BEFORE THE PUBLIC UTILITIES COMMISSION
OF THE STATE OF CALIFORNIA

In the Matter of the Application of Pacific Gas and Electric Company for Approval of its 2018- 2020 Electric Program Investment Charge Investment Plan. U 39 E	A.17-04-___ (Filed April 28, 2017)

APPLICATION OF PACIFIC GAS AND ELECTRIC COMPANY (U 39 E) FOR APPROVAL OF ITS 2018- 2020 ELECTRIC PROGRAM INVESTMENT CHARGE INVESTMENT PLAN

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Dated: April 28, 2017

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Pursuant to Ordering Paragraph 11 of Decision (D.) No. 12-05-037, D.15-04-020 and Article 2 of the Commission's Rules of Practice and Procedure, Pacific Gas and Electric Company (PG&E) hereby files this "Application For Approval of Its 2018- 2020 Electric Program Investment Charge Investment Plan."

PG&E's 2018- 2020 Electric Program Investment Charge Investment Plan ("EPIC Investment Plan") is provided as Attachment 1 to this Application.

I. STATUTORY AND PROCEDURAL REQUIREMENTS

A. Statutory Authority

This Application is filed pursuant to D.12-05-037 and Public Utilities Code Sections 451, 728, 740.1 and 8360.

B. Categorization - Rule 2.1. (c)

PG&E proposes that this Application be categorized as a "quasi-legislative" or compliance proceeding.

C. Need for Hearing - Rule 2.1(c)

PG&E anticipates that evidentiary hearings will not be needed. PG&E's proposed schedule is set forth in subsection E, below.

D. Issues to be Considered - Rule 2.1(c)

The principal issue presented in this Application is whether the Commission should approve PG&E's request for approval of its 2018- 2020 EPIC Investment Plan in compliance with the requirements of D.12-05-037. In addition, PG&E requests that this Application be consolidated with other existing EPIC applications in order for the Commission and interested parties to consider extending the general authorization for EPIC funding by rulemaking beyond 2020 in order to provide stable and sustainable research, development and demonstration programs to meet California's long-term clean energy and environmental goals.

E. Relevant Safety Considerations

In D.16-01-017, the Commission amended Rule 2.1(c) requiring an applicant to identify all relevant safety considerations implicated by an Application to which the assigned Commissioners and presiding officer could refer to during the proceeding. In order to ensure that safety considerations have received full consideration by parties and the Commission, PG&E's EPIC Investment Plan is administered in accordance with all applicable and appropriate safety standards and requirements, including promotion of public safety.

F. Proposed Schedule – Rule 2.1(c)

File Application	April 28, 2017
Protests Due	May 30, 2017
Reply to Protests	June 9, 2017
Prehearing Conference	June 20, 2017
Scoping Memo	July 3, 2017
Stakeholder workshops	July 11- 12, 2017
Opening comments	July 25, 2017
Reply comments	August 8, 2017
Proposed Decision	September 19, 2017
Opening Comments on Proposed Decision	October 9, 2017
Reply Comments on Proposed Decision	October 16, 2017
Decision	November 2017

G. Legal Name and Principal Place of Business – Rule 2.1(a)

The legal name of the Applicant is Pacific Gas and Electric Company. PG&E's principal place of business is San Francisco, California. Its post office address is Post Office Box 7442, San Francisco, California 94120.

H. Correspondence and Communication Regarding This Application - Rule 2.1.(b)

All correspondence and communications regarding this Application should be addressed to Christopher J. Warner and George Zahariudakis at the addresses listed below:

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I. Articles of Incorporation – Rule 2.2

PG&E is, and since October 10, 1905, has been, an operating public utility corporation organized under California law. It is engaged principally in the business of furnishing electric and gas services in California. A certified copy of PG&E's Restated Articles of Incorporation, effective April 12, 2004, is on record before the Commission in connection with PG&E's Application 04-05-005, filed with the Commission on May 3, 2004. These articles are incorporated herein by reference pursuant to Rule 2.2 of the Commission's Rules.

J. Balance Sheet and Income Statement - Rule 3.2(a)(1)

PG&E's balance sheet and an income statement for the period ending December 31, 2016, was included in Application No. 17-02-005, filed on February 28, 2017 and incorporated herein by reference.

K. Statement of Presently Effective Rates - Rule 3.2(a)(2)

No presently effective electric rates will be modified by PG&E's application.

L. Statement of Proposed Changes and Results of Operations at Proposed Rates - Rule 3.2(a)(3)

Electric Program Investment Charge rates already have been approved by the Commission in R.11-10-003, D.12-05-037, and D.15-04-020. Therefore, there will be no changes in revenues at present rates.

M. General Description of PG&E's Electric and Gas Department Plant - Rule 3.2(a)(4)

Because this submittal is not a general rate application, this requirement is not applicable.

N. Statement of Election of Method of Computing Depreciation Deduction for Federal Income Tax - Rule 3.2(a)(7)

Because this submittal is not a general rate application, this requirement is not applicable.

O. Most Recent Proxy Statement - Rule 3.2(a)(8)

Because this submittal is not a general rate application, this requirement is not applicable.

P. Type of Rate Change Requested - Rule 3.2(a)(10)

No rate change is requested by this application.

Q. Notice and Service of Application – Rule 3.2(b)-(d)

Because this Application does not propose a general rate increase, PG&E does not have a statutory obligation to provide notice thereof. Nevertheless, as a courtesy, PG&E has served this Application on all parties to Decision 13-11-025, the decision approving the First Triennial EPIC Plan applications; Decision 15-04-020, the decision approving the Second Triennial EPIC Plan applications; and PG&E's most recent General Rate Case.

R. Exhibit List and Statement of Readiness

PG&E is ready to proceed with this case based on the Application and the attached PG&E 2018- 2020 EPIC Investment Plan.

II. REQUEST FOR COMMISSION ORDERS

PG&E requests that the Commission issue appropriate orders:

1. Approving PG&E's 2018- 2020 EPIC Investment Plan; and

2. Granting such additional relief as the Commission may deem proper, including extending the general authorization for EPIC program funding beyond 2020 by rulemaking; providing flexibility for utilities to participate as subcontractors for CEC-funded EPIC projects; approving an increase in PG&E's EPIC 3 total approved budget by $7 million, which is proposed to be sourced by leveraging the forecasted unspent project and administration funds from EPIC 1; and providing a more streamlined, expedited Tier 2 advice letter approval process for new projects initiated between EPIC plan approvals.

Respectfully Submitted,

CHRISTOPHER J. WARNER

By: */s/ Christopher J. Warner*
CHRISTOPHER J. WARNER

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Attorney for
PACIFIC GAS AND ELECTRIC COMPANY

Dated: April 28, 2017

VERIFICATION

I, the undersigned, say:

I am an officer of Pacific Gas and Electric Company, a corporation, and am authorized to make this verification on its behalf. The statements in the foregoing document are true of my own knowledge, except as to matters which are therein stated on information or belief, and as to those matters I believe them to be true.

