC, neighboring utilities, and the CAISO. The data exchange portion of the project includes positioning PG&E to share data with WECC. Nine other partner entities can coordinate and exchange data amongst partner entities, including PG&E.	May 2014
Asset Management and Operational Efficiency Projects	
Transformer Load Management Project The SmartMeter™ Transformer Loading Management project enables T&D electric planning engineers and estimators to access actual customer usage data from SmartMeter™ for analysis in equipment sizing and voltage analysis. The solution will enable PG&E to report transformer (or multiple transformers) load based on interval usage data and the ability to drill down to month, week, day, and Service Point level to see the peak usage. The solution will also identify transformer (or multiple transformers) by load category (over loaded, under loaded) over the entire SmartMeter™ population.	June 2012

2015 Annual Smart Grid Report
Closed Smart Grid Projects
(Continued)

Project Name	Completion Date
Condition-Based Maintenance (CBM) – Substation Project The CBM Substation Project was a PG&E initiative to convert substation inspections collected on paper to a centralized electronic form. Centralizing the data aids in identifying problematic substation assets based on inspected condition trends in a predictive manner. The CBM technology solution for substation provides the platform for equipment inspection readings, temperature, and other data points to provide equipment predictive maintenance. The solution will automate many of the manual processes that are used today including: (1) review of station inspection and test data to identify abnormal conditions; (2) update maintenance trigger plans from oil condition assessment results, counter readings, etc.; and (3) equipment ranking for replacement decisions. The tool is also designed to provide easy access to inspection and test data to asset strategy and engineering personnel that do not have it readily available today. The data will be used to adjust maintenance triggers and for capital investment strategy.	February 2013
Load Forecasting Automation Program The Load Forecasting Automation program will automate existing manual electric distribution system load forecasting to increase accuracy of the process and improve forecast documentation. Current and future SCADA data will be gathered and stored within the existing data historian system and will become an input to the new forecasting tool. Circuits with SCADA will provide hourly load data into the historian system and non-SCADA circuits will provide a single monthly peak load from monthly substation inspections. Additionally, this project will replace analog bank demand meters with electronic recording meters.	October 2012
Security (Physical and Cyber) Projects	
Advanced Detection and Analysis of Persistent Threats (ADAPT) Cyber Security Project The ADAPT project is focused on increasing PG&E's ability to effectively anticipate, prevent, and respond to current and shifting cyber and physical threats by enhancing the following three control areas: a) Intelligence and threat management controls: Build specific "early-warning" controls that electronically collect, analyze, and correlate information on Utility targeting threats before they "approach" the Utility's logical perimeter. b) Advanced detective and preventative controls: Develop controls that "harden" the Utility's cyber security infrastructure with multiple layers of technology to filter, quarantine, and send alarms on questionable data. c) Adaptive response controls: Enhance incident monitoring, response, and investigation capabilities to quickly respond to potential security incidents.	May 2012
Integrated and Cross-Cutting Systems Projects	
Applied Technology Services (ATS) Distribution Test Yard (DTY) The DTY will serve as an electrical laboratory that includes simulated distribution capabilities for monitoring and evaluating various new distribution tools, equipment, and applications. It will include the necessary primary line equipment with isolated communications networks to allow safe and thorough testing without risking network security issues. This DTY is part of the overall ATS end to end test capability for distribution systems of the future.	September 2012
SmartMeter™ Operations Center (SMOC) The SMOC project implements telecommunication network operations management capabilities to support PG&E's SmartMeter™ network to handle growth in the number of deployed meters, effectively monitor the increased amount of data communications from the meters, bring new SmartMeter™-related customer services on-line efficiently, and enable timely customer response as well as proactive reliability and availability management. This scope includes designing and implementing a new SMOC for the day to day operations of the existing installed systems and ensure vendor production and operational commitments.	July 2012

Project Name	Completion Date
Data Historian Foundation Project This project will implement enhanced data historian software for managing and analyzing operational data with select user groups in electric transmission, gas operations, power generation, and energy procurement. When deployed and integrated with other electric systems such as EMS and SCADA, the new data historian will serve as the central data archiving and analysis system for all-time series operational data. This solution enables PG&E operators, engineers, managers and executives to analyze, visualize, and share operational and business data in a manner that not only makes the most sense to them, but also informs intelligent decision-making throughout the utility value chain. The benefits of this capability include productivity improvements, situational awareness, reliability improvements, and regulatory compliance. A separate project is required to enable these capabilities for electric distribution.	July 2014
Information Management Architecture PG&E proposed to invest in a core set of Information Management and processing capabilities to allow participants in the Smart Grid to have timely access to the best available data to drive their energy related decisions. The Information Architecture foundation includes enhanced decision support tools to more accurately analyze, predict, and respond to energy impacting events based on data processed from a multitude of systems and stakeholders. The approach to information management is being optimized and will launch as a new project in 2017.	Jan 2016