PACIFIC GAS AND ELECTRIC COMPANY
ELECTRIC PROGRAM INVESTMENT CHARGE
TRIENNIAL PLAN (2015-2017)

MAY 1, 2014

ATTACHMENT 1

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EXECUTIVE SUMMARY AND REGULATORY BACKGROUND

Executive Summary

Overview of PG&E's 2015-2017 Investment Plan

Pacific Gas and Electric Company (PG&E) is pleased to present its 2015-2017 Triennial Electric Program Investment Charge (EPIC) Investment Plan ("Investment Plan") to the California Public Utilities Commission (CPUC or Commission).

The purpose and governance for the EPIC program was established by the CPUC in Decision (D.) 12-05-037, issued on May 31, 2012, to assist in the development of pre-commercialized, new and emerging clean energy strategies and technologies in California, while providing assistance to commercially viable projects. The decision established approximately $370.9 million in funding in the 2015-2017 triennial period for the California Energy Commission (CEC) to pursue Applied Research, Technology Demonstration and Deployment, and Market Facilitation projects; and approximately $96.8 million allocated between PG&E, Southern California Edison Company (SCE), and San Diego Gas & Electric Company (SDG&E) for Technology Demonstration and Deployment initiatives over the same time period, with PG&E's authorized 2015-2017 EPIC triennial funding amount at approximately $48.5 million.

The Utility-administered portion of the EPIC program is intended to fund grid-specific projects that advance grid safety, reliability and cost-efficiency while advancing California's clean energy goals. The program's focus is to test pre-commercial or not yet widely commercialized strategies and/or technologies in the utility-specific environment and guide them through to commercial deployment for the benefit of electricity customers.

PG&E's First EPIC Triennial Plan was approved on November 14, 2013 and PG&E has quickly begun to execute against that first EPIC project portfolio.[1] This plan outlines PG&E's proposed Second EPIC Triennial (2015-2017) project portfolio.

PG&E's 2015-2017 Investment Plan has been developed based on the parameters identified above. As part of the process, PG&E consulted with internal and external

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1 EPIC First and Second Triennial Plans overlap due to the timing of the regulatory decision.

stakeholders, subject matter specialists, industry associations, research organizations, academia, and received input from public workshops and other forums to identify both emergent grid challenges and innovative technology demonstrations to address those needs. PG&E followed the common-Investor-Owned Utility (IOU) EPIC investment framework, developed and approved as part of the First EPIC Triennial Plan,[2] to categorize its Technology Demonstration and Deployment project portfolio into the following investment areas:

- **Renewables and Distributed Energy Resource (DER) Integration** (Smart Energy Markets) – maps to grid operations/market design under EPIC
- **Grid Modernization and Optimization** (Smart Utility) – maps to transmission and distribution (T&D) under EPIC
- **Customer Service and Enablement** (Smart Customers) – maps to Demand-Side Management (DSM) under EPIC
- **Cross-Cutting/Foundational Strategies and Technologies** (Cross-Cutting) – maps across the electric value chain

Table ES-1 summarizes the 30 specific projects PG&E intends to pursue as part of its 2015-2017 EPIC Plan. The table organizes the projects by investment area and identifies the primary benefits that PG&E believes the projects would demonstrate to increase safety, promote greater reliability and improve affordable policy attainment. Initiation and development of each of these projects will be subject to further stakeholder collaboration and consultation including coordination with the CEC, SCE, SDG&E, and other stakeholders in the Research, Development and Demonstration (RD&D) community in order to leverage the benefits of similar projects and to maximize potentially complementary efforts.

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2 The jointly developed IOU EPIC Investment framework was approved as part of D.13-11-025.

TABLE ES-1
PACIFIC GAS AND ELECTRIC COMPANY
PG&E'S 2015-2017 EPIC PROJECT PORTFOLIO

PG&E's 2015-2017 EPIC Project Portfolio			
Investment Area: Renewables and DER Integration Technology Demonstration and Deployment **Objectives in this category:** • **Integrate DER, Generation, and Storage** • **Improve Transparency of Resource Information** • **Increase Generation Flexibility**			
	Safety	**Reliability**	**Affordability**
1. Evaluate storage on the distribution grid	✓	✓	✓
2. Pilot Distributed Energy Management Systems (DERMS)	✓	✓	✓
3. Test Smart Inverter enhanced capabilities	✓	✓	✓
4. DG monitoring & voltage tracking		✓	
5. Inertia response emulation for DG impact improvement		✓	
6. Intelligent Universal Transformer (IUT)		✓	✓
Investment Area: Grid Modernization and Optimization Technology Demonstration and Deployment **Objectives in this category:** • **Optimize Existing Grid Assets** • **Prepare for Emerging Technologies** • **Design and Demonstrate Grid Operations of the Future**			
	Safety	**Reliability**	**Affordability**
7. Real time loading data for distribution operations and planning		✓	✓
8. "Smart" monitoring and analysis Tools		✓	✓
9. Distributed Series Impedance (DSI)		✓	✓
10. Emergency preparedness modeling	✓	✓	✓
11. New mobile technology & visualization applications	✓	✓	✓
12. Emergency management mobile applications	✓	✓	✓
13. Digital substation/substation automation		✓	
14. Automatically map phasing information		✓	✓
15. Synchrophasor applications for generator dynamic model validation		✓	✓
16. Enhanced Synchrophasor analytics & applications		✓	✓
17. Geomagnetic Disturbance (GMD) evaluation		✓	
18. Optical sensors for protection and control systems		✓	

TABLE ES-1
PG&E'S 2015-2017 EPIC PROJECT PORTFOLIO
(CONTINUED)

Investment Area: Customer Service and Enablement Technology Demonstration and Deployment **Objectives in this category:** • **Drive Customer Service Excellence by Leveraging PG&E's SmartMeter™ Platform** • **Drive Customer Service Excellence by Offering Greater Billing Flexibility** • **Integrate Demand Side Management for Grid Optimization**			
	Safety	**Reliability**	**Affordability**
19. Enable distributed demand-side strategies & technologies	✓	✓	✓
20. Real-time energy usage feedback to customers			✓
21. Home Area Network (HAN) for commercial customers			✓
22. Demand reduction through targeted data analytics		✓	✓
23. Integrate demand side approaches into utility planning		✓	✓
24. Appliance level bill disaggregation for non-residential customers			✓
Investment Area: Cross-Cutting/Foundational Strategies & Technology Demonstration and Deployment **Next Generation Infrastructure: Smart Grid Architecture, Cybersecurity, Telecommunications and Standards**			
	Safety	**Reliability**	**Affordability**
25. Enhanced Smart Grid Communications		✓	✓
26. Customer & distribution automation open architecture devices	✓	✓	✓
27. Next generation integrated Smart Grid communications network management	✓	✓	✓
28. Smart Grid communications path monitoring		✓	✓
29. Mobile meter applications			✓
30. Leverage EPIC funds to participate in industry-wide RD&D programs	✓	✓	✓

The project portfolio identified in Table ES-1 meets the primary guiding principle of the EPIC program which is to advance safety, reliability and/or affordability. PG&E's portfolio also addresses complementary EPIC guiding principles which include: demonstrating societal benefits; greenhouse gas (GHG) emission reductions; advancing the Loading Order; low-emission vehicles and transportation; economic development; and efficient use of ratepayer monies.

The project portfolio also incorporates California Public Utilities Code (Pub. Util. Code) 740.1 which includes elements of environmental improvement, conservation by efficient resource use, and many other guidelines for evaluating research, development, and demonstration programs. Finally, the project portfolio also aligns to California Pub. Util. Code 8360-8369 (Senate Bill (SB) 17), which seeks to advance smart grid goals in order to maintain safe, reliable, efficient, and secure electrical service.

Demonstration projects are by their nature designed to either identify promising strategies and technologies or provide learnings that the technology or strategy *will not* provide sufficient benefits to justify broader deployment. Hence PG&E expects that, over the course of the triennial period, projects may be refocused and/or re-scoped; projects may be terminated/off-ramped; projects may require additional pilots and/or demonstration to sufficiently assess operational and performance characteristics; or projects may be recommended for broader deployment via applicable filings such as future General Rate Cases or Transmission Owner rate cases. Program and project status updates will be reported in the EPIC Annual Reports and the stakeholder consultations that occur at least twice per year.

PG&E fully anticipates the range of scenarios outlined above for these early stage strategy and/or technology demonstrations. In fact, high failure rates of up to 90 percent have been associated to new technologies as they cross the "valley of death."[3] As a result, PG&E will establish project "off-ramps" at pre-defined stages in order to assess deployment viability and evaluate whether a project should advance, be re-scoped, or be terminated to avoid further expenditure of funds.

PG&E's Investment Plan is organized and presented consistent with the Ordering Paragraph (OP) 12 requirements and other provisions in D.12-05-037 as follows:

- **Chapter 1** describes PG&E's EPIC investment framework, developed and refined in conjunction with SCE, SDG&E, and stakeholder feedback workshops and approved by the CPUC as part of the first EPIC triennial cycle. The framework highlights priority technology demonstration areas to address emergent grid needs; provide safe, reliable and affordable services through the 21st century; and also advance

3 Gompers, Lerner; Harvard Business Review, 2001.

California energy policies in a cost-effective manner. This chapter also describes the collaboration efforts with the other EPIC Program Administrators, and consultation/information sharing process with other interested stakeholders.

- **Chapter 2** describes PG&E's Research, Development & Deployment Vision and Strategy consistent with EPIC's guiding and complementary principles, mapped to the electricity value chain, and consistent with Pub. Util. Code Sections 740.1 and 8360.
- **Chapter 3** outlines PG&E's 2015-2017 EPIC Project Portfolio, which is organized into the four investment areas: (1) Renewable Distributed Energy Resources Integration; (2) Grid Modernization and Optimization; (3) Customer Service and Enablement; and (4) Cross-Cutting/Foundational.
- **Chapter 4** describes Administration and Governance processes for PG&E's EPIC Plan including ongoing collaboration and coordination with the other EPIC program administrators, and PG&E's internal project governance processes for managing the EPIC Portfolio.
- **Chapter 5** describes the Metrics, Measurement and Evaluation PG&E expects to use for its Second Triennial Investment Plan. These quantitative and qualitative measures will be used to evaluate potential benefits, including alignment with the EPIC primary and complementary principles, as defined by the projects.

PG&E would like to acknowledge the contributions of interested stakeholders throughout the development of the EPIC Investment Portfolio and provides a summary of stakeholder feedback in Appendix A.[4] Appendix B provides a summary of PG&E's Energy Efficiency (EE) and Demand Response (DR) "RD&D" type activities as well as describes the coordination mechanisms in place to maintain the distinct nature of each program while also leveraging complementary efforts.

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4 D.12-05-037, OP 12(b)(viii).

Regulatory Background

Funding authorized in Pub. Util. Code Section 399.8, which governed the public goods charge (PGC), expired as of January 1, 2012.[5] The Commission opened an Order Instituting Rulemaking (R.11-10-003) to establish the Electric Program Investment Charge to preserve funding for the public and ratepayer benefits associated with the renewables and research, development and demonstration (RD&D) activities provided by the electric PGC. The rulemaking included two phases with Phase I to establish the EPIC program on an interim basis in 2012, and Phase II to establish purposes and governance for EPIC to continue from 2013-2020.[6] The EPIC Program administrators include three IOUs (PG&E, SCE, and SDG&E) and CEC.

The Commission in its Phase I *Decision Establishing Interim Research, Development and Demonstration and Renewables Program Funding Levels* (D.11-12-035), established 2012 funding at approximately $142 million and authorized PG&E, SCE, and SDG&E to institute the EPIC Program, effective January 1, 2012, to collect funds for renewables programs, and RD&D programs at the same level authorized in 2011. Additionally, the surcharge was imposed on all distribution customers, based on the existing rate allocation between customer classifications, and collected in the Public Purpose Program component of rates.

On May 24, 2012, the Commission issued its Phase II Decision Establishing Purposes and Governance for Electric Program Investment Charge and Establishing Funding Collections for 2013-2020. The decision established an annual funding amount of $162 million for 2013-2020 and set the funding allocations among the three IOUs as

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5 EPIC replaces the Public Interest Energy Research (PIER) program that was funded via the PGC. PIER provided funding to the CEC from 1996-2012 for electric research and development activities whereas EPIC allocates 80 percent of the funds to the CEC and 20 percent of the funds to PG&E, SCE and SDG&E apportioned according to customer base, by 50.1 percent, 41.1 percent and 8.8 percent, respectively.

6 See Phase I, D.11-12-035 and Phase II, D.12-05-037.

50.1 percent, 41.1 percent and 8.8 percent for PG&E, SCE, and SDG&E, respectively.[7] As ordered in the Phase II Decision, PG&E filed its first EPIC Triennial Investment Plan (2012-2014) on November 1, 2012 and the Commission approved its plan, with modifications, on November 14, 2013.

Conclusion

PG&E's 2015-2017 EPIC Plan is designed to advance California's energy policies and plays an important role in funding innovative new strategies and/or technologies with the potential to address emergent needs for the electric grid in the 21st century. The plan is premised on ongoing collaboration and coordination between the EPIC administrators and broader industry collaboration to provide a viable path to larger scale deployment for promising new technologies.

PG&E believes each project proposed in this portfolio is important and has the potential, at broader deployment to benefit electricity ratepayers. As such, PG&E respectfully requests Commission approval of its 2015-2017 EPIC Investment Plan.

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7 OP 7 of D.12-05-037 requires the total collection amount to be adjusted on January 1, 2015 and January 1, 2018 commensurate with the average change in the Consumer Price Index (CPI), specifically the CPI for Urban Wage Earners and Clerical Workers for the third quarter, for the previous three years. As reflected in Chapter 4.3, PG&E applies an interim escalation rate of 2.44 percent annually (7.5 percent compounded for three years) for the 2015-2017 triennial period, resulting in an estimated total program annual collection of $174.2 million.

CHAPTER 1

PG&E'S 2015-2017

EPIC INVESTMENT FRAMEWORK

1. PG&E'S EPIC Framework

PG&E's Investment Plan is based on significant IOU collaboration and stakeholder engagement to identify technology demonstration and deployment initiatives that are important to the long term sustainability of the electric grid. PG&E and the other IOUs collaboratively developed a working framework to identify and categorize the high priority investment needs that are common across all three IOUs. This framework:

1. Captures the overarching EPIC Guiding Principles of safety, reliability and cost-effective/affordable energy policy attainment.

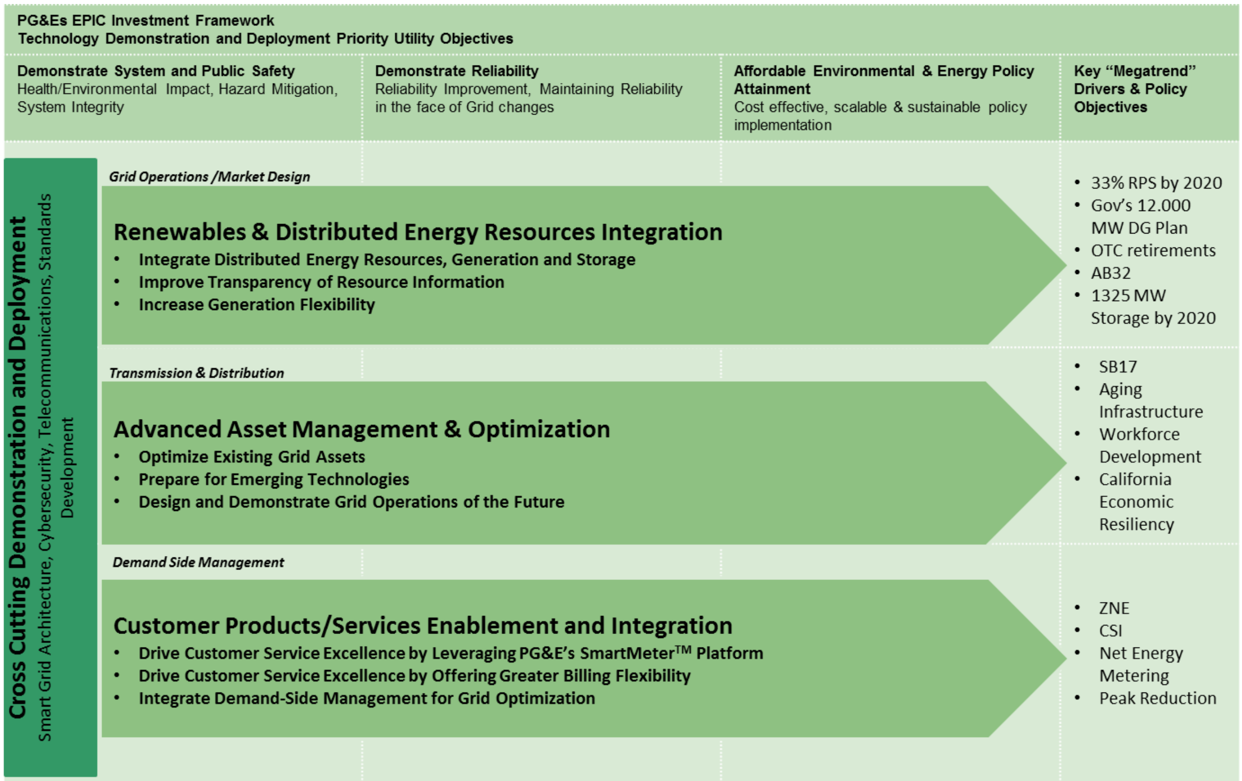
2. Demonstrates the direct linkage between the Utilities' proposed investment areas and key policy requirements such as achieving the 33 percent Renewable Portfolio Standard (RPS) by 2020, 1,325 Megawatt Energy Storage Procurement by 2020, and other macro trends such as aging infrastructure, and/or workforce development needs that will significantly impact the 21st century grid.

3. Outlines the three primary investment areas and one Foundational, or "Cross-Cutting" category; the IOUs have identified these as critical areas for focused, sustained, and collaborative Technology Demonstration and Deployment (TD&D) investment in order to modernize the grid and provide long-term benefits to Californians.

The framework was adopted as part of the first EPIC triennial investment plan and approved by the CPUC in D.13-11-025. PG&E and the other IOU administrators have re-adopted this framework as part of the second triennial EPIC planning cycle as the EPIC guiding principles, policy attainment goals, and macro drivers remain the same.

Figure 1-1 depicts PG&E's EPIC investment framework, which is described further in Chapter 3 of the investment plan.

FIGURE 1-1
PACIFIC GAS AND ELECTRIC COMPANY
PG&E'S EPIC INVESTMENT FRAMEWORK



1.1 Collaboration With Other Program Administrators and Consultation With Interested Stakeholders

The Program Administrators have met almost weekly, conducted working sessions, as well as held various in-person and online public workshops to solicit input on the development of their investment plans. Public opportunities for comment included the following:

- **December 18, 2013** – Joint public webinar conducted by all four program administrators (CEC, PG&E, SCE, SDG&E) to outline the EPIC investment framework, discuss implementation of the First Triennial Plan, and provide a timeline for the Second EPIC Plan.

- **February 21, 2014** – Joint public webinar conducted by PG&E, SCE and SDG&E to outline preliminary proposed areas for TD&D investment as part of the Second Triennial Plan.

- **March 17, 2014** – Northern California public workshop conducted by all four program administrators outlining their proposed EPIC Second Triennial Plans.
- **March 21, 2014** – Southern California public workshop conducted by all four program administrators outlining their proposed EPIC Second Triennial Plans.

Notice of each public webinar and workshop was provided to the parties on the service list of this proceeding. During each webinar and workshop, stakeholders and members of the public were provided the opportunity to comment on the EPIC program and encouraged to do so. The EPIC administrators provided an additional opportunity for public feedback after each webinar and workshop, by announcing a post-workshop written comment period of at least one week. PG&E also established a website (http://www.pge.com/en/about/environment/pge/epic/index.page) and email address (EPIC_info@pge.com) to receive stakeholder input at any time. A summary of stakeholder comments received during the development of this plan is included in Appendix A.

PG&E consulted with additional internal and external stakeholders to inform and shape its second triennial investment plan. This consultation includes members of academia, research institutions such as the Electric Power Research Institute (EPRI), national laboratories, industry associations, the vendor community and subject matter experts from within PG&E as well as across United States (U.S.) utilities. The purpose of these discussions was to probe for gaps in PG&E's investment approach as well as to understand other RD&D activities in the electric utility industry.

CHAPTER 2

PG&E'S 2015-2017 EPIC PLAN

RD&D VISION AND STRATEGY

2. PG&E's EPIC RD&D Vision and Strategy

PG&E's energy RD&D vision is to provide customers with safe, reliable and affordable energy services through the analysis, testing and piloting of innovative new energy technologies that support its core utility electric transmission, distribution, customer service and electricity procurement operations. **The TD&D activities under EPIC are an important component of the RD&D spectrum**, allowing the Utilities to test strategies and/or technologies that are near commercialization, inform vendor product maturity, prove the proper functioning of new technologies under grid specific conditions, and evaluate the costs, benefits, operational and financial risks of a new strategy or technology prior to full scale deployment.

2.1 EPIC Project Selection and Execution Approach Incorporates Key Legislation and Policy

PG&E explicitly incorporated Pub. Util. Code Sections 740.1 (utility RD&D) and 8360 (Smart Grid) as key inputs into the EPIC planning process, as required by D.12-05-037.[8] Projects were evaluated for their ability to meet the principles set forth under these codes in addition to their ability to meet the EPIC Primary and Complementary Principles established in D.12-05-037. Specifically, PG&E considers the following in developing and executing the EPIC investment portfolio:

- Alignment to EPIC mandatory guiding principles
  - Projects must demonstrate the potential to produce electricity ratepayer benefits defined as promoting greater reliability, lower costs, and/or increased safety at full scale deployment.
- Alignment to EPIC complementary guiding principles
  - In addition to the mandatory principles, projects can demonstrate additional benefits such as: societal benefits; GHG emission mitigation and adaptation in the electricity sector at lowest possible cost; loading order, low-emission

8 *Id.*, OP 12e.

vehicles & transportation; economic development; efficient use of ratepayer monies.

- Alignment to Pub. Util. Code 740.1 (Utility RD&D Goals)

  – In addition to the mandatory and complementary guiding principles, projects can demonstrate additional benefits in advancing the policy objectives of Pub. Util. Code 740.1. These include: environmental improvement; public and employee safety; development of new resources, particularly renewable resources, and processes which further supply technologies; conservation by efficient resource use or by reducing or shifting system load; improve operating efficiency and reliability or otherwise reduce operating costs.

- Alignment to Pub. Util. Code 8360 (Smart Grid Goals)

  – In addition to the mandatory principles, projects can demonstrate additional benefits in advancing the policy objectives of Pub. Util. Code 8360. These include: increased use of cost-effective digital information and control technology to improve reliability, security, and efficiency of the electric grid; dynamic optimization of grid operations and resources, including appropriate consideration for asset management and utilization of related grid operations and resources, with cost-effective full cyber security; integration of cost-effective smart appliances and consumer devices; provide consumers with timely information and control options.

In addition to regulatory and policy alignment, PG&E evaluated potential projects from an "Innovation" or "RD&D" lens consistent with the objectives of the EPIC program:

- The project must be new or innovative, and demonstrate a strategy and/or technology that has not yet been widely tested or deployed in a grid environment.

- The project must address a concern, gap or problem, and assess the likelihood that it can be solved through utility TD&D.

PG&E has implemented project governance processes that will provide an additional filter during the execution of TD&D projects. Requirements include the following:

- The project must have specific goals and objectives, a clear budget and timeframe.
- The project must have standards or metrics (including an evaluation, measurement and verification plan as appropriate) by which the results of the project can be measured.
- The project must have a plan for disseminating the information and results of the project to other California utilities and stakeholders.
- The project team must evaluate for any potential duplication, overlap and/or synergies with projects in PG&E's energy efficiency (EE) and demand response (DR) programs, other RD&D programs, as well as the EPIC initiatives of the other Program Administrators.

PG&E believes that this three-lens approach—Policy/Regulatory Alignment, Innovation Aspect and Project Governance—to select and execute projects achieves the appropriate balance of stimulating innovation while making efficient use of EPIC funds, including terminating projects when they do not demonstrate the desired goals. In addition, PG&E's ongoing consultation process with stakeholders, including the other Program Administrators, to share lessons learned and complementary efforts will help stretch scarce RD&D dollars and foster a stronger, both competitive and collaborative RD&D community that encourages market advancement.

PG&E has included 30 potential demonstration projects in its EPIC Plan as described in Chapter 3. Selection of EPIC projects will occur from this list of candidate projects once the EPIC program is approved, anticipated by December 2014. The actual scope, timeline and budgets for projects will then be baselined, i.e., set based on initial scoping efforts based on information obtained through competitive solicitation processes, requirements analysis, etc. as appropriate. Project governance processes, as described above and in more detail in Chapter 4, will further define the actual projects selected and executed.

CHAPTER 3

PG&E'S EPIC 2015-2017 PROJECT PORTFOLIO

3. PG&E'S 2015-2017 EPIC Project Portfolio

The IOU-administered portion of the EPIC Program is limited, per D.12-05-037, to the TD&D funding category. Investments in this area are intended for the installation and operation of pre-commercial technologies or strategies at a scale sufficiently large and in conditions sufficiently reflective of anticipated actual operating environments to enable appraisal of the operational and performance characteristics and the financial risks.[9]

While utilities need to be engaged across the entire technology maturation curve, beginning with early stage research and ending with deployment of commercially mature technologies, utilities play a key role in the technology demonstration portion of the RD&D maturation spectrum. Grid-specific demonstrations are important to evaluate the safety, reliability, and cost-effectiveness of new technologies against the utility's grid-specific composition, Information Technology (IT) landscape, customer profile, and business requirements. Therefore, utility specific demonstrations, such as a proof of concept, prototype, laboratory or pilot testing of a particular strategy and/or technology is essential to inform real costs, benefits and feasibility at full deployment.

An equally important but less tangible aspect of TD&D is the understanding of potential risks to strategy or technology acceptance. This includes evaluating customer attitudes, workforce acceptance factors, and integration with existing work processes, standards or systems. Even the best technology can fail if it is not accepted by its consumers or seen as providing value from their perspective. Therefore, PG&E projects may include an evaluation of customer or stakeholder adoption as appropriate.