I declare under penalty of perjury that the foregoing is true and correct.

Executed on April 27, 2017, at San Francisco, California.

/s/ Kevin Dasso
Name: Kevin Dasso
Vice President, Electric Asset Management

ATTACHMENT 1

PACIFIC GAS AND ELECTRIC COMPANY
ELECTRIC PROGRAM INVESTMENT CHARGE
TRIENNIAL PLAN (2018-2020)

April 28, 2017

ATTACHMENT 1

TABLE OF CONTENTS

Chapter

Executive Summary and Regulatory Background 1
1. PG&E's 2018-2020 Epic Investment Framework 13
1.1 Collaboration with Other Program Administrators and Consultation with Interested Stakeholders 14
2. PG&E's EPIC RD&D Vision and Strategy 17
2.1 PG&E's EPIC Project Selection and Execution Approach Incorporates Key Legislation and Policy 17
3. PG&E'S 2018-2020 EPIC Project Portfolio 21
3.1 Renewables and Distributed Energy Resources Integration 22
3.2 Grid Modernization and Optimization 42
3.3 Customer Service and Enablement 61
3.4 Cross-Cutting and Foundational 74
4. Administration and Governance of PG&E's EPIC Investment Plan 87
4.1 Collaboration with Program Administrators and Industry Leaders 87
4.2 Proposed Project Portfolio Governance Process to Leverage EPIC Investments 89
4.3 Proposed 2018-2020 EPIC Budget and Funding Allocation 91
4.4 Procedures for Competitive Solicitation of Projects and Outreach to Stakeholders and Third Parties 97
5. Metrics, Measurement and Evaluation of PG&E's EPIC Investment Plan 99
5.1 Plan for Disseminating Information and Results of EPIC Programs and Projects to Stakeholders and the Public 103
6. Conclusion 104

Appendix A – Summary of Stakeholder Feedback A-1
Appendix B – Information Summary of Energy Efficiency (EE) and Demand Response (DR) Research, Development and Demonstration (RD&D) Activities B-1
Appendix C – PG&E Advice Letter 5015-E C-1

Project Index

Project No.	Title	Page
1	Automated DER Impact and Long Term Dynamics Evaluation	25
2	Utility Aggregated Resources with Market Participation	26
3	Distributed Energy Resource Management System (DERMS) and Advanced Distribution Management System (ADMS) Advanced Functionality	28
4	Multi-Nodal Distributed Digital Ledger	30
5	Virtual DER Markets for Capacity and Other Attributes	32
6	Auto Identification (AutoID) of Behind-the-Meter (BTM) Storage	34
7	Utility Scale Storage for Load Balancing	35
8	Second-Life Batteries for Grid Needs	36
9	Dynamic Near-Term DER Load Forecasting	38
10	Grid of the Future Scenario Engine	39
11	Location-Specific Options for Reliability and/or Resilience Upgrades	40
12	Advanced Volt/Var Optimization (VVO) Functionalities	44
13	Transformer Monitoring via Field Area Network (FAN)	45
14	Maintenance Prioritization for Imminent Asset Risk	47
15	Proactive Wires Down Mitigation	48
16	Advanced Condition Monitoring for Remote Diagnostics	49
17	Generic Universal Distribution Controller (UDC) for Relay, Regulator, Load Tap Changer (LTC), Capacitor, Interrupter Control	50
18	Transformer Health Monitoring	51
19	Unified Network Solution	52
20	Data Analytics for Predictive Maintenance	54
21	Advanced Vegetation Management Insights Using Prescriptive Analytics	55
22	Abnormal State Configuration Risk and Mitigation	56
23	Enhanced Distribution Line Equipment Device Settings Management	57
24	Automatic Power Factor (PF) Management	59
25	Electric Grid Monitoring (EGM) Meter	62
26	Predictive Data Analytics for Proactive Meter Replacement	64
27	Multi-Purpose Meter (MPM)	65
28	Real-Time Load-Based Charging	67
29	Advanced Customer Bill Scenario Calculator	68
30	Connected Device Real-Time Pricing-Based Control	70
31	Real-Time DER Price Signals	71
32	System Harmonics for Power Quality Investigations	72

Project Index
(Continued)

Project No.	Title	Page
33	Cyber-Physical Integrated Security	75
34	Local Wireless Security for Critical Facilities	76
35	Advance Security of Internet of Things (IoT) Communications	77
36	Cybersecurity for Industrial Control Systems (ICS)	79
37	Augmented Reality	80
38	Voltage Checks	81
39	Optimized Dispatch for Restoration Events	82
40	Advanced Field Reference Tool	83
41	Drone Enablement and Operational Use	84

Executive Summary and Regulatory Background

Overview of PG&E's 2018-2020 Investment Plan

Pacific Gas and Electric Company (PG&E) is pleased to present its 2018-2020 Triennial Electric Program Investment Charge (EPIC) Investment Plan ("Investment Plan") to the California Public Utilities Commission (CPUC or Commission).

The purpose and setup of the EPIC Program was established by the CPUC in Decision (D.) 12-05-037, issued on May 31, 2012, to support 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 for the 2018-2020 triennial period for three program areas: (1) Applied Research, (2) Technology Demonstration and Deployment (TD&D), and (3) Market Facilitation. The California Energy Commission (CEC) is authorized to administer 80 percent of the total approved EPIC funding amount for all three program areas. PG&E, Southern California Edison Company (SCE), and San Diego Gas & Electric Company (SDG&E), collectively referred to as the Investor Owned Utilities (IOUs), are authorized to administer 20 percent of the EPIC funding for TD&D-related projects. The approved funding for the IOUs is split in the following percentages for each utility:

- PG&E: 50.1 percent
- SCE: 41.1 percent
- SDG&E: 8.8 percent

For the Third Triennial EPIC Investment Plan (2018-2020), PG&E's approved funding amount is approximately $52.1 million for both administrative and TD&D project-related budgets, as well as PG&E's portion of the CPUC program oversight budget.[1]

The utility-administered portion of the EPIC Program is intended to fund grid-specific projects that advance the EPIC guiding principles, including enhancements to 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

[1] The proposed budget amount includes the three-year compounded interest adjustment based on the CPUC's approved method for establishing the average change in the Consumer Price Index (CPI) for the previous three years.

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 (EPIC 1) was approved on November 14, 2013 in CPUC D.13-11-025. This first portfolio executed by PG&E demonstrated its ability to adopt and successfully execute on a new model for managing, aligning, tracking and executing Research, Development and Demonstration (RD&D) activities. This portfolio covered a wide spectrum of technologies that helps make the electrical grid safer, more reliable and more affordable for customers. PG&E is pleased that most of PG&E's EPIC 1 projects have been completed at the time of writing this Application. Upon completion of these projects, PG&E is leveraging their learnings and may operationalize associated results, where applicable and cost-effective. The results of these technology demonstrations are also highly applicable to other industry stakeholders, and PG&E has worked to share the results with relevant stakeholders. The projects' final reports can be found on PG&E's website[2] and are included in PG&E's 2015 Annual Report[3] and 2016 EPIC Annual Report.[4]

On April 15, 2015, the CPUC issued D.15-04-020, which approved the Second Triennial Investment Plan period of 2015-2017 (EPIC 2), and PG&E continues to execute these projects.[5] The projects in EPIC 2 have an even greater focus on long-term strategic objectives and, in many cases, are built on the foundation of previous technology investments. As part of this portfolio, PG&E also further explored opportunities to leverage connections between projects with similar objectives that can benefit by taking advantage of each other's technologies. When feasible, this approach can lower project cost through sharing resources. It also facilitates exploring the integration challenges of how the technologies may interact, which will become increasingly important in the future high-DER connected grid.

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2 www.pge.com/epicfinalreports.

3 www.pge.com/includes/docs/pdfs/about/environment/epic/EPICAnnualReport AttachmentA.pdf.

4 www.pge.com/pge_global/common/pdfs/about-pge/environment/what-we-are-doing/electric-program-investment-charge/2016-EPIC-Annual-Report.pdf.

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

This plan outlines PG&E's proposed Third EPIC Triennial (2018-2020) project portfolio. PG&E's 2018-2020 EPIC Investment Plan has been developed based on the parameters identified above, while also accounting for the learnings from the previous Investment Plan cycles. As part of the process, PG&E collaborated with internal and external stakeholders, subject matter experts, 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 California's ambitious policy goals. As required in D.12-05-037, PG&E's Investment Plan maps proposed investments to the electricity system value chain, including: (i) Grid operations/market design; (ii) Generation, (iii) Transmission; (iv) Distribution; and (v) Demand-side management. PG&E followed the common IOU EPIC investment framework, developed and approved as part of the First EPIC Triennial Plan,[6] to categorize its TD&D project portfolio into the following investment areas:

- Renewables and Distributed Energy Resource (DER) Integration (Smart Energy Markets):
  - Focus: Integrate distributed energy resources, generation and storage; improve transparency of resource information; increase generation flexibility.
  - Value Chain Relation: Maps to Grid Operations / Market Design under EPIC.
- Grid Modernization and Optimization (Smart Utility):
  - Focus: Optimize existing grid assets; prepare for emerging technologies; design and demonstrate grid operations of the future.
  - Value Chain Relation: Maps to Transmission and Distribution (T&D) under EPIC.
- Customer Service and Enablement (Smart Customers):
  - Focus: Drive customer service excellence through new offerings for customers and enable greater customer choice; integrate Demand-Side Management (DSM) for grid optimization.

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

  - Value Chain Relation: Maps to DSM under EPIC.

- Cross-Cutting / Foundational Strategies and Technologies (Cross-Cutting):
  - Focus: Support next generation infrastructure, including smart grid architecture, cybersecurity, telecommunications and standards, as well as other "foundational" activities in support of all three program areas above.
  - Value Chain Relation: Maps to the entire electric value chain.

Table ES-1 summarizes the 41 specific projects that PG&E proposes to explore as part of its Third Triennial (2018-2020) EPIC Investment Plan (EPIC 3). 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 affordability for PG&E's customers. Initiation, development and execution 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 RD&D community in order to leverage the benefits of similar projects and to maximize potentially complementary efforts.

TABLE ES-1
PG&E'S 2018-2020 EPIC PROJECT PORTFOLIO

PG&E's 2018-2020 EPIC Project Portfolio

Investment Area: Renewables and DER Integration Technology Demonstration and Deployment

Objectives in this category:

- Integrate Distributed Energy Resources (e.g., Distributed Generation and Storage)
- Improve Transparency of Resource Information
- Increase Generation Flexibility

Project #	Project Name	Safety	Reliability	Affordability
01	Automated DER Impact and Long Term Dynamics Evaluation		x	x
02	Utility Aggregated Resources with Market Participation			x
03	Distributed Energy Resource Management System (DERMS) and Advanced Distribution Management System (ADMS) Advanced Functionality	x	x	x
04	Multi-Nodal Distributed Digital Ledger		x	x
05	Virtual DER Markets for Capacity and Other Attributes		x	x
06	Auto Identification (ID) of Behind-the-Meter (BTM) Storage		x	x
07	Utility Scale Storage for Load Balancing	x	x	x
08	Second-Life Batteries for Grid Needs		x	x
09	Dynamic Near-Term DER Load Forecasting			x
10	Grid of the Future Scenario Engine	x	x	x
11	Location-Specific Options for Reliability and/or Resilience Upgrades		x	x

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

Project #	Project Name	Safety	Reliability	Affordability
12	Advanced Volt/Var Optimization (VVO) Functionalities		x	x
13	Transformer Monitoring via Field Area Network (FAN)	x	x	x
14	Maintenance Prioritization for Imminent Asset Risk	x	x	x
15	Proactive Wire Down Mitigation	x	x	
16	Advanced Condition Monitoring for Remote Diagnostics		x	x
17	Generic Universal Distribution Controller (UDC) for Relay, Regulator, Load Tap Changer (LTC), Capacitor, Interrupter Control		x	x
18	Transformer Health Monitoring		x	x
19	Unified Network Solution	x	x	x
20	Data Analytics for Predictive Maintenance	x	x	
21	Advanced Vegetation Management Insights Using Prescriptive Analytics		x	x
22	Abnormal State Configuration Risk and Mitigations		x	
23	Enhanced Distribution Line Equipment Device Settings Management		x	x
24	Automatic Power Factor (PF) Management		x	x

TABLE ES-1
PG&E'S 2018-2020 EPIC PROJECT PORTFOLIO
(CONTINUED)

Investment Area: Customer Service and Enablement Technology Demonstration and Deployment

Objectives in this category:

- Drive Customer Service Excellence by Leveraging Data, such as PG&E's SmartMeter™ Platform
- Drive Customer Service Excellence by Offering Greater Billing Flexibility
- Integrate Demand-Side Management for Grid Optimization

Project #	Project Name	Safety	Reliability	Affordability
25	Electric Grid Monitoring (EGM) Meter		x	x
26	Predictive Data Analytics for Proactive Meter Replacement		x	x
27	Multi-Purpose Meter (MPM)		x	x
28	Real-Time Load-Based Charging		x	x
29	Advanced Customer Bill Scenario Calculator			x
30	Connected Device Real-Time Pricing-Based Control		x	x
31	Real Time DER Price Signals		x	x
32	System Harmonics for Power Quality Investigations	x	x	

Investment Area: Cross-Cutting/Foundational Strategies & Technology Demonstration and Deployment

Objectives in this category:

- Next Generation Infrastructure, such as Smart Grid Architecture, Cybersecurity, and Telecommunications

Project #	Project Name	Safety	Reliability	Affordability
33	Cyber-Physical Integrated Security	x	x	x
34	Local Wireless Security For Critical Facilities	x	x	x
35	Advance Security of Internet of Things (IoT) Communications	x	x	
36	Cybersecurity for Industrial Control Systems	x	x	
37	Augmented Reality	x		x
38	Voltage Checks	x	x	x
39	Optimized Dispatch For Restoration Events		x	x
40	Advanced Field Reference Tool	x		x
41	Drone Enablement and Operational Use	x	x	x

The project portfolio, identified in Table ES-1, meets the primary guiding principle of the EPIC Program, which is to provide electricity customer benefits, defined as promoting greater reliability, lower costs, and increased safety.[7] PG&E's portfolio also addresses complementary EPIC guiding principles, which include the following: demonstrating societal benefits; greenhouse gas (GHG) emission reductions; advancing the Loading Order;[8] low-emission vehicles and transportation; economic development; and efficient use of ratepayer monies.

The project portfolio also aligns with California Public Utilities Code (Pub. Util. Code) 740.1, which includes elements of environmental improvement, conservation by efficient resource use, and other guidelines for evaluating research, development, and demonstration programs. Finally, the project portfolio also aligns to California Pub. Util. Code 8360-8369, 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 to cost-effectively make a broader deployment more efficient or to provide learnings that demonstrate the technology or strategy *will not* provide sufficient benefits to justify that broader deployment at the time. Therefore, PG&E expects that, over the course of the triennial period, projects may be refocused and/or adjust their approach. For instance, projects may be terminated or 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 (GRC) or Transmission Owner rate cases. Program and project status updates will continue to be reported in the EPIC Annual Reports and the stakeholder workshops that occur at least twice per year.

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:

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7 D.12-05-037, at Ordering Paragraph (OP) 2.

8 The loading order is priority list of electricity sources set by the CPUC. The loading order identifies energy efficiency and demand response as the State's preferred means of meeting growing energy needs to meet customer demand. Then, energy from renewable sources should be prioritized, such as wind, solar and geothermal. Only after all those supplies are exhausted may the utilities purchase power from fossil fuel plants.

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 exemplifies priority technology demonstration areas to address emergent grid needs, provide safe, reliable and affordable services through the 21st century, and also advance California energy policies in a cost-effective manner. This chapter also describes the collaboration efforts with the other EPIC Program Administrators, and the consultation/information sharing process with other interested stakeholders.

Chapter 2 describes PG&E's RD&D 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 8360-8369.

Chapter 3 outlines PG&E's 2018-2020 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 PG&E's Administration and Governance processes for PG&E's EPIC Plan including ongoing collaboration and coordination with the other EPIC program Administrators. Furthermore, in this section, PG&E proposes the following modifications to previous CPUC Decisions, which are based on learnings from the first two triennial program periods:

- *Funding:* As a modification to D.12-05-037 (OP 7) and D.13-11-025 (OP 38 and 39), PG&E requests an increase in PG&E's EPIC 3 total budget by approximately $7 million, which is proposed to be sourced by leveraging the expected unspent funds from EPIC 1. Reflecting the growing maturity and knowledge base of the program strategies and California's ambitious energy policy goals, this funding will help support maximizing what PG&E can achieve in the robust EPIC 3 proposed portfolio, which reflects a larger quantity and depth of projects than previously proposed portfolios.
- *Tier 3 Advice Letter Process for "New Projects":* As a modification to D.15-09-005, PG&E requests that the Commission re-assess the level of approval process required when proposing project additions to an approved portfolio. PG&E proposes the CPUC revise the requirements to a Tier 2,

instead of Tier 3, advice letter, which will still allow adequate time for evaluation of a proposed project based on that project's merits, while also making the approval process more nimble. This approach helps PG&E and the other IOUs stay current with new RD&D developments and propose projects that meet evolving customer needs and California's aggressive energy policy goals.

- *CEC Program Opportunity Notices (PON):* As a modification to D.12-05-037 (OP 5) and D.15-04-020 (OP 23), PG&E requests the CPUC permits the ability for the IOUs to receive CEC funding for CEC PON initiatives, such as in-kind support, use of facilities, or specified services, to act as a sub-contractor on a CEC-funded EPIC project. The IOUs have resources which can be valuable to these projects, such as grid simulation labs; however, the CPUC's current restrictions on IOU participation in CEC PONs restrict the ability of the IOUs to providing these resources with CEC cost reimbursement.
- *Minimize the Program Gap:* As a modification to D.12-05-037 (OP 1), PG&E requests that the Commission consider modifying its prior EPIC program authorization in order to provide a stable, longer-term funding structure for RD&D activities to minimize any gap after the end of the currently approved EPIC program cycle in 2020. As part of this, the CPUC should leverage the results of completed EPIC projects to also re-evaluate the funding allocation across the three areas of RD&D and across the program Administrators. Alternatively, the CPUC could consider the continuation of the existing EPIC portfolio structure to minimize the gap between program periods while a larger program structural assessment is underway.

Additionally, PG&E requests the following consideration by the Commission:

- *PG&E's EPIC Tier 3 Advice Letter 5015-E:* If not approved before the approval date of this EPIC 3 proposed portfolio, PG&E requests approval of PG&E's Advice Letter 5015-E (see Appendix C) to add six new projects to the EPIC 2 portfolio leveraging the EPIC 2 funding expected to be unspent based on current project status as reflected in PG&E's 2016 Annual Report.

Chapter 5 describes the Metrics, Measurement and Evaluation that PG&E expects to use for its Third 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.

Chapter 6 includes the Conclusion, which summarizes PG&E's portfolio approval request, in addition to the requests for CPUC approval to modify a number of Decisions previously instated through the EPIC Program.

Appendices: PG&E would like to acknowledge the contributions of interested stakeholders throughout the development of the EPIC Investment Plan and provides a summary of stakeholder feedback in Appendix A.[9] A multitude of feedback from these public workshops has been considered and/or incorporated into the EPIC 3 Investment Plan, including how the PG&E EPIC portfolios (both historically and proposed) address recommendations from CPUC staff to advance the DER Action Plan. Additionally, PG&E describes how input from the stakeholders have been incorporated or addressed, which are related to new project ideas, as well as feedback to ensure there is no unnecessary duplication for proposed projects. In alignment with reducing risk of duplication, Appendix B provides a summary of PG&E's Energy Efficiency (EE) and Demand Response (DR) "RD&D" type activities, and also describes the coordination mechanisms in place to maintain the distinct nature of each program while also leveraging complementary efforts. Appendix C includes a copy of the previously submitted Advice Letter 5015-E that is referenced in this Application.

Regulatory Background

Funding for the Public Interest Energy Research (PIER) Program authorized in Pub. Util. Code Section 399.8, which governed the Public Goods Charge (PGC), expired as of January 1, 2012.[10] The Commission opened an Order Instituting Rulemaking (R.11-10-003) to establish EPIC to preserve funding for the public and customer benefits associated with the renewables and RD&D activities provided by the electric PGC. The rulemaking included two phases: Phase I established the EPIC Program on an interim basis in 2012, and Phase II established purposes and setup for

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

10 EPIC replaces the PIER Program that was funded via the PGC. PIER provided funding to the CEC from 1996-2012 for electric research and development activities. EPIC, however, 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.

EPIC to continue from 2013-2020.[11] The EPIC Program Administrators include the three IOUs (PG&E, SCE, and SDG&E) and the CEC.

In the Phase I Decision Establishing Interim Research, Development and Demonstration and Renewables Program Funding Levels (D.11-12-035), the Commission 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 50.1 percent, 41.1 percent and 8.8 percent for PG&E, SCE, and SDG&E, respectively.[12] Approximately 80 percent of the total EPIC funding is administered by the CEC and the remaining 20 percent is administered by the IOUs. Additionally, 0.5 percent of the budget funds Commission oversight of the EPIC.[13] 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 19, 2013.[14] On April 29, 2014, PG&E filed its Second Triennial Investment Plan (2015-2017) and the Commission approved its plan with modifications, on April 15, 2015,[15] including clarification of program budgets among Administrators, which

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

12 D.12-05-037, at OP 7 requires the total collection amount to 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. As reflected in Chapter 4.3, PG&E applies an interim escalation rate of 0.684 percent annually (2.065 percent compounded for three years) for the 2018-2020 triennial period, resulting in an estimated total program annual collection of $173.4 million.

13 D.12 05 037, at OP 1.

14 D. 13-11-025.

15 D. 15-04-020.

included adjusted program collections and budgets based on the three-year compounded Consumer Price Index (CPI) adjustment.[16]

Conclusion

PG&E's EPIC 3 Investment Plan continues to further advance California's energy policies and plays an important role in funding new, innovative strategies and/or technologies with the potential to address emergent needs for the smarter, more integrated electric grid and PG&E's customers 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. Additionally, PG&E's EPIC Program continues to mature after years of experience building out the program's governance and project execution procedures, while demonstrating valuable results and lessons learned. This includes the successful closure and publication of fifteen EPIC 1 projects, which are relevant to not only PG&E, but also other stakeholders, such as utilities, research organizations, third party vendors, and other interested stakeholders.

PG&E continues to be strongly committed to the EPIC Program and the value it provides to its customers, as it offers the opportunity to cost-effectively develop and demonstrate innovative technologies which can advance PG&E's core values of safety, reliability, and affordability, while also enabling more customer choice and enabling increased clean energy adoption. PG&E believes each project proposed in this portfolio is important and has the potential, at broader deployment, to benefit electricity customers and the State. As such, PG&E respectfully requests Commission approval of its Third Triennial (2018-2020) EPIC Investment Plan.

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16 *Id*., at OP 7; D.15-04-020, Appendix B Table 5: Approved, Escalated 2015-2017 EPIC Budgets, p. B-7.

Chapter 1. PG&E's 2018-2020 Epic Investment Framework

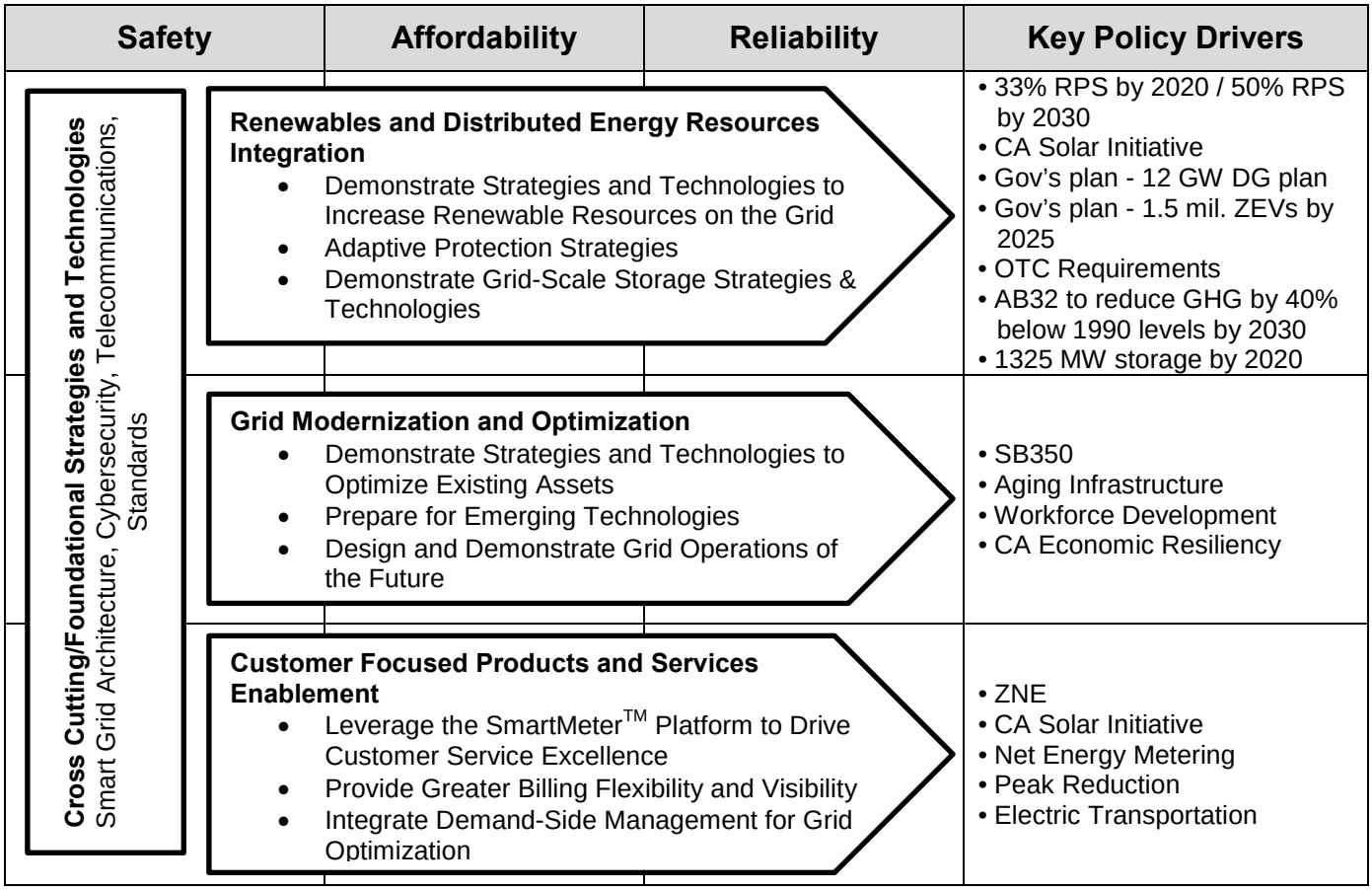
PG&E's EPIC 3 Investment Plan is based on significant IOU collaboration and stakeholder engagement to identify technology demonstration and deployment initiatives that are important to the long term sustainability of the electric grid and the needs of its customers. PG&E and the other IOUs collaboratively 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 and the 50 percent RPS by 2030 as established in Senate Bill (SB) 350 (Clean Energy and Pollution Reduction Act of 2015), reducing greenhouse gas emissions by 40 percent below 1990 levels by 2030 as established by Assembly Bill (AB) 32, procuring 1,325 Megawatts (MW) of energy storage by 2020 as embodied in AB2514 (Energy Storage Systems), getting 1.5 million zero-emission vehicles (ZEVs) on the California roadways by 2025 as set by California Governor Edmund Brown's ZEV Action Plan, supporting California's DER Action Plan and the Integrated Resource Plan (IRP) in cooperation with AB327 California RPS Program, and supporting other macro trends, such as aging infrastructure, need for diversifying pricing options, addressing changing customer needs, and supporting 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 TD&D investment in order to modernize the grid and provide long-term benefits to customers.

This framework was adopted as part of the first EPIC Triennial Investment Plan and approved by the CPUC in D.13-11-025, which was also leveraged in the second EPIC Investment Plan. PG&E and the other IOU Administrators have re-adopted this framework as part of the Third Triennial EPIC Plan as the EPIC guiding principles, policy attainment goals, and macro-level 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
PG&E'S EPIC INVESTMENT FRAMEWORK



1.1 Collaboration with Other Program Administrators and Consultation with Interested Stakeholders

The Program Administrators continue to meet bi-weekly, conduct administrative and working sessions, and also held various in-person and online public workshops to solicit input from interested stakeholders on the development of their Third Triennial Investment Plans. Public stakeholder workshops are required at least twice per year, during the development of the Administrators' respective investment plans and during the execution of those plans. Interested stakeholders may include: California legislature, government agencies, utilities, California Independent System Operator (CAISO), consumer groups, environmental organizations, agricultural organizations, academic experts, business community, energy efficiency community, and clean energy

or other industry associations. Public opportunities for comment on the EPIC 3 Investment Plan included the following:

February 3, 2017 – Joint public workshop and webinar conducted by all Administrators (CEC, PG&E, SCE, SDG&E) to outline the EPIC investment framework, discuss implementation plans, approach and timeline of the Third Triennial EPIC Plan.

March 9, 2017 – Northern California joint public workshop that focused on the proposed EPIC Third Triennial Plans by the IOUs (PG&E, SCE and SDG&E). This workshop also included CEC overview of areas of focus, details for their upcoming workshops and avenues to provide comment.

March 13, 2017 – CEC-hosted workshop to review CEC's DER-related proposed EPIC projects and obtain public feedback.

March 14, 2017 – Northern California joint public workshop that focused on CEC's Third Triennial Investment Plan. This workshop included the IOU overview of areas of focus and details for their past and upcoming workshops, as well as avenues to provide comment.

March 24, 2017 – Southern California joint public workshop that focused on the proposed EPIC Third Triennial Plans by the IOUs (PG&E, SCE and SDG&E). This workshop included CEC overview of areas of focus, details for their past and upcoming workshops and avenues to provide comment.

Notice of each public webinar and workshop was provided to the parties on the service list of this proceeding, among others. During each webinar and workshop, stakeholders and members of the public were provided the opportunity to comment on the EPIC Program. The EPIC Administrators provided an additional opportunity for public feedback after each webinar and workshop, by announcing a post-workshop written comment period through March 31, 2017. PG&E also shared the materials directly with workshop attendees, posted the presentation to their website at www.pge.com/epic and provided an email address (EPIC_info@pge.com) to provide a mechanism 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 Third Triennial Investment Plan. This consultation included 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 with other utilities throughout the United States. 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.

The feedback from these public workshops has either been considered and/or incorporated into the EPIC 3 Investment Plan, including how the PG&E EPIC portfolios (both historical and proposed) address recommendations from CPUC staff to advance the DER Action Plan and how input from the stakeholders have been incorporated or addressed which are related to proposed projects.

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

PG&E's electric RD&D vision is to provide customers with safe, reliable and affordable energy services through the analysis, testing and piloting of new, innovative energy technologies that support its core utility electric transmission, distribution, customer service and electricity procurement operations. The TD&D activities under EPIC continue to be an important component of the RD&D spectrum, allowing PG&E 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.

Additionally, the main goals of EPIC align closely with PG&E's "Grid of the Future" strategy, which drives the advancement of innovative technologies that support PG&E's core values and an evolving grid. The "Grid of the Future" vision calls for the integration of new energy devices and technologies with the grid and, by virtue of their grid connectivity, allows PG&E's customers to capture greater value from their energy technology investments, including rooftop solar, electric vehicles, energy storage, and other such emerging technologies. PG&E is the key builder and enabler of this interconnected and integrated platform that will continue to help define and shape California's future energy landscape.

2.1 PG&E's EPIC Project Selection and Execution Approach Incorporates Key Legislation and Policy

PG&E implements a four lens approach for selecting and executing EPIC projects within the TD&D framework, which includes the following: (1) Policy/Regulatory Alignment; (2) Alignment to Utility Strategies and Customer Needs; (3) Alignment with Innovation Characteristics; and (4) Alignment to Project Governance Considerations. 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.[17] As required by D.12-05-037,[18] PG&E also explicitly incorporated Pub. Util. Code Sections 740.1 (Utility RD&D) and 8360-8369 (Smart Grid)

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[17] *Id*., OP 2.

[18] *Id*., OP 12e.

as key inputs into the EPIC planning process. Specifically, PG&E considers the following in developing and executing the EPIC Investment Plan:

Policy and Regulatory Alignment

- Alignment to EPIC mandatory guiding principles:
  - Projects must demonstrate the potential to produce electricity ratepayer (i.e., customer) 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 vehicles and transportation; economic development; and efficient use of ratepayer monies.
- Alignment to Commission Proceedings:
  - The EPIC portfolio also directly supports and complements Commission proceedings, such as the Distribution Resource Plan (DRP), Transportation Electrification, and other similar proceedings by seeking complementary technology demonstrations and avoiding duplication.
- 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; and improve operating efficiency and reliability or otherwise reduce operating costs.
- Alignment to Pub. Util. Code 8360-8369 (Smart Grid Goals):
  - In addition to the principles above, projects can demonstrate additional benefits in advancing the policy objectives of Pub. Util. Code 8360-8369. 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; and provide consumers with timely information and control options.

Alignment to Utility Strategies and Customer Needs

In addition to alignment with EPIC's primary and secondary principles, relevant public utility codes and California energy policies, it is critical that the projects selected also align with strategies to ensure the issue(s) addressed by the project solves relevant concerns faced by PG&E's customers, while also having a clear path to production if the technology is proven ready to scale. Confirming there is alignment to utility strategies and customer needs helps to ensure the deliverables of the project lead to tangible and important changes to the way PG&E (and potentially other utilities) serve its customers and delivers safe, reliable, and affordable clean energy.

Alignment with Innovation Characteristics

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 demonstrate a new or novel technology, demonstrate an existing technology in a novel way, and/or demonstrate a new or novel process or strategy 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.

Alignment to Project Governance Considerations

PG&E continues to implement project governance processes through the established Program Management Office (PMO), which has matured throughout the EPIC program cycles, including continuous improvements to internal reporting, project execution, documentation, and others. PG&E's EPIC PMO provides an additional level of support during the planning of TD&D projects, including ensuring the following for all projects PG&E proposes to pursue:

- The project must have specific goals and objectives, a clear budget, and timeframe as established in the approved project business plan;

- The project must define initial standards or metrics up front (including an evaluation, measurement and verification plan, as appropriate) by which the results of the project can be measured;
- The project team must have a plan for disseminating the information and results of the project to other California utilities and stakeholders;
- The project team must complete a benchmarking effort to evaluate for any potential for unnecessary duplication, overlap and/or synergies with projects in PG&E, other RD&D programs, as well as the EPIC initiatives of the other Program Administrators; and
- There is a defined and agreed to path to production if the technology proves ready to scale.

PG&E believes that this holistic approach achieves the appropriate balance of stimulating innovation and integrating lessons learned to help support California's environmental and energy policy goals, as well as Commission proceedings. The approach also makes efficient use of EPIC funds by executing a strong program management governance process, which may include not advancing 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 can help stretch scarce RD&D dollars and foster a stronger, competitive and collaborative RD&D community that encourages market advancement of technologies that are in the best interest of California customers.

PG&E has included 41 proposed technology demonstration projects in its Third Triennial EPIC Investment Plan as described in Chapter 3. Once the EPIC Program is approved by the Commission, internal prioritization and selection of EPIC projects will occur from this list of candidate projects. The actual scope, timeline and budgets for projects will then be established in a project business plan. Project governance processes, as described above and in more detail in Chapter 4, will further define the prioritization of projects selected and executed post filing approval.

Chapter 3. PG&E'S 2018-2020 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.[19]

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 other 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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19 D.12-05-037, at OP 3.

3.1 Renewables and Distributed Energy Resources Integration

3.1.A Program Area Background and Current Challenges

California has the most aggressive clean energy goals in the United States (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 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.

By 2025, California policy calls for 1.5 million ZEVs to be on the California roadways, and by 2030, utilities shall purchase or produce enough California-eligible renewable energy to meet 50 percent of customer needs and reduce statewide GHG emissions to 40 percent below 1990 levels. All of these factors imply significant increases in the amount of renewable energy moving on California utility transmission and distribution grids.

As renewables increase on the grid, a number of challenges and opportunities arise for the utilities to address. For instance, the variability of renewables on the grid creates generation uncertainty and may also impact grid stability, such as through potential voltage, frequency or power quality fluctuations, which need to be better understood to maintain grid safety and reliability. The growing rate of DERs can therefore also impact planning and operational practices, which requires utilities to have an improved understanding of the DER grid impacts to be proactive in addressing in advance the potential risks to the grid's safety, reliability and affordability for its customers.

California also expects to add other variable resources that will operate outside of utility or the CAISO control. While one PG&E project in EPIC 1 determined operationally capabilities to bid into the CAISO market leveraging utility scale resources, there is still a strong need to confirm ability to optimize the prioritization of multiple DERs that could be a resource with the CAISO wholesale markets. 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 continue to be 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, not only the reliable integration of variable resources into the PG&E grid, but more importantly the optimization of these resources to work harmoniously in concert to maximize the benefits of these resources, and limit the potential risks to grid stability. Key needs include identifying strategies and technologies to minimize grid disruptions, identifying cost-efficient methods to optimize intrinsically variable renewable resources output, and improving forecasting of DER generation and load to reduce the generation purchasing buffer required. The electric industry has seen many recent technological advances in these areas, and these new emerging technologies must be further assessed, evaluated, and if successful provided a path towards viable large scale implementation if California is to be successful in reaching its ambitious energy policy goals.

Current Challenges

Integrate Distributed Energy Resources

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 similar 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 also been receiving much attention as a means to facilitate the integration of renewable energy, and to also 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.

The emergence and expected growth of Electric Vehicles (EV), 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 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 these new technologies. Considering customer side factors in a holistic manner, including EE, DR, rate design and price signals, usage data, distributed generation and customer-sited energy storage, can be more effective than considering each individual component, which may lead to the enablement of integration with the grid in a manner that reduces customer costs and creates customer value while also enabling better holistic 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, distributed generation potentially represents an opportunity to strengthen the grid and provide increased resiliency. Likewise, the use of other integrated DERs, such as grid-integrated energy storage and DR technology in a locally targeted and aggregated manner, may also achieve specific demand reductions during local peak periods to react to local grid conditions, and thereby slow or postpone distribution system capacity expansions.

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 optimized control of resources, when needed, to maintain grid reliability.

PG&E supports TD&D projects that improve the utilities' 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 DER Integration program area.

TABLE 3-1
SUMMARY OF PROJECTS BY PROGRAM AREA
RENEWABLES AND DER INTEGRATION

Investment Area: Renewables and DER Integration Technology Demonstration and Deployment				
Project #	**Project Name**	**Safety**	**Reliability**	**Affordability**
01	Automated DER Impact and Long Term Dynamics Evaluation		x	x
02	Utility Aggregated Resources with Market Participation			x
03	Distributed Energy Resource Management System (DERMS) and Advanced Distribution Management System (ADMS) Advanced Functionality	x	x	x
04	Multi-Nodal Distributed Digital Ledger		x	x
05	Virtual DER Markets for Capacity and Other Attributes		x	x
06	Auto Identification (ID) of Behind-the-Meter (BTM) Storage		x	x
07	Utility Scale Storage for Load Balancing	x	x	x
08	Second-Life Batteries for Grid Needs		x	x
09	Dynamic Near-Term DER Load Forecasting			x
10	Grid of the Future Scenario Engine	x	x	x
11	Location-Specific Options for Reliability and/or Resilience Upgrades		x	x

Project Number: 01

Project Title: Automated DER Impact and Long Term Dynamics Evaluation

Description of Technology or Strategy to Be Demonstrated

This project seeks to automate the DER impact and long term dynamics evaluation processes leveraged in detailed engineering analysis in order to aim to reduce DER study timelines and costs, while also seeking to support distribution engineers to better understand and manage the voltage impacts caused by multiple DERs on a single circuit and on Load Tap Changer (LTC) operations. The project may explore inputting system conditions on a system peak day and system minimum day using an engineering analysis study. The new automated evaluation modules may then produce a report showing device loading, steady state voltage analysis, and voltage flicker analysis. The long term dynamics module could potentially further identify potential voltage issues due to interactions between capacitors, voltage regulators, and DER production schedules that may lead to Electric Rule 2 violations.

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

Concern, Gap, or Problem to Be Addressed

In 2016, PG&E completed 250 DER projects that required detailed engineering analysis. On average, a single review takes eight hours of engineering analysis. The current evaluation method requires the engineer to iterate through different loading and fault scenarios, recording the results for each scenario. The DER evaluation module may be used to automate many of the iterative scenarios and generate a report summarizing the results.

Additionally, PG&E currently has no proven methodology to evaluate the interaction between capacitors, voltage regulators, and DERs throughout the course of a day, week, or year. Engineers study discrete points in time and manually assume the state and output of each device. The long term dynamics module could potentially allow engineers to input the control strategy for each device, as well as the DER schedule, and more rapidly simulate the results over a specified time.

Potential Benefits at Full Deployment

At full deployment, these new automated processes could result in reducing the DER study timelines and reducing DER study costs. This project could also help distribution engineers better understand and manage the voltage impacts caused by multiple DERs on a single circuit as well as its impact on LTC operations. Better voltage control strategies could lead to improved hosting capacity within the distribution system.

Project Number: 02

Project Title: Utility Aggregated Resources with Market Participation

Description of Technology or Strategy to Be Demonstrated

This project will seek to demonstrate multi-technology DER aggregation (e.g., Solar, Storage) for wholesale market operations with potential to explore multiple uses including distribution support, retail, and/or T&D interfaces for control center operations.

The project may develop a wholesale market optimization model for DERs, using an aggregation of two or more DERs. The proposed demonstration may integrate dynamic input data during a project period (e.g., solar forecast data, current battery state of charge) to re-optimize market bids and schedules in response to changing market and grid conditions. The primary technologies that may be demonstrated in this project could include aspects such as an optimization model capable of addressing DERs and

DER aggregations and/or software to manage necessary automated flow of data from input parameters, to optimization model, to bidding software and/or wholesale market interface (CAISO Scheduling Infrastructure Business Rules). The project may also include an element that provides the DER operator with an available/unavailable status prior to scheduling and dispatching a DER aggregation into a potential abnormal distribution circuit configuration.

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

Concern, Gap, or Problem to Be Addressed

Today's optimization process is divided into a number of iterative processes (e.g., pre-day ahead, post-day ahead, and real-time). Each process involves a team of analysts and multiple hours to implement, despite a moderate amount of automation for existing DER resources in the portfolio, such as batteries.

Optimization of DERs in real-time markets is difficult, due to the shorter time horizons between market intervals, as well as the challenges of rapidly changing market conditions. Development of a more automated optimization solution may enable realization of additional value from these resources with minimal operator intervention or disruption to operations. Additionally, as DERs become more standard in participating in the CAISO market, a mechanism may be needed to help indicate whether the current as-is switching of the system makes it safe and reliable for them to do so.

Potential Benefits at Full Deployment

The potential benefits of the project at full deployment include improving efficiency and increasing the value capture for DERs. Enhanced optimization and operation of DERs may further support renewable resource integration, unlock additional value from energy storage, and develop the capability for DER multiple-use applications.

The project anticipates more effective utilization of distributed generation assets, which may include enhanced bidding in real-time to enable realization of additional wholesale market value from DERs or enhanced reliability by providing an indication of whether the current state of the grid is configured in a way that allows bidding into the CAISO market. Additionally, there may be increased operational efficiency by reducing manual

processes required to implement bidding of DERs, which may enhance the ability to integrate additional DERs into wholesale markets.

Project Number: 03

Project Title: Distributed Energy Resource Management System (DERMS) and Advanced Distribution Management System (ADMS) Advanced Functionality

Description of Technology or Strategy to Be Demonstrated

The overarching goal of this project is to incorporate additional DER technologies and grid management approaches into DERMS and/or ADMS to build upon efforts from the EPIC 2.02 DERMS project. The project would potentially explore one or more DERMS-related initiatives, including but not limited to:

1. Expand DER participation in the demonstration to Demand Response and/or Electric Vehicle Charging (in addition to existing storage and photovoltaic (PV) resources as part of EPIC 2.02 DERMS). This initiative may identify key characteristics and applicability of each asset type for different distribution grid services, work with aggregators to deploy DERs in a targeted area, and/or demonstrate the ability to provide distribution services using the portfolio of DERs.
2. Dispatch DERs to support restoration switching. This initiative may demonstrate DER dispatch to enhance restoration efforts during outages based on a probabilistic Estimated Time of Restoration forecasting model. Field demonstration may evaluate the feasibility and effectiveness of such a system and the required performance of underlying DERs.
3. Develop automated load shedding schemes for customers already participating in DR programs, as well as generation curtailment from DERs to mitigate overloading of lines and equipment in T&D networks. Additionally, this initiative may potentially focus on load synchronization technology that enables coordinated shifting of load cycles for appliances that operate on schedules, such as refrigeration, pool pumps, and Heating, Ventilation and Air Conditioning (HVAC).
4. Demonstrate the ability of DERs to contribute to Volt/VAR Optimization (VVO), in conjunction with traditional utility-owned voltage regulating assets, to evaluate the incremental value of DERs for Voltage support.

5. Demonstrate using DERMS as the Scheduling Coordinator for direct aggregation of customer-owned DERs that may not already be served through a separate aggregator. This initiative could evaluate the impact of market integration using Distribute Energy Resource Provider (DERP) aggregations on the distribution system, develop requirements for stakeholders, demonstrate end-to-end data exchange to expose any unanticipated impacts when DERs are controlled based on wholesale price signals, demonstrate an automated feasibility study for DERP bidding during outages and abnormal conditions, and/or demonstrate automated outage notifications to CAISO and DERP aggregators.

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

Concern, Gap, or Problem to Be Addressed

The DRP and Integrated DER (IDER) proceedings are focused not only accommodating increased DER penetration on the grid, but also on solving a number of grid issues utilizing DER innovations. As discussed in PG&E's DRP filing, PG&E may face operational challenges in effectively and reliably operating the distribution system with high levels of DERs unless advanced technologies are deployed. Development and deployment of a centralized DERMS is required to monitor, control and optimize the dispatch of DERs to support utility efforts to safely and efficiently manage the grid.

This project would advance the learnings from the EPIC 2.02 DERMS project, which is the most comprehensive demonstration of distribution grid services to date with DERMS. The existing EPIC 2.02 DERMS project at PG&E is demonstrating control of a limited subset of DERs to provide distribution grid services in order to gain initial learnings on the base set of functionality