This chapter presents each of the four areas of investment: (1) Renewables and Distributed Energy Resources; (2) Grid Modernization and Optimization; (3) Customer Service and Enablement; and (4) Cross-Cutting/Foundational. A description has been provided of each program area, key objectives and current challenges followed by the proposed demonstration projects to help overcome today's challenges.

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9 D.12-05-037, OP 3.

3.1 Renewables and Distributed Energy Resources Integration

3.1.A Program Area Background and Current Challenges

California has the most ambitious clean energy goals in the U.S. Specifically, by 2020, California energy policies call for utilities to: (1) contribute to reducing statewide GHG emissions to 1990 levels; (2) purchase or produce enough California-eligible renewable energy to meet 33 percent of customer needs; (3) interconnect 12,000 megawatt (MW) of locally-produced renewable generation; (4) retire 12,000 MW of once-through-cooling power plants; and (5) serve new residential dwellings that operate on a Zero Net Energy basis. All of these factors imply significant increases in the amount of renewable energy moving on California utility transmission and distribution grids.

Some forms of renewable generation (e.g., geothermal and biomass) act much like current central station power plants, presenting no significant new technological challenges. However, most of the new utility-scale renewable energy generation that is increasingly connecting to the utility grid has very different operating characteristics. The most common type will be resources defined by the Federal Energy Regulatory Commission (FERC) as a "Variable Energy Resource" or VER. FERC defines a VER as an energy source that: (1) is renewable; (2) cannot be stored by the facility owner or operator; and (3) has variability that is beyond the control of the facility owner or operator. VERs generate electricity when natural conditions such as wind and sunshine allow it, presenting new challenges across the generating and load balancing time spectrum of seconds, minutes, hours, days, and months.

In addition to an increasing level of VERs, California expects to add other variable resources that will operate outside of utility or the California Independent System Operator (CAISO) control, such as more Combined Heat and Power, self-optimizing customer micro-grids, customer energy storage, and/or fuel cells installed behind customer meters. The principal need in this program area is to facilitate the integration of variable resources into the grid and coordinate with CAISO wholesale markets, such that the resources can be deployed reliably within the timeframes required to meet the policy goals noted above.

The operating characteristics of variable resources add complexities to managing the grid and make it more difficult for the CAISO to maintain required balancing area standards for frequency, voltage, imbalances, and other requirements. At the same time, distribution-connected variable resources present a challenge for utilities to maintain distribution grid operating standards for voltage, harmonics and overall reliability.

Investment in this program area is needed to facilitate the reliable integration of variable resources into the PG&E grid. Key needs include identifying strategies and technologies to minimize grid disruptions, identifying cost-efficient methods to deal with intrinsically variable renewable resources output, and improving forecasting of VER generation and load. The electric industry has seen many recent technological advances in these areas, and these new emerging technologies must be further assessed, evaluated and provided a path towards viable large scale implementation if California is to be successful in reaching its energy policy goals.

Current Challenges

Integrate Distributed Energy Resources, Generation and Storage

Changes to today's grid are necessary to accommodate more variable resources. Utility distribution systems were designed to receive power from transmission systems, which were connected to large, central generating stations in a "one way flow of energy." New distributed resources that generate power behind the meter and flow back across the transformer and into the distribution feeder create the potential for new issues such as voltage spikes and dips, harmonics, over-generation and other issues. The variable nature of the new resources requires that the grid is able to respond to sudden changes in output by using flexible resources on the grid to provide Ancillary Services such as frequency regulation, voltage control, load following and reserves. Energy storage has been receiving much attention as a means to facilitate the integration of renewable energy as well as serve several other purposes on the electrical grid; however, utility experience with the new energy storage technologies is still in the early demonstration stages to understand the cost/benefit model of various use cases as well as technical performance.

Improve Transparency of Generating Resource Information

Generating Resource visibility is necessary to assist the CAISO as well as Utilities to more effectively manage the grid. Visibility includes better forecasting of renewable and distributed energy resources and also improved control of resources when needed, to maintain grid reliability.

PG&E supports Technology Demonstration and Deployment projects that improve the Utility's and the CAISO's ability to manage the grid by improving the visibility of generation conditions both on a distributed basis and for large-scale resources. Implementing the TD&D projects in PG&E's operating utility environment using real data and equipment will be of significant value to advance the body of existing conceptual level applied research and enable California's policy goal of 12,000 MW of distributed generation by 2020.

PG&E's Proposed Projects in the Renewables and Distributed Energy Resources Integration Program Area

Table 3-1 below outlines PG&E's proposed projects in the Renewables and Distributed Energy Resources Integration program area.

TABLE 3-1
PACIFIC GAS AND ELECTRIC COMPANY
SUMMARY OF PROJECTS BY PROGRAM AREA

Program Area: Renewables and Distributed Energy Resources Integration	Safety	Reliability	Affordability
1. Evaluate storage on the distribution grid	✓	✓	✓
2. Pilot Distributed Energy Management Systems (DERMS)	✓	✓	✓
3. Test Smart Inverter enhanced capabilities	✓	✓	✓
4. DG monitoring & voltage tracking		✓	
5. Inertia response emulation for DG impact improvement		✓	
6. Intelligent Universal Transformer (IUT)		✓	✓

Project Number: 1

Project Title: Evaluate storage on the distribution grid

Description of Technology or Strategy to Be Demonstrated

This project seeks to identify and evaluate whether system needs can be cost-effectively addressed with energy storage, including identifying a range of storage deployment locations and grid interconnection requirements on a granular level. The demonstration would inform a simplified process and/or tools for future energy storage resource deployment, connection and control. Additionally, the demonstration would evaluate the economic value of deploying utility scale storage.

Applicable Electricity Value Chain Elements	
☒ Grid operations/market design	☒ Distribution
☐ Generation	☒ Demand-side management
☒ Transmission	

Concern, Gap, or Problem to Be Addressed

California Utilities are mandated to procure 1,325 megawatts of energy storage by 2020. The storage technologies outlined in the procurement mandate including compressed air energy storage, batteries, thermal energy and fuel cells are recognized as early stage, emerging technologies. While not currently deployed at scale, they may provide "smoothing" benefits to integrate intermittent solar and wind energy into the grid. This demonstration seeks to evaluate the costs and benefits of siting strategies for storage including identifying a range of cost-effective, desirable storage locations to provide benefits to the grid. The demonstration would advance the development of a repeatable process for both utilities and third parties to more quickly evaluate storage locations upfront and understand the full cost benefit impact of a given location.

Potential Benefits at Full Deployment

A successful demonstration will help inform the larger scale deployment of storage technologies and help provide a cost-benefit comparison across different storage technologies, use cases and locations. This would enable better investment decisions by both utilities and third parties in procuring and siting storage.

Project Number: 2

Project Title: Pilot Distributed Energy Management Systems (DERMS)

Description of Technology or Strategy to Be Demonstrated

Distributed energy resources can provide benefits to the grid if there is sufficient visibility and control of the resources. This project will seek to demonstrate a DERMS pilot system to coordinate the control of various types of distributed energy resources, which could include demand response, Distributed Generation (DG), Electric Vehicles (EV), energy storage, and microgrids.

Applicable Electricity Value Chain Elements	
☐ Grid operations/market design	☒ Distribution
☐ Generation	☒ Demand-side management
☐ Transmission	

Concern, Gap, or Problem to Be Addressed

The amount of storage, DG and EVs on the grid will continue to increase; control and coordination of these resources will become progressively more important in order to maintain grid reliability and stable power quality. Industry efforts have investigated the control of individual resources, but a well-tested and validated central control platform capable of coordinating numerous distributed energy resources in real-time has not yet been commercially deployed at scale.

Potential Benefits at Full Deployment

Development, testing and demonstrations of DERMS will further California's goals in adopting higher amounts of distributed energy resources 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.

Project Number: 3

Project Title: Test Smart Inverter enhanced capabilities

Description of Technology or Strategy to Be Demonstrated

This project consists of a pilot demonstration of smart inverter capabilities both in a lab setting as well as at targeted residential grouping of Distributed Generation installations, such as high penetration Solar Photovoltaic (PV) locations. The pilot will seek to demonstrate the inverters' local voltage control capabilities, which can include: Volt-VAR Control; Low Voltage Ride Through; Low Frequency Ride Through; Generation Curtailment; High Voltage Real Power Curtailment; High Frequency Real Power Curtailment; and High Voltage, High Speed Disconnect.

Applicable Electricity Value Chain Elements	
☐ Grid operations/market design	☒ Distribution
☐ Generation	☐ Demand-side management
☐ Transmission	

Concern, Gap, or Problem to Be Addressed

Smart inverters are a relatively new technology offering various communication and control capabilities. Current industry standards are more aligned towards "passive" inverters as opposed to active inverter controls, and as a result various inverter functionalities are not fully utilized today. Industry experience suggests that more "active," i.e., dynamic, coordinated or automated inverter control may be necessary at higher DG penetration levels to maintain the safe, stable and reliable operations of the grid. In addition, a standard communication scheme has not been defined to allow "two way" communications between Utilities and the Inverters. As California moves towards higher DG penetration levels, targeted demonstrations of inverter controls will help inform emerging industry standards as well as define the operational and communication requirements to support the advancement and deployment of new inverter technologies.

Potential Benefits at Full Deployment

Demonstrating smart inverter controls in a pilot setting is important to improving inverter technologies, informing standards, as well as to advancing California energy policy to increase the amounts of renewable and distributed generation on the grid. Inverter control will be of increasing importance to mitigate the intermittency of renewable resources, avoid grid disturbances and unintentional "islanding," and correct for voltage and frequency dips and spikes. Defining and implementing inverter control operational requirements before widespread DG penetration will also potentially avoid the need for more costly retrofits in the future.

Project Number: 4

Project Title: DG monitoring & voltage tracking

Description of Technology or Strategy to Be Demonstrated

This project aims to utilize the voltage measurement capabilities of smart meters to monitor DG output and evaluate voltage fluctuations on high DG penetrated feeders caused by the intermittent nature of distributed renewable resources. As part of the demonstration, this data will be mapped with Geographic Information System (GIS) information to prototype the visualization tools necessary for distribution planners to assess, monitor and mitigate the impact of DG on the grid, for electric estimators to design systems and size equipment correctly, and for system operators to be aware of DG locations for operational purposes.

Applicable Electricity Value Chain Elements	
☐ Grid operations/market design	☒ Distribution
☐ Generation	☐ Demand-side management
☐ Transmission	

Concern, Gap, or Problem to Be Addressed

High penetration of intermittent DG can cause voltage fluctuations, including spikes and drops that are outside of Electric Rule 2 limits. Simulation based impact studies have been conducted but larger scale evaluation using field measurements have not been widely undertaken. Leveraging field-based voltage measurements is an initial step to understand and assess voltage issues and subsequently determine a new, comprehensive solution to integrate DG into utility planning and decision analysis tools, as well as grid operations.

Potential Benefits at Full Deployment

Utilities are in the early stage of leveraging metering infrastructure and data for integrated operational use. Deploying strategies and tools that combine the different sources of data, including voltage data, operations, and geospatial data at the systemwide level for DG visibility would enable PG&E to proactively plan for DG integration, and identify and mitigate potential voltage issues that could denigrate service reliability for our customers.

Project Number: 5

Project Title: Inertia response emulation for DG impact improvement

Description of Technology or Strategy to Be Demonstrated

Inertia traditionally refers to the stored rotating energy in an electrical system that is proportional to frequency and provided mostly by synchronous generators. This means that a loss of a synchronous generator will result in a drop in frequency until the system reaches a new steady state operating point.

This project will seek to demonstrate the concept of emulating the injection of inertia using energy storage device coupled with distributed PV and smart inverters.

Applicable Electricity Value Chain Elements	
☒ Grid operations/market design	☐ Distribution
☐ Generation	☐ Demand-side management
☒ Transmission	

Concern, Gap, or Problem to Be Addressed

Increased DG penetration on the grid is expected to result in a reduced number of connected conventional power plants and hence reducing the available inertia to the grid. This will require changes in controlling the grid frequency. The California ISO is anticipating additional market requirements for renewable resources, which could include emulating injection of inertia and resynchronization standards. The concept of emulating inertia using PV, energy storage with smart inverter can help solve part of the inertia problem. However, many operational issues regarding the effective deployment and management of such devices remain unsolved. There is a need for a demonstration project to prove if this technology is viable and can be operationalized.

Potential Benefits at Full Deployment

Demonstration of the capability to emulate inertia injection and support primary frequency control using energy storage and smart inverter technologies can mitigate the impacts of large-scale DG to the grid, improve the grid performance and reliability, and advance California energy policy to increase the amounts of renewable and distributed generation on the grid. In addition, the demonstration of smart inverter technology would assess continued controllability and reliability of the grid with high penetration of renewables, and make the DG technology compatible with the CAISO's as well as PG&E's control platform.

Project Number: 6

Project Title: Intelligent Universal Transformer (IUT)

Description of Technology or Strategy to Be Demonstrated

This project seeks to develop and demonstrate a solid-state transformer field prototype Medium Voltage Fast Charger (MVFC) system, as an application use case of solid-state transformers for DC fast charging of plug-in electric vehicles (PEV), featuring intelligent controls and multiple fast charging of PEVs. A solid-state transformer that can manage Medium Voltage DC connections has the potential to serve multiple competing PEV DC fast charging standards and this demonstration would explore the use of the MVFC system to connect to all three competing connector charging protocols: CHAdeMo; SAE COMBO; and the Tesla Super Charger protocol.

This project entails three stages. In stage one, the advanced MVFC system will be built and its operational performance validated in controlled settings and then piloted in the field under one or more controlled real-world environments. Stage two would add an energy storage device to the charging site and develop a use case with processes to utilize energy from the storage device to support the fast charging use case and serve to mitigate potential distribution impacts, identifying further cost savings opportunity. Stage three would add solar generation to the site to recharge the battery and document integration opportunities and challenges for system optimization. Each of these three stages would create use cases to test the grid service capabilities of a solid-state transformer. Progression to subsequent stages depends on findings in earlier stages and related costs.

Applicable Electricity Value Chain Elements	
☒ Grid operations/market design	☒ Distribution
☐ Generation	☒ Demand-side management
☐ Transmission	

Concern, Gap, or Problem to Be Addressed

Currently, DC Fast charging has three competing connector standards, including CHAdeMO, on Nissan, Mitsubishi and Kia vehicles; COMBO, on Chevrolet, Ford, and BMW; and Tesla using a proprietary system. Third party business models for electric vehicle infrastructure have not proven successful due to hardware, installation and operational costs. These issues become exacerbated with three competing standards. Serving the three DC fast charging standards through the solid state transformer system, while balancing solar and stationary electro-chemical energy storage, has the potential to lower costs of charging infrastructure through efficiencies and improve the value proposition to accelerate market development. Demonstrating solid-state transformers could help enable the installation of a universal DC Fast Charging system. This project seeks to significantly test and validate assumptions and develop various use cases for a flexible grid modernization solution to help address many PEV infrastructure deployment site characteristics and challenges that stakeholders will likely encompass.

Potential Benefits at Full Deployment

By directly connecting a solid-state transformer to the existing electrical distribution network for DC Fast Charging, it may be possible to achieve PEV charging infrastructure cost savings and efficiency improvements of the charging infrastructure when compared to traditional DC Fast Charger installations. While the primary goal is enabling the grid so that it can more effectively integrate electric vehicles with minimal impact and at the least cost, this proposed project may also generate valuable learning and experience in the application of solid state transformers for validating various technologies and their grid beneficial uses cases, identifying grid interconnection alternatives, and testing various scenarios for vehicle charging utilization. Accelerating the electric vehicle market has the potential to provide GHG reductions and could support system reliability by serving as storage as we move toward higher targets for RPS in California.

3.2 Grid Modernization and Optimization

3.2.A Program Area Background and Current Challenges

Today's electric grid is a complex integration of electrical equipment components including meters, wires, structures, transformers, reclosers and switches, capacitor banks, substations, operations control centers, generation assets, communications networks, and measurement and monitoring systems (both equipment and software systems). This equipment and these systems must work together in perfect harmony to deliver electricity safely, reliably, and efficiently. PG&E's grid is extensive, covering 70,000 square miles and serving a population of 15 million people, over 141,000 circuit miles of distribution lines with 20 percent of the lines located underground, over 18,000 circuit miles of transmission lines, 864 substations that include circuit breakers, transformers, voltage regulation equipment, and capacitor banks, over 2,000 substation transformers, over 3,000 distribution circuits, and over 2.2 million wood poles.

Much of this grid infrastructure has been in place for more than 40 years; upgrading of aging assets to take advantage of modern technology is often necessary. This is a significant challenge faced by many U.S. utilities. In 2011, EPRI estimated that the costs to modernize the grid in the U.S. would be in the range of $338-$476 billion over a 20-year period.[10] Yet, this modernization is imperative in order to continue to improve employee and public safety, provide reliable electric service in the face of changing needs, and improve the efficiency of electric operations to maintain electric service affordability. Managing this "grid overhaul" process in a well-planned manner is a major initiative for California utilities and imperative to meet California energy policy goals including SB 17—smart grid goals to improve the efficiency of electrical system operations; Assembly Bill 32 2020—GHG emissions reduction goals; RPS—to increase procurement from eligible energy resources to 33 percent of total procurement by 2020; Executive Order S-3-05—to set GHG emissions targets; the Loading Order-Energy Action Plan and SB 626—to adopt Low Emission Vehicles/Transportation.

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[10] EPRI, "Estimating the Costs and Benefits of the Smart Grid, A Preliminary Estimate of the Investment Requirements and the Resultant Benefits of a Fully Functioning Smart Grid," March 2011.

The application of improved monitoring, measuring, and communicating technologies could drive more efficient asset management programs and reduce the labor-intensive efforts to inspect, test and maintain each of the millions of infrastructure components that comprise the grid. While these technologies are becoming increasingly available, they are not sufficiently tested nor at scale to be considered fully vetted commercial technologies that adhere to industry standards, critical cybersecurity requirements, or data protocols. Without utility scale demonstration, operators are reluctant to introduce unknown technologies into the grid environment that could potentially compromise system and public safety and reliability.

Current Challenges

Optimize Existing Grid Assets

As noted earlier, utilities are facing the task of performing grid “overhauls” while continuing to safely and reliably operate a complex electrical system containing millions of legacy components.

Utilities have focused on safely optimizing and extending the life of existing assets as well as implementing new remote monitoring and evaluation techniques. Advances in data analytics have also begun to move the industry from a forensic, “what happened” approach to a more proactive, “predict what will happen” approach. Optimizing existing assets will increase the cost-effectiveness of grid modernization, and enable existing infrastructure to better integrate with new participants on the grid, including distributed generation resources, electric vehicles, and new customer-oriented products and services.

PG&E has identified various emerging technologies in the utility industry, such as visualization, data integration, and mobile technology that can improve and optimize the underlying assets in service. These include new or improved “self-serve” data analysis engines and techniques to access existing utility and other sources of data, analyze it quickly, and efficiently develop actionable results.

Prepare for Emerging Technologies

While the typical lifecycle of traditional electric assets from planning through to operation, for example for a substation, can be more than 30 years, the general lifecycle for technology ranges from 12 to 18 months, representing one-tenth of the lifespan of traditional energy infrastructure. Therefore new technologies that do not have 30 years of "in the field" utility deployment are at a disadvantage. While promising technologies have been demonstrated in limited deployment, operators are often reluctant to "turn them on" or integrate them with existing, "tried and true" assets that have years of safety, reliability and operating data. Therefore, PG&E's EPIC program intends to proactively identify emerging technologies for pilot in a "real world" utility setting to help enhance adoption.

Design and Demonstrate Grid Operations of the Future

Utilities must remain engaged and informed on early stage, proof-of-concept technologies to understand the potential benefits, interactions with existing grid assets, and help drive interoperability standards to drive utility application of the new products. PG&E intends to pursue demonstration projects in this area that emphasize early stage technology assessments as well as understanding of the operator and customer impact of the strategy and/or technology.

PG&E anticipates working collaboratively with the CEC, the other IOUs, academia, vendors, as well as other members of the R&D community to advance understanding of promising early stage technologies.

PG&E's Proposed Projects in the Grid Modernization and Optimization Program Area

Table 3-2 below outlines PG&E's proposed projects in the Grid Modernization & Optimization program area.

TABLE 3-2
PACIFIC GAS AND ELECTRIC COMPANY
SUMMARY OF PROJECTS BY PROGRAM AREA

Program Area: Grid Modernization & Optimization	Safety	Reliability	Affordability
7. Real Time loading data for distribution operations and planning		✓	✓
8. “Smart” monitoring and analysis tools		✓	✓
9. Distributed Series Impedance (DSI)		✓	✓
10. Emergency preparedness modeling	✓	✓	✓
11. New mobile technology & visualization applications	✓	✓	✓
12. New emergency management mobile applications	✓	✓	✓
13. Digital substation/substation automation		✓	
14. Automatically map phasing information		✓	✓
15. Synchrophasor applications for generator dynamic model validation		✓	✓
16. Enhanced Synchrophasor analytics & applications		✓	✓
17. Geomagnetic Disturbance (GMD) evaluation		✓	
18. Optical sensors for protection and control systems		✓	

Project Number: 7

Project Title: Real Time loading data for distribution operations and planning

Description of Technology or Strategy to Be Demonstrated

Real time meter loading data can provide detailed and precise information for enhanced and dynamic distribution planning and real time distribution grid operations. This demonstration will leverage near real time and interval data to improve feeder modeling, inform load allocation throughout the distribution grid and transformer loading profiles, and identify opportunities to enhance current load forecasting processes for distribution transformers, feeders and substation transformers. The project will also test methods for automatic customer-to-transformer mapping, to-feeders and to-substation transformers.

Applicable Electricity Value Chain Elements (check all that apply)	
☒ Grid operations/market design	☒ Distribution
☐ Generation	☒ Demand-side management
☐ Transmission	

Concern, Gap, or Problem to Be Addressed

The existing common practice within the industry for estimating peak demand on distribution line sections is a "point in time" analysis that allocates loads based on monthly kilowatt-hour consumption. In addition, seasonal load studies for total distribution grid devices are only scheduled to be calculated twice a year for summer and winter "peak". However customer loads on the same line section peak at different times throughout the calendar year, so the allocation based on seasonal information can underestimate or overestimate the system status due to these different times of load peaks. Similarly, transformer peak loading is currently measured and recorded on a monthly basis, without a full loading history available to planning and operating engineers. A more precise, granular and near real-time understanding of distribution system status such as line loading and distribution transformer loading can enhance distribution planning for system capability, improve reliability and reduce cost.

PG&E intends to demonstrate improvements to distribution feeder modeling, system status estimation, real time switching decisions and inform preventive transformer maintenance as part of this project. Vendors and utilities are currently in the early stages of assessing these more granular load planning and operations methods and innovation is required to integrate these new strategies and tools into existing planning and operations systems.

Potential Benefits at Full Deployment

This demonstration could improve planning and investment decision analysis tools. Improved planning reduces costs because replacing overloaded transformers after failure is more expensive than replacing them before failure. It may also have a localized impact on reliability to some customers. Adequate capacity buildup enables economic development and improves system reliability. Also, more granular distribution planning would enable better integration of new demand resources including distributed generation as these are increasingly brought online to the system. As noted the scope of this project to aggregate meter loading to the transformer level at a higher frequency level, as well as aggregate transformer loading data upwards within the distribution model to all devices including feeder breakers has the potential to provide benefits to real time grid operations (planned and unplanned switching and restoration) as well as planning teams via more accurate planning models. It may improve the process of sizing and replacing distribution transformers before failures, planning feeder and substation capacity for cost-effective investment in electric infrastructure, and switching operations for system reliability.

Project Number: 8

Project Title: "Smart" monitoring and analysis tools

Description of Technology or Strategy to Be Demonstrated

This project will evaluate "smart" real-time asset monitoring and analysis tools, and demonstrate information visualization technologies for cost-effective asset management decisions. The project objectives are: Demonstrate strategies and technologies for real time, online monitoring of substation equipment; Demonstrate communication protocols and equipment to support the smart devices; Develop visualization techniques for improved monitoring; and evaluate new vendor technologies that enable data correlation and predictive analysis to better identify and respond to potential safety, reliability and/or operational issues.

Applicable Electricity Value Chain Elements	
☐ Grid operations/market design	☐ Distribution
☐ Generation	☐ Demand-side management
☒ Transmission	

Concern, Gap, or Problem to Be Addressed

Legacy grid assets built 40 years ago do not have the online monitoring capabilities available today. This demonstration would seek to demonstrate improvements to existing assets by incorporating new, real time monitoring technologies to better assess equipment condition and extend the life of grid assets in a cost-effective manner.

Potential Benefits at Full Deployment

This proposed project could lead to improvements in system reliability through “early warning” of asset issues to enable targeted corrective maintenance. In addition, successful deployment of smart monitoring on existing assets would be a cost effective approach to modernize the grid, thereby avoiding larger scale capital investments and maintaining affordability for customers.

Project Number: 9

Project Title: Distributed Series Impedance (DSI) Phase 2

Description of Technology or Strategy to Be Demonstrated

This project will demonstrate congestion mitigation by installing DSIs on parallel transmission facilities. It will include the DSI modules, communications equipment, and additional hardware or software needed for monitoring and control. This project will demonstrate the next generation of the Distributed Series Reactor (DSR) devices from the First EPIC Triennial Plan. DSRs are designed to reduce power flowing on transmission lines by inserting a series reactance, whereas the next generation DSI devices can either reduce or increase power flow on a transmission line by inserting either a series reactance or a series capacitance thus allowing PG&E to better control the line loading. This project expects to leverage the engineering, procurement and construction experience from the DSR demonstration project.

Applicable Electricity Value Chain Elements	
☐ Grid operations/market design	☐ Distribution
☐ Generation	☐ Demand-side management
☒ Transmission	

Concern, Gap, or Problem to Be Addressed

The primary purpose of demonstrating new DSI technologies is to potentially mitigate congestion problems that can exist on the grid. DSI can create variable line impedance, helping to control active power flow. As such, to mitigate an overloaded facility would require the installation of DSIs on that facility (operated in the inductive mode) and on a parallel facility with available capacity (operated in the capacitive mode). In areas where network transfer capability is congested, the system must be operated in a manner that mitigates that congestion. Such mitigation measures include generation re-dispatch, generation or load tripping, or facility upgrades.

Potential Benefits at Full Deployment

If proven effective, DSIs can be considered in various areas of the system. If analysis shows that DSIs are more economic than conventional transmission upgrades, such as reconductoring and new transmission lines, transmission asset utilization would increase resulting in affordability benefits.

Project Number: 10

Project Title: Emergency preparedness modeling

Description of Technology or Strategy to Be Demonstrated

This project seeks to incorporate natural hazard damage model information into one integrated tool which would provide the ability to quickly estimate the impacts of natural hazards (e.g., earthquake, tsunami, flooding, rising sea levels, wild land fires) on PG&E facilities to enable faster response and restoration. This tool would also provide the ability to prepare for these hazards by proactively modeling the impacts of potential hazards, to understand system vulnerabilities and restoration resource requirements. The demonstration involves overlaying asset locations and conditions with multiple potential hazards and including dashboards and visualization functionality.

In addition, this project seeks to demonstrate a Restoration Management and Optimization tool to allow for the aggregation of equipment damage estimates (via damage models, outage information systems, and damage assessments), hours to repair, and work resources. This innovative aggregation of newly available damage model data and visualization will provide PG&E with the ability to understand the impacts of the natural hazards (number of outages, customers out, and potential length of outages) to improve resource allocation and prioritization decisions and potentially provide more accurate estimated time of restorations (ETOR).

Applicable Electricity Value Chain Elements	
☐ Grid operations/market design	☒ Distribution
☐ Generation	☐ Demand-side management
☒ Transmission	

Concern, Gap, or Problem to Be Addressed

The incomplete understanding of potential damage to the electric system caused by natural hazards restricts the ability to effectively invest money to prevent, or reduce the length of, those outages. In addition, the inability to quickly estimate damage from actual events prevents a more accurate ETOR estimate and delays response to the level desired for quick restoration. Real life restoration efforts due to super storms, tsunamis, flooding and other incidents in the U.S. and globally have demonstrated the need for improved, integrated risk based emergency planning.

Potential Benefits at Full Deployment

This project has the potential to demonstrate reliability benefits in the face of natural hazards and recover from outages caused in emergency situations, or “extreme” events more quickly. Improved emergency response capability has additional benefits to system and public safety.

Project Number: 11

Project Title: New mobile technology & visualization applications

Description of Technology or Strategy to Be Demonstrated

This pilot project aims to demonstrate tailored, advanced mobile applications for PG&E field operations that build upon Grid Operations Situational Intelligence (Project #15) demonstration projects in the EPIC First Triennial Plan as well as existing “baseline” mobile deployments underway. Demonstrations could include mobile applications for enhanced situational intelligence; real-time hazard identification and field crew routing; crowd-sourced GIS updates; mobile-enabled customer “pinging” for restoration confirmation; field evaluation of voltage issues; enhanced and integrated asset information via mobile apps; radio-frequency identification asset tagging for asset management; and wearable “hands free” mobile devices. These technologies that would potentially integrate social media, location-aware technology, “big data” computing incorporating edge devices and sensor data are beyond what is commonly available today.

Applicable Electricity Value Chain Elements	
☐ Grid operations/market design	☒ Distribution
☐ Generation	☐ Demand-side management
☐ Transmission	

Concern, Gap, or Problem to Be Addressed

While various utilities have begun in-house demonstrations, wide deployment of mobile applications and newer mobile devices tailored to utility field resource needs are not commonplace, Distribution field resources still utilize manuals, paper and phone/radio communications between operators/control centers and the crews to execute procedures.

Potential Benefits at Full Deployment

Interactive handheld, new “hands-free” field and/or wearable devices and mobile applications providing real time, updated data may increase field crew efficiency, work effectiveness and allow work to be performed more safely.

Project Number: 12

Project Title: New emergency management mobile applications

Description of Technology or Strategy to Be Demonstrated

This project will develop new mobile applications to enhance PG&E’s emergency preparedness and response capabilities. Potential examples include:

Earthquake Early Warning Indicator and Mobile Alarm: The ability to receive early warning of large earthquakes provides the short but necessary time interval needed to allow employees get away from potentially dangerous situations and operators to enact earthquake protocols for the power grid or specific critical equipment.

Employee Mobile Application for Major Events: Interactive mobile application for employees during major events (e.g., storms, earthquakes) to allow employee “check-in,” assignment and dispatch, and to provide access to interactive and real-time updated emergency response plans.

First Responder Mobile Application: First responders and, potentially, customers could use this tool to submit pictures of unsafe conditions (e.g., wires down) and damaged equipment (e.g., broken poles) for better coordination during catastrophic emergencies. This application is innovative due to the new ways in which first responders could potentially report unsafe conditions to PG&E.

Applicable Electricity Value Chain Elements	
☐ Grid operations/market design	☒ Distribution
☐ Generation	☐ Demand-side management
☒ Transmission	

Concern, Gap, or Problem to Be Addressed

Current technologies do not provide sufficient “in the field” intelligence and coordination capabilities to support the new “emergency roles” program PG&E will utilize for responding to catastrophic emergencies. Additionally, employees working in the field may be unaware that an earthquake or aftershock has occurred, and shaking at their location is likely, putting them at risk. Finally, PG&E personnel may be dispatched unnecessarily (e.g., for telecommunication wires down instead of electric wires down) or dispatched without sufficient context “to the trouble” that a mobile application can help provide real time.

Potential Benefits at Full Deployment

If successful, this project would facilitate benefits related to increased awareness of unsafe conditions, rapid assessment of the damage, effective resource dispatch, and potentially faster system restoration. These factors lead to improved public, employee, and system safety as well as grid reliability.

Project Number: 13

Project Title: Digital substation/substation automation

Description of Technology or Strategy to Be Demonstrated

The project will investigate and evaluate sustainable protection and control technologies for future "digital" substations. Potential activities include industry surveys and benchmarking of available emerging technologies in this arena, testing technologies in a lab setting, and performing a pilot implementation to demonstrate technology adoption and integration with legacy substation protection and control technologies.

A typical protection and control system is composed of many devices beyond just primary and alternate line protections. A specific example of technology to be demonstrated includes evaluation, testing and demonstration of new electronic devices including, but not limited to, "merging units," Substation LANs, and assessing the cost/benefit of the devices compared to existing technologies. A Merging unit is an intelligent electronic device in digital substations to collect multichannel signals output, to merge and timely correlate current and voltage values from three phases, and to transmit these signals with the protocol of IEC61850-9-2 to protective devices and measure-control devices. The proposed project will investigate standardization, IT infrastructure to support the roadmap for deployment, and life cycle support. As the technology in this area has changed rapidly, this project goes beyond the proposed "Demonstrate new communication system to improve substation automation and interoperability" in the EPIC 2012-2014 Investment Plan. This project will also determine maintenance strategies of this technology when deployed.

Applicable Electricity Value Chain Elements	
☐ Grid operations/market design	☒ Distribution
☐ Generation	☐ Demand-side management
☒ Transmission	

Concern, Gap, or Problem to Be Addressed

New technologies related to substation controls and relays are emerging; however, there are limited demonstrations of these new substation protection and control technologies and their sustainability and cost/benefit have not yet been proven. A demonstration would provide information to validate whether the merging unit is more cost-effective than current methodologies and determine the sustainability with this protocol and others within the substation including interoperability concerns.

Potential Benefits at Full Deployment

This proposed project could demonstrate a sustainable way to engage emerging substation protection and control technologies to improve system reliably in a cost-effective manner. This may provide benefits in establishing efficient and sustainable technologies within substation design.

Project Number: 14

Project Title: Automatically map phasing information

Description of Technology or Strategy to Be Demonstrated

This project aims to explore a variety of pre-commercial analytics and/or hardware options to automatically map 3-phase electrical power information in order to improve the distribution network models. Use of Advanced Metering Infrastructure (AMI) data; Light Detection and Ranging mapping technology; Micro Phasor Measurement Units (PMUs); and hardware at the transformer may provide this automated capability.

Applicable Electricity Value Chain Elements	
☐ Grid operations/market design	☒ Distribution
☐ Generation	☒ Demand-side management
☐ Transmission	

Concern, Gap, or Problem to Be Addressed

The Distribution network model is central to many existing control systems, analyses, and processes. Normal means of improving the model include field surveys as outlined in CPUC General Order 165. Field surveys represent a significant expense, and do not collect the more detailed phase information needed for distribution operations. "Big data" approaches as well as hardware such as micro PMUs can drive innovations in automated mapping, improve cost-effectiveness and drive efficiencies across multiple processes that rely on the Distribution model.

Potential Benefits at Full Deployment

This proposed project can improve the efficiency of electric operations to maintain electric service affordability. Better phase identification can also help accommodate the interconnection of renewable and/or distributed energy resources which can facilitate GHG emissions mitigation and adaptation.

Project Number: 15

Project Title: Synchrophasor applications for generator dynamic model validation

Description of Technology or Strategy to Be Demonstrated

This project will demonstrate PMU on PG&E generator tie-lines or generators and test new Synchrophasor analysis software applications and evaluate their ability to perform generator dynamic model validation by analyzing the collected Synchrophasor data following transient disturbances on the transmission system.

Applicable Electricity Value Chain Elements	
☐ Grid operations/market design	☐ Distribution
☒ Generation	☐ Demand-side management
☒ Transmission	

Concern, Gap, or Problem to Be Addressed

In the aftermath of two major grid outages in 1996, the Western Electricity Coordinating Council (WECC) mandated testing and validation of generator dynamic models every five years or whenever a change is made to the generator, excitation system, or governor. Present test methods involve a time intensive test requiring multiple test personnel. The test typically involves tripping the generator multiple times over a period of several days. New Synchrophasor applications could potentially perform the same model validation more cost-effectively and without requiring an onsite test.

Potential Benefits at Full Deployment

This project could enable the WECC/North American Electric Reliability Corporation generator dynamic model validation to be conducted utilizing Synchrophasor data instead of periodic generator testing. The new technology can replace time and resource intensive test methodology, enhance system reliability and meet compliance requirements cost effectively.

Project Number: 16

Project Title: Enhanced Synchrophasor analytics & applications

Description of Technology or Strategy to Be Demonstrated

This project will explore new techniques to synthesize Synchrophasor data and utilize the data for advanced real-time system applications such as wide-area monitoring, protection, and control systems.

Applicable Electricity Value Chain Elements	
☐ Grid operations/market design	☐ Distribution
☐ Generation	☐ Demand-side management
☒ Transmission	

Concern, Gap, or Problem to Be Addressed

PMUs collect vast amounts of data, however efficient means to mine the data and employ it for rapid decision making have not yet been developed. As more data is generated, the importance of interpreting the data for overall trends and patterns will increase. By reducing the "data dimensionality" of Synchrophasor data and improving real time analytic tools, this demonstration would help move Synchrophasor applications beyond planning, forensics, and visualization to enhanced wide-area monitoring, protection, and control applications.

Potential Benefits at Full Deployment

This project could advance the applications for Synchrophasor technology and allow for better integration into existing system operation, monitoring, and protection processes. Primary benefits of full deployment are expected to system security and reliability.

Project Number: 17

Project Title: Geomagnetic Disturbance (GMD) evaluation

Description of Technology or Strategy to Be Demonstrated

This project aims to evaluate system vulnerability to GMD. The demonstration involves modeling GMD that occur during a geomagnetic storm and evaluating the impact on transmission lines, interconnection lines, substations and system voltages. This project will also compare GMD and Electromagnetic Pulse (EMP) and attempt to determine synergies with these impacts and necessary mitigations.

Applicable Electricity Value Chain Elements	
☐ Grid operations/market design	☐ Distribution
☐ Generation	☐ Demand-side management
☒ Transmission	

Concern, Gap, or Problem to Be Addressed

Geomagnetic disturbances occur when solar storms send electrically charged particles toward earth and interact with earth's magnetic field. This has potential implications for the high-voltage transmission grid. GMD can send Geomagnetic Induced Current (GIC) through transmission lines, potentially through transformers and into the earth through ground connections. GIC may reduce system voltage, overheat transformer cores and lead to equipment damage or failure, and potentially cause a widespread power outage when the disturbance is severe. This phenomenon and its impact on the grid is not yet well understood as well as mitigation or recovery processes.

Potential Benefits at Full Deployment

This demonstration could enable deployment of targeted GIC prevention, detection, and recovery strategies and technologies which would improve grid reliability in the phase of GMD events.

Project Number: 18

Project Title: Optical instrument transformers and sensors for protection and control systems

Description of Technology or Strategy to Be Demonstrated

This project will demonstrate newer technologies such as optical sensors as well as demonstrate strategies and technologies to configure appropriate protection settings, including the coordination required between both new and conventional instrumentation. Additionally, the project will evaluate the lifecycle costs of newer optical instruments. This project may also determine maintenance strategies of this technology when deployed.

Applicable Electricity Value Chain Elements	
☐ Grid operations/market design	☐ Distribution
☐ Generation	☐ Demand-side management
☒ Transmission	

Concern, Gap, or Problem to Be Addressed

Conventional instrumentation is less precise than some of the newer technologies. For example, optical sensors may provide more precise measurements to enable better protection compared with schemes provided by conventional instrumentation, not impacted by high magnitude currents saturation. The demonstration would evaluate the benefits of modern instrumentation as well as the associated adoption and deployment strategies.

Potential Benefits at Full Deployment

This proposed project could lead to the deployment of cost-effective, potentially more accurate protection and control methodologies that ultimately improve system reliably.

3.3 Customer Service and Enablement

3.3.A Program Area Background and Current Challenges

Driven by State energy policies and enabled by the emergence of new or newly cost-effective technologies, opportunities for California energy customers to be more than just consumers of electricity are increasing. PG&E customers can now adopt energy efficient technologies and processes, buy electric vehicles or demand response automation equipment, install distributed generation or energy storage, and also leverage near-real time and interval data and energy management devices to monitor, control, and operate their energy usage at home and in business in a more optimal manner.

To support California's ambitious goals for EE and reduced GHG emissions, the challenge is to find compelling ways to inform, serve and engage customers so that they may embrace these opportunities. The "Customer Service and Enablement" program area is designed to support projects that allow customers to actively manage their bills and reduce their environmental footprint.

Current Challenges

Drive Customer Service Excellence by Leveraging PG&E's Smart Meter Platform

PG&E has deployed Smart Meter technology throughout a majority of its service territory, establishing a critical framework and foundational platform for further innovation in DR, EE and customer services. Leveraging the deployed technology and AMI communications network will maximize the value of this investment and further the capability to support new information-based services and deploy future energy management services for customers. PG&E expects that these EPIC demonstrations will also assist in developing the marketplace for consumer-oriented tools and products that leverage the existing platform.

Drive Customer Service Excellence by Offering Greater Billing Flexibility

The availability of new, more granular energy use information is a growing opportunity to provide customers with cost-effective tools to manage their energy use and lower their bills. New technologies not yet largely grid-tested can provide near real-time energy usage feedback to customers as well as respond to grid and market signals to potentially delay or reduce demand. Overall, demonstrations in this area would evaluate and prove the viability of new strategies and technologies that support California energy policies in EE, DR and reduction of GHGs while offering increased billing flexibility to customers.

Integrate Demand-Side Management for Grid Optimization

The emergence and expected growth of EVs, distributed generation and other consumer side changes present both a potential source of stress on local areas of the electric grid as well as the opportunity for increased value creation between the interaction of customers, customer investments and the grid. When considering load growth, system planners will need to account for the impact of these technologies when planning for local peak loads. At the same time, customers expect to receive value from adopting new technologies. Considering customer side factors in a holistic manner—

including EE, DR, rate design and price signals, usage data, distributed generation and customer cited energy storage—can be more effective than considering each individual component and enable integration with the grid in an additive manner that reduces customer costs, creates customer value and better grid planning. Increasing penetration of distributed generation, for example, could potentially put the safe and reliable operation of the grid at risk. However, with proper integration DG potentially represents an opportunity to strengthen the grid and provide increased resiliency. The use of DR in a locally targeted and aggregated manner may also achieve specific demand reductions during local peak periods to react to local grid conditions, or slow or postpone distribution system capacity expansions.

PG&E's Proposed Projects in the Customer Service and Enablement

Program Area

Table 3-3 below outlines PG&E's proposed projects in the Customer Service and Enablement program area.

TABLE 3-3
PACIFIC GAS AND ELECTRIC COMPANY
SUMMARY OF PROJECTS BY PROGRAM AREA

Program Area: Customer Service and Enablement	Safety	Reliability	Affordability
19. Enable distributed demand-side strategies & technologies	✓	✓	✓
20. Real-time energy usage feedback to customers			✓
21. Home Area Network (HAN) for commercial customers			✓
22. Demand reduction through targeted data analytics		✓	✓
23. Integrate demand side approaches into utility planning		✓	✓
24. Appliance level bill disaggregation for non-residential customers			✓

Project Number: 19

Project Title: Enable distributed demand-side strategies & technologies

Description of Technology or Strategy to Be Demonstrated

This project will demonstrate various options to utilize distributed demand-side technologies and approaches to address local and flexible resource needs by testing through small scale deployment. Examples are:

Demonstrate real time pricing incentive strategies and technologies to support critical peak reduction in constrained areas.

Evaluate fuel switching/electrification options in order to support the grid in response to intermittent renewable generation (e.g., the use of electric water heaters as a fuel switching device, the use of pumped storage for agricultural customers).

Evaluate the cost/benefit of using customer-sited and community storage to smooth integration of renewables during daytime peak and provide flexible resource during evening peak and other use cases (e.g., ancillary service and capacity).

Work in coordination with proposed Project #3 to evaluate the benefits of enabling smart inverters control functionality focused on customer to grid-interaction for storage and DG.

Evaluate and test small business and residential scale Energy Management Systems.

Applicable Electricity Value Chain Elements	
☒ Grid operations/market design	☒ Distribution
☐ Generation	☒ Demand-side management
☐ Transmission	

Concern, Gap, or Problem to Be Addressed

While various demand side technologies exist, integration of these technologies at a large scale and with interoperability for grid purposes does not yet exist. In addition, emerging areas such as storage have limited deployment experience but the potential to help address intermittent distributed energy resources requirements. Demonstrations integrating the Grid to Demand Side technologies will assist in determining the range of cost-effective approaches and help advance California Energy Policy objectives.

Potential Benefits at Full Deployment

This project could help the utility to identify and apply a range of cost-effective options for wider deployment. Wider scale demand side integration has the potential to provide system flexibility, reliability and resiliency benefits as well as auxiliary benefits related to the loading order and GHG emissions mitigation and adaptation.

Project Number: 20

Project Title: Real-time energy usage feedback to customers

Description of Technology or Strategy to Be Demonstrated

The project intends to evaluate innovative feedback technologies to provide near real-time energy usage information to customers and to drive greater customer performance during DR events. The demonstrated technologies include behavior based DR by leveraging customer data access in order to help customers succeed on optional rates, and “real time” feedback provided via gamification strategies or other targeted, specific messaging.

Applicable Electricity Value Chain Elements	
☒ Grid operations/market design	☒ Distribution
☐ Generation	☒ Demand-side management
☐ Transmission	

Concern, Gap, or Problem to Be Addressed

Analysis of customer loads during demand response events suggests that there is opportunity to improve the magnitude and consistency of customer response. It is believed that customers are better performers during DR events when they have real-time or near-real-time feedback on their performance. This feedback could be further enhanced with location specific grid condition information that could be obtained through newer data analytics technologies.

Potential Benefits at Full Deployment

This project has the potential to achieve reliability and affordability benefits by better utilizing and integrating demand-side resources. Additionally, this may have auxiliary benefits related to GHG emissions mitigation.

Project Number: 21

Project Title: Home Area Network (HAN) for commercial customers

Description of Technology or Strategy to Be Demonstrated

This project will demonstrate the application of HAN technology to PG&E’s commercial customers. HAN deployments to date have been targeted at smaller customers including residential and small business. This project will work in coordination with previous HAN residential efforts in order to demonstrate HAN technology for commercial customers who have different meters.

Applicable Electricity Value Chain Elements	
☐ Grid operations/market design	☐ Distribution
☐ Generation	☒ Demand-side management
☐ Transmission	

Concern, Gap, or Problem to Be Addressed

To date, PG&E HAN capabilities have only been tested and enabled for residential and small commercial customers. Larger customers such as the small to medium commercial segment may potentially benefit from HAN applications and the use of its lower-cost telemetry for energy management. Since these customers have different metering set-ups, this demonstration would test compatibility of these commercial customer meters with HAN.

Potential Benefits at Full Deployment

This project has the potential to demonstrate HAN as a cost-effective energy management application to a broader customer base, which in turn broadens the participation of customers in California energy policy goals including advancing the preferred Loading Order, providing customers with rich information to manage energy use, and participate in demand side GHG emissions mitigation and adaptation strategies.

Project Number: 22

Project Title: Demand reduction through targeted data analytics

Description of Technology or Strategy to Be Demonstrated

This project will use load, interval and other sources of data to develop a new analytical tool which will identify strategic customers and target demand reduction in local areas by combining and integrating multiple DSM technologies (e.g., EE, DR, Distributed Energy Storage, Consumer-oriented Energy Tools). The project aims to investigate whether PG&E can achieve a sufficient amount of demand reduction, give visibility into the customer-side resources and improve the reliability of customer-side resources at the local level in order to delay the need for local capacity expansion expenditures.

Applicable Electricity Value Chain Elements	
☐ Grid operations/market design	☒ Distribution
☐ Generation	☒ Demand-side management
☐ Transmission	

Concern, Gap, or Problem to Be Addressed

Targeted approaches for identifying and deploying DSM products at specific locations on the distribution grid are essential to achieve sufficient peak load reductions, and mitigate specific and localized capacity and reliability needs. New availability of granular data and data analytics technology may make this targeted approach feasible where the information and technology did not previously exist.

Potential Benefits at Full Deployment

At full deployment, potential benefits could include increased system reliability and reduction in customer bills (affordability) as a result of targeted demand reduction through analytics. Additionally, broader deployment could have auxiliary benefits related to the loading order, GHG emissions mitigation, and societal benefits.

Project Number: 23

Project Title: Integrate demand side approaches into utility planning

Description of Technology or Strategy to Be Demonstrated

This project will develop a new analytical tool to help evaluate various DSM solutions, for integration into utility investment planning. The demonstration will evaluate whether alternative distributed and/or demand-side solutions can be successfully and cost-effectively integrated into utility capacity and reliability planning. This is an extension of the EPIC First Triennial Project #24 “DSM for T&D Cost Reduction” that focused on a specific pre-commercial application of DSM solutions and explores how to integrate a broader range of customer technologies and DSM approaches into grid planning and operations.

Applicable Electricity Value Chain Elements	
☒ Grid operations/market design	☒ Distribution
☐ Generation	☒ Demand-side management
☒ Transmission	

Concern, Gap, or Problem to Be Addressed

DSM mitigations may offer a lower cost option to maintain local area reliability under some circumstances. Potential DSM solutions are not able to be fully integrated in the least-cost planning framework at the distribution feeder/bank/substation level. This is because that there is limited visibility into the efficacy of the DSM mitigation as well as a limited definition around the relative cost-effectiveness of demand and supply side alternatives.

Potential Benefits at Full Deployment

This project can provide the potential benefit of more truly integrated least-cost planning at the transmission and distribution level. Development of an integrated least-cost planning framework which incorporates DSM as well as traditional supply side mitigations may result in lower system costs.

Project Number: 24

Project Title: Appliance level bill disaggregation for non-residential customers

Description of Technology or Strategy to Be Demonstrated

This project aims to demonstrate the ability to use sub-minute level usage information to determine appliance load for non-residential customers. This project expects to leverage the experience from the Appliance-level Load Disaggregation-Residential demonstration project in the First EPIC Triennial Plan (Project #18). Unlike the residential sector, usage patterns for non-residential customers vary widely, depending on the type of business. Even within a sector, appliance usage varies widely (for example, the difference between a salad restaurant and a full-service restaurant). This project will determine the relevant customer segments that would be good candidates based on savings potential.

Applicable Electricity Value Chain Elements	
☐ Grid operations/market design	☐ Distribution
☐ Generation	☒ Demand-side management
☐ Transmission	

Concern, Gap, or Problem to Be Addressed

In a rate research survey, 55 percent of non-residential customers indicate that seeing how much it costs to operate major pieces of equipment in their business is among the top two valuable tools for understanding their energy usage. Current tools, which give customers similar information, are based on industry appliance surveys and may not reflect the customer's actual usage. The deeper level of understanding of usage is available through an audit, which can be time consuming and more costly. Undertaking this demonstration would potentially allow PG&E to provide targeted programs to additional non-residential customers that do not depend on "typical load" segmentation.

Potential Benefits at Full Deployment

This project could help enable and maintain electric service affordability by providing customers with detailed billing insights. Additionally, this would have auxiliary benefits related to GHG emissions mitigation and adaptation.

3.4 Cross-Cutting & Foundational

3.4.A Program Area Background and Current Challenges

PG&E's EPIC investment plan includes TD&D activities in the "Cross-Cutting/ Foundational Strategies and Technologies" category. These demonstrations cut across all areas of the electric value chain and include evaluating cybersecurity issues, new telecommunications strategies and technologies, information system architecture, standards, workforce development and adoption, as well as other "foundational" activities in support of all three program areas: Renewables and Distributed Resources Integration, Grid Modernization, and Customer Service Excellence.

Demonstrations in the foundational area are aligned to California Pub. Util. Code 8360-8369 and SB 17 Smart Grid goals to provide the following:

- Increase the use of cost-effective digital information and control technology to improve reliability, security, and efficiency of the electric grid.
- Dynamic optimization of grid operations and resources, including appropriate consideration for asset management and utilization of related grid operations and resources, with cost-effective full cyber security.
- Integration of cost-effective smart appliances and consumer devices.
- Provide consumers with timely information and control options.

PG&E's Proposed Projects in the Cross-Cutting & Foundational Program Area

Table 3-4 below outlines PG&E's proposed projects in the Cross-Cutting & Foundational program area.

TABLE 3-4
PACIFIC GAS AND ELECTRIC COMPANY
SUMMARY OF PROJECTS BY PROGRAM AREA

Program Area: Cross-Cutting & Foundational	Safety	Reliability	Affordability
25. Enhanced Smart Grid communications		✓	✓
26. Customer & distribution automation open architecture devices	✓	✓	✓
27. Next generation integrated Smart Grid network management	✓	✓	✓
28. Smart Grid communications path monitoring	✓	✓	✓
29. Mobile meter applications			✓
30. Leverage EPIC funds to participate in Industry-wide RD&D programs	✓	✓	✓

Project Number: 25

Project Title: Enhanced Smart Grid communications

Description of Technology or Strategy to Be Demonstrated

New vendors have developed technologies offered on the Federal Communications Commission (FCC) licensed frequency range or band (called spectrum) that may potentially be more flexible, reliable, cost efficient, and secure. This project seeks to evaluate these license spectrum providers not yet widely tested or adopted, compare the benefits to existing infrastructure, and assess their ability to provide for future envisioned smart grid communications and customer services.

Applicable Electricity Value Chain Elements	
☒ Grid operations/market design	☒ Distribution
☐ Generation	☒ Demand-side management
☐ Transmission	

Concern, Gap, or Problem to Be Addressed

The FCC makes spectrum available either on a licensed or unlicensed basis. Current U.S. AMI networks are largely unlicensed spectrum with specific protocols and standards. As more and more Smart Grid services and devices are rolled out, utilities will need to evaluate how to leverage existing AMI networks to provide these additional services, or build additional telecommunications infrastructure and bandwidth. In addition, while many AMI networks have been largely “purpose built” for billing, differentiated telecommunications infrastructure may be needed to support increased distribution automation and customer services based on future Smart Grid use cases.

Potential Benefits at Full Deployment

A strong network consisting of multiple telecommunications “channels” provides grid communications resiliency and flexibility to adapt to new automation and customer service needs in the future. Early demonstrations in this area keep infrastructure options “open,” and explicitly evaluate newer technology vendors so as not to lock in to one single path. This provides benefits to long term affordability.

Project Number: 26

Project Title: Customer and distribution automation open architecture devices

Description of Technology or Strategy to Be Demonstrated

This project aims to demonstrate the means by which new customer and distribution devices could interoperate with PG&Es Internet Protocol version 6 (IPv6) network. The project will demonstrate the methodology, protocols, and standards for customers and vendors to connect and communicate various new devices and applications (e.g., HAN, EV charging, smart appliances, distributed automation devices, etc.) with the IPv6 network in an effective manner.

Applicable Electricity Value Chain Elements	
☒ Grid operations/market design	☒ Distribution
☐ Generation	☒ Demand-side management
☐ Transmission	

Concern, Gap, or Problem to Be Addressed

Interoperability is essential to provide a path for customers and vendors to develop and connect new technology (e.g., HAN, EV charging, smart appliances, distributed automation devices, etc.) seamlessly. This interoperability is also important to allow increased customer-to-grid interaction, allow customers to participate in energy markets, and enhance distribution operations with new Smart Grid technology. Without interoperability, the connectivity between technologies can be hindered, technology and functionality can operate in silos, and multiple interfaces and applications between systems are often necessary, which have high development costs and can lead to inefficiencies.

Potential Benefits at Full Deployment

A successful demonstration creates opportunities for new service offerings to customers and can lead to operational improvements in distribution planning. Increased customer-to-grid-to-market integration furthers Smart Grid goals and has the potential to enable many of California's energy policies.

Project Number: 27

Project Title: Next generation integrated Smart Grid network management

Description of Technology or Strategy to Be Demonstrated

This project will evaluate new technologies to holistically monitor, control and evolve the communications network and supporting infrastructure as a platform to enable Smart Grid solutions. Potential demonstration components would focus on new technologies that can cost-effectively integrate network management systems to distribution systems including asset management systems; network cyber resiliency demonstrations; and integration to support new and evolving customer services and needs.

Applicable Electricity Value Chain Elements	
☒ Grid operations/market design	☒ Distribution
☐ Generation	☒ Demand-side management
☐ Transmission	

Concern, Gap, or Problem to Be Addressed

Utilities are in the early phases of evolving AMI telecommunications systems to more comprehensive and integrated infrastructure that can support multiple and more complex Smart Grid solutions. This demonstration would seek to advance "conceptual" Smart Grid Models and Reference Architecture into practical applications to coordinate systems, apply common standards, and create interoperability.

Potential Benefits at Full Deployment

Integrated and holistic network management systems can yield operational efficiencies; optimize workflow and asset tracking; increase network cyber resiliency; enable improved smart grid solutions and support new and evolving customer services.

Project Number: 28

Project Title: Smart Grid communications path monitoring

Description of Technology or Strategy to Be Demonstrated

This demonstration will evaluate more efficient communication paths for AMI-related messages, including methods to clear potential interference, congestion, validate proper authorizations, and grant clearances for sending message over a secured communication path.

Applicable Electricity Value Chain Elements	
☒ Grid operations/market design	☐ Distribution
☐ Generation	☐ Demand-side management
☐ Transmission	

Concern, Gap, or Problem to Be Addressed

This demonstration seeks to improve AMI telecommunications, specifically interference and potential cybersecurity issues to improve the current AMI platform for future uses. The demonstration will evaluate options to enhance the security of the network, encrypt message, monitor for interference, and mitigate for interference from adjacent inhabitants of frequency.

Potential Benefits at Full Deployment

A successful demonstration will enhance PG&Es ability to manage the increasing telecommunications and infrastructure demands on the AMI network, as well as position the medium for the next generation of data throughput needs, utility and customer services that could strain on the network. Early evaluation of network needs and applying new solutions will enhance the throughput and reliability necessary to provide new services.

Project Number: 29

Project Title: Mobile meter applications

Description of Technology or Strategy to Be Demonstrated

This project seeks to develop new mobile meter technologies that can be used to monitor plug-in electric vehicles (PEVs), mobile distributed generation, and mobile storage. The demonstration would develop and test various applications of mobile meter technology, which could include use cases for remotely and near real-time tracking vehicle charge locations and energy flow; tracking locations of mobile storage systems, dynamic charge, & discharge across locations; simulating and testing the resiliency and operations of the mesh network with these additional meters; testing the availability of emergency power source during disasters; stress-test capability of the electric grids.

This project seeks to demonstrate the utility's ability to enable dynamic electric mobile metering for customers who will no longer be associated with a single point of electric network demarcation. This technology will be used to monitor the grid impact of knowing when, where, and what size load will be necessary to support new, flexible location technologies such as: PEVs, mobile distributed generation, and mobile storage. The demonstration would develop and test various applications of mobile meter technology, which could include use cases for remotely and near real-time tracking of vehicle charge locations and energy flow; tracking locations of mobile storage systems, dynamic charge, & discharge across locations; simulating and testing the resiliency and operations of the mesh network with these additional meters; testing the availability of emergency power source during disasters; stress-test capability of the electric grids.

Applicable Electricity Value Chain Elements	
☒ Grid operations/market design	☒ Distribution
☐ Generation	☒ Demand-side management
☐ Transmission	

Concern, Gap, or Problem to Be Addressed

With current stationary meter technology, it is challenging to meter PEV charges at a public location/station while appropriately billing the EV user and crediting the 3rd party charging station. Further, it will be a difficult challenge to predict where, when, and how much demand will be placed on the grid with flexible location devices and applications. A second concern is that as distributed generation becomes more prevalent, storage options may be desired in different locations at various times of the day. Mobile storage could support flexibility of grid connection opportunities, but current stationary meter technology does not allow for the ability to meter mobile storage.

Potential Benefits at Full Deployment

A successful demonstration will help inform a potential longer term deployment of mobile meter technology. At full deployment, mobile meter technology could inform when, where these flexible location grid impact points are, and what they require to be supported. Some additional potential examples of the benefits that these future services may provide are: provide mobile energy storage; reduce the infrastructure costs of EV charging stations providing both an affordability benefit to customers as well as encouraging further development of EV charging stations; promote green energy, greenhouse gas reductions, and the use of electric vehicles through reduced costs and increased availability of EV charging; advance the smart grid infrastructure, stimulate the energy storage and distributed energy industry; enable resource supply to be managed on a more granular level which would support higher use of demand side management; enhance the resiliency and operations of the mesh communication network by adding more meters.

Project Number: 30

Project Title: Leverage EPIC funds to participate in industry-wide RD&D programs

Description of Technology or Strategy to Be Demonstrated

PG&E can leverage EPIC dollars by participating and collaborating in multi-utility, industry-wide research, demonstration and deployment initiatives conducted by third-party organizations such as EPRI, industry associations, national labs and universities. These programs would allow PG&E to cost effectively participate and remain informed on industry trends, access real world experience through pilot programs, and benchmark its progress against leading efforts. This project is similar to the industry-wide RD&D program participation proposed in the First EPIC Triennial Plan and extends participation into the second triennial period.

Applicable Electricity Value Chain Elements	
☒ Grid operations/market design	☒ Distribution
☐ Generation	☒ Demand-side management
☒ Transmission	

Concern, Gap, or Problem to Be Addressed

PG&E can leverage limited EPIC funds by collaborating with and participating in other national RD&D efforts. By selecting specific programs that seek to further knowledge in areas of common concern to the utilities, PG&E can both maintain cost-effective use of its resources and TD&D funds as well as contribute to the advancement of new strategies and technologies through the broader RD&D community.

Potential Benefits at Full Deployment

RD&D collaboration is strongly focused and aligned to advancing the safe, reliable and affordable modern grid operations while advancing energy policy objectives.

CHAPTER 4

ADMINISTRATION AND GOVERNANCE OF PG&E'S EPIC INVESTMENT PLAN

4. Administration and Governance of PG&E’s EPIC Investment Plan

4.1 Collaboration With Program Administrators and Industry Leaders

The CPUC’s EPIC decision requires the four administrators to file coordinated triennial investment plans. Throughout the investment plan process, PG&E worked collaboratively with the other three administrators (CEC, SCE, and SDG&E), conducting conference calls, participating in each other’s public workshops, and meeting periodically to coordinate investment plans and ensure funding initiatives were complementary and not duplicative.

Together, the program administrators have identified topics where coordinated efforts from all the administrators is warranted and plans to continue to share information and coordinate efforts in these areas as needed to capture benefits for IOU customers. Areas of coordination may include RD&D activities related to microgrids, Smart Inverters, Energy Storage, and others. Indeed, many working groups, cross-utility and industry collaborative efforts already exist in these categories.

In furtherance of the guiding principles and goals of the EPIC Program as set out by the CPUC, and in order to maximize the benefits of the program to electric utility ratepayers, the EPIC administrators have agreed to pursue the following principles for cooperating and collaborating for EPIC funded projects:

Information Sharing and Coordinated Planning

- The EPIC Administrators will work together to address common goals, consistent with the state’s energy and environmental policies and the guiding principles for energy RD&D as stated in the CPUC’s EPIC Phase 2 decision. To this end, the EPIC Administrators plan to share information regarding their EPIC investment plans, programs and projects as much as practicable in order to maximize the efficient use of the funds and facilitate the dissemination of the results of the program efforts for the benefit of customers.

Leveraging Funding and Avoiding Duplication of Projects

- To the extent legally permissible, the EPIC administrators will work together to avoid unnecessary duplication of efforts, consistent with Pub. Util. Code 740.1, and to leverage the EPIC funding for the benefit of electric utility ratepayers. Furthermore, when developing projects for this plan, PG&E evaluated RD&D projects included in other regulatory filings (e.g., General Rate Cases, Demand Response and Energy Efficiency Programs, Smart Grid Pilot Projects, CES-21) to avoid unnecessary duplication.

Coordinated Input and Advice from Stakeholders

- The EPIC administrators will continue working together to schedule, solicit, and respond to comments and advice from stakeholders on their respective proposed and ongoing EPIC Plans and programs.

Treatment of Intellectual Property

- PG&E will administer and protect intellectual property rights in accordance with the guidelines provided in the Commission's EPIC decisions.

4.2 Proposed Project Portfolio Governance Process to Leverage EPIC Investments

Given the dynamic nature of RD&D efforts and the rapidly evolving electric industry, PG&E will continue to evolve the portfolio as well as utilize project and program governance processes to identify, evaluate, select and prioritize projects in an efficient manner.

PG&E has implemented a four-step process as part of its EPIC First Triennial Plan execution and will follow a similar process for its Second Triennial Plan:

Step 1: Perform an internal ideation process to identify priority demonstration needs for PG&E that advance EPIC guiding principles to improve safety, reliability and achieve state energy policies cost-effectively.

Step 2: Obtain external stakeholder feedback and perform a gap analysis of PG&E proposed initiatives with subject matter experts across the industry including vendor input, feedback from the research community, academia and the public through multiple workshops.

Step 3: Continue collaborative efforts with EPIC program administrators, internal and external subject matter experts to refine the TD&D portfolio including project specific objectives, scope, timelines and resourcing approach.

Step 4: Following the steps noted above, projects will undergo established PG&E EPIC program governance procedures to prioritize, initiate and execute projects as well as any external contracting required to support the project objectives at each phase.

As a result of the four step governance process, PG&E may decide, in the best interest of customers, to execute the entire portfolio of projects, defer or terminate some projects, or refine individual project scope with enhancements or modifications. While PG&E will signal any significant changes to projects (terminations, significant scope revision) to external stakeholders as part of its twice annual workshops, website and annual reporting processes as applicable, PG&E believes the internal governance mechanisms outlined above are appropriate for less significant project changes. As noted in the EPIC first triennial decision, CPUC noted that “Administrators may shift funds within a funding category/program area (i.e., TD&D) without limitation because Administrators need the flexibility to efficiently administer authorized proposals within a funding category/program area.” PG&E outlines below several scenarios that may impact the Second Triennial Plan:

- PG&E may seek a “Phase 2” of projects proposed in the First Triennial Investment Plan to demonstrate additional needs, use cases or objectives based on project specific learnings, new policies, performed gap analysis with other utilities/research community or other new variables that may naturally arise over the course of the project. In these situations PG&E will follow internal governance processes to determine if projects proposed as part of the Second Triennial plan should be deferred and/or shifted to instead introduce the “Phase 2” of projects from the First

Triennial Plan. This will be highlighted as part of the external stakeholder engagement activities noted previously.

- Given the evolutionary nature of an R&D portfolio, PG&E recognizes that new policy or other environmental factors may lends itself to a new project not contemplated in the three year plan today. In this case, PG&E also proposes to use the stakeholder engagement processes to announce and vet these projects, in addition to PG&E's internal governance mechanism. PG&E believes this is the most expedient method that complies with legal requirements and allows public and ratepayer input, and provides Utilities with the necessary agility and flexibility to adapt to new circumstances, policy and other external factors.

- As part of the EPIC 1 decision, CPUC noted that "Administrators may shift funds within a funding category/program area without limitation because Administrators need the flexibility to efficiently administer authorized proposals within a funding category/program area." Shifting between funding categories/program areas, i.e., from TD&D to Market Facilitation or Applied Research is not contemplated at this time due to utility program restrictions. However consistent with the Decision, PG&E would file a petition if it were to propose a new category of expenditures.

4.3 Proposed 2015-2017 EPIC Budget and Funding Allocation

D.12-05-037 authorized EPIC statewide funding collections at $162 million annually, from 2013-2020. OP 7 of that decision states the total collection amount shall be adjusted on January 1, 2015 and January 1, 2018 commensurate with the average change in the CPI, specifically the CPI for Urban Wage Earners and Clerical Workers for the third quarter, for the previous three years. Pursuant to this order, PG&E applied a 2.44 percent annual escalation rate (7.5 percent compounded for three years) to result in an annual collection of $174.2 million for 2015-2017.[11] The CEC is designated as administrator for approximately 80 percent of the EPIC funds with approximately

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[11] 2.44 percent annual escalation rate is based on data available at the time of this filing, for third quarters of 2011, 2012, and 2013. This rate may be updated to reflect the third quarter 2014 rate.

20 percent of program funding administered by the IOUs.[12] The 2015-2017 program budget for PG&E's portion of TD&D activities is approximately $48.5 million. In addition, the EPIC decision provides approximately $5.5 million for general PG&E administration of the EPIC program.[13]

TABLE 4-1
PACIFIC GAS AND ELECTRIC COMPANY
PG&E'S 2015-2017
TRIENNIAL INVESTMENT PLAN
PROGRAM BUDGET
(MILLIONS)

	CEC	PG&E	SCE	SDG&E	Total
Utility Collection/Funding Allocation		50.1%	41.1%	8.8%	100%
Authorized EPIC Funding Collection		261.747	214.727	45.9756	522.450
Program Administrator Budget by Funding Element					
Applied Research	177.375	0	0	0	177.375
Technology Demonstration and Deployment	145.125	48.472	39.764	8.514	241.875
Market Facilitation	48.375	0	0	0	48.375
Program Administration	41.280	5.493	4.507	0.965	52.245
Program Oversight (to be remitted to CPUC)	0	1.293	1.060	0.227	2.580
Total	**412.155**	**55.258**	**45.331**	**9.706**	**522.450**

Consistent with the Phase 2 Decision, PG&E's EPIC Investment Plan will operate within the 10 percent program administration cap. As described in Table 4-1, PG&E will allocate $48.5 million funding to the TD&D investment area only and is not authorized for expenditures in other program areas. Furthermore, administrators are asked to propose in their investment plans any requirements to seek or obtain match funding from other sources. PG&E would like to note that once the investment plan is approved, specific project budgets will be developed as part of project initiation and will include evaluation of potential fund-matching opportunities.

The procedural schedule established by the Commission in D.12-05-037 contemplates a Commission Decision adopting the second investment plan by December 2014. Due to the late timing of the decision approving the first investment plan and the shortened

12 D.12-05-037, OP 5.

13 *Id.*, OP 12(b)(i).

timeframe for the initial investment cycle, the Commission ordered uncommitted or unencumbered funds be rolled over to the second investment cycle.[14] Thus, upon Commission approval of this plan, PG&E will simultaneously manage the budgets of the 2012-2014 and 2015-2017 cycles.

4.4 Procedures for Competitive Solicitation of Projects and Outreach to Stakeholders and Third Parties

PG&E intends to consult regularly with other California energy RD&D stakeholders and subject matter experts as part of the execution of the EPIC investment plan. These have been noted earlier in Chapter 1. This consultation included multiple public workshops, benchmarking gap analysis activities with other utilities and research organizations and weekly meetings with the Program Administrators. In addition, PG&E has established a website to inform interested parties of PG&Es EPIC portfolio as well as bidding opportunities for specific projects.

Eligibility Criteria

PG&E's selection of new strategy and/or technology partners or vendors for individual projects will employ a public competitive solicitation process when appropriate, such as Request for Information and Request for Proposal, in order to draw on a broad array of external expertise and innovation. Eligibility criteria for award of TD&D funds will be determined on a project-by-project basis and PG&E will generally follow the IOU Contractor Solicitation Process and Evaluation Guidelines adopted in D.13-11-025.[15] Where a unique or specific expertise or capability is identified for an individual project, PG&E may employ sole source procurement procedures following PG&Es established procurement processes.

Funding Mechanisms

PG&E does not expect to utilize grants, loans or "pay-for-performance" types of contracts for EPIC projects, but does not rule them out or including other types of

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[14] D.13-11-025, OP 39.

[15] D.13-11025, Attachment 3.

“performance-based” incentives or requirements in its contracts, such as demonstrating a minimum level of operating experience and performance when piloting a particular technology, facility or process in the field. PG&E generally will use standard contractual provisions for each project based on standard time-and-materials contracts it has used in the past for similar RD&D projects. As is usual for utility contracts in general, PG&E’s EPIC contracts will retain audit rights for both PG&E and the CPUC.

CHAPTER 5

METRICS, MEASUREMENT AND EVALUATION OF PG&E'S EPIC INVESTMENT PLAN

5. Metrics, Measurement and Evaluation of PG&E's EPIC Investment Plan

PG&E expects to use a combination of quantitative metrics and qualitative criteria, in evaluating the potential benefits and actual results of its EPIC-funded projects. Each project funded through the investment plan will demonstrate how it conforms to the EPIC primary and secondary guiding principles as relevant including societal benefits, GHG emissions mitigation and adaptation in the electricity sector at the lowest possible cost, the loading order, low emission vehicles and transportation, economic development and efficient use of customer funds. PG&E intends to use these criteria to evaluate and report on individual projects.

In addition, in January 2013 the EPIC administrators collaboratively developed a list of proposed metrics and potential areas of measurement that administrators could choose based on the scope and objectives for an investment area. The list of proposed metrics includes metrics for public and worker safety, as recommended by the Energy Division, and was adopted as a supplement to each investment plan. Administrators are allowed the flexibility to choose metrics on a project-by-project basis and the list is not exhaustive. Once the investment plan is approved, PG&E can determine the appropriate metrics applicable to each project during the initiation or planning phase.

The applicable metrics, by project, may be used to evaluate the success of each project at its conclusion. The Commission approved metrics and areas of measurement include, but are not limited to: potential energy and cost savings; job creation; economic benefits; environmental benefits; safety, power quality, and reliability; other metrics; identification of barriers or issues resolved that prevented widespread deployment of technology or strategy; effectiveness of information dissemination; adoption of EPIC technology, strategy, and research data/results by others; and reduced ratepayer project costs through external funding or contributions committed by others.

Where practicable, PG&E will also apply metrics detailed in its Smart Grid Annual Report to evaluate the potential benefits and cost-effectiveness of various TD&D projects at full scale deployment. These include:

- Savings in Operation and Maintenance costs

- Energy savings
- Reliability improvement
- Reduced GHG emissions

Using the EPIC primary and complementary principles as a baseline, Table 5-1 outlines the potential benefit areas for each of the projects.

TABLE 5-1
PACIFIC GAS AND ELECTRIC COMPANY
SUMMARY OF EPIC INVESTMENT PORTFOLIO

PG&E's EPIC Investment Plan Project Portfolio									
	Primary EPIC Guiding Principles			Complementary EPIC Guiding Principles					
Program Area: Renewables and Distributed Energy Resources Integration Technology Demonstration and Deployment Projects									
	Safety	Reliability	Affordability	Societal Benefits	GHG Emissions Mitigation/ Adaptation	Loading Order	Low-Emission Vehicles/ Transportation	Economic Development	Efficient Use of Ratepayer Monies
1. Evaluate storage on the distribution grid	✓	✓	✓	✓	✓				✓
2. Pilot Distributed Energy Management Systems (DERMS)	✓	✓	✓	✓	✓		✓	✓	
3. Test Smart Inverter enhanced capabilities	✓	✓	✓	✓	✓				
4. DG monitoring & voltage tracking		✓							✓
5. Inertia response emulation for DG impact improvement		✓			✓				
6. Intelligent Universal Transformer (IUT)		✓	✓	✓	✓		✓		✓
Program Area: Grid Modernization and Optimization Technology Demonstration and Deployment Projects									
7. Real Time loading data for distribution operations and planning		✓	✓	✓	✓		✓	✓	✓
8. "Smart" monitoring and analysis tools		✓	✓						✓
9. Distributed Series Impedance (DSI)		✓	✓						✓
10. New emergency preparedness modeling	✓	✓	✓	✓	✓				✓
11. New mobile technology & visualization applications	✓	✓	✓						✓
12. New emergency management mobile applications	✓	✓	✓	✓	✓				✓
13. Digital substation/substation automation		✓							✓
14. Automatically map phasing information		✓	✓	✓	✓		✓		✓
15. Synchrophasor applications for generator dynamic model validation		✓	✓						✓
16. Enhanced Synchrophasor analytics & applications		✓	✓						✓
17. Geomagnetic Disturbance (GMD) evaluation		✓							✓
18. Optical sensors for protection and control systems		✓							✓
Program Area: Customer Services and Enablement Technology Demonstration and Deployment Projects									
19. Enable distributed demand-side strategies & technologies	✓	✓	✓	✓	✓	✓		✓	✓

TABLE 5-1
PACIFIC GAS AND ELECTRIC COMPANY
SUMMARY OF EPIC INVESTMENT PORTFOLIO
(CONTINUED)

PG&E's EPIC Investment Plan Project Portfolio									
	Primary EPIC Guiding Principles			Complementary EPIC Guiding Principles					
Program Area: Customer Services and Enablement Technology Demonstration and Deployment Projects									
	Safety	Reliability	Affordability	Societal Benefits	GHG Emissions Mitigation/ Adaptation	Loading Order	Low-Emission Vehicles/ Transportation	Economic Development	Efficient Use of Ratepayer Monies
20. Real-time energy usage feedback to customers			✓	✓	✓				✓
21. Home Area Network (HAN) for commercial customers			✓	✓	✓				✓
22. Demand reduction through targeted data analytics		✓	✓	✓	✓	✓			✓
23. Integrate demand side approaches into utility planning		✓	✓	✓	✓	✓			✓
24. Appliance level bill disaggregation for non-residential customers			✓		✓				✓
Program Area: Cross-Cutting/Foundational Strategies & Technologies Demonstration and Deployment									
25. Enhanced Smart Grid Communications		✓	✓				✓	✓	✓
26. Customer and distribution automation open architecture devices	✓	✓	✓	✓				✓	✓
27. Next generation integrated Smart Grid network management	✓	✓	✓						✓
28. Smart Grid communications path monitoring	✓	✓	✓	✓				✓	✓
29. Mobile meter applications			✓	✓	✓		✓		✓
30. Leverage EPIC funds to participate in industry-wide RD&D programs	✓	✓	✓	✓	✓		✓		✓

5.1 Plan for Disseminating Information and Results of EPIC Programs and Projects to Stakeholders and the Public

PG&E intends to use formal and informal means for widely disseminating EPIC program and project information and results to stakeholders and the public.[16] On a formal basis, PG&E will provide updates on its EPIC program and specific projects in the twice-yearly meetings with stakeholders and the annual reports required by the EPIC decision. PG&E has also established a website to disseminate information. On a more informal basis, PG&E will seek to establish informal working groups and clearinghouses for exchange of information and RD&D results among the four EPIC administrators as well

[16] D.12-05-037, OP 12(c)(iii).

as with other leading California RD&D institutions and stakeholders. The goals of these information dissemination protocols will be to maximize the sharing of RD&D insights, innovations and results so that the “know how” and benefits of the EPIC program can be leveraged for the benefit of all utility customers and the public as quickly and efficiently as possible. An additional goal of such information sharing is to enhance the ability of PG&E and RD&D leaders in the state to “benchmark” RD&D goals, ideas and results on a national as well as global scale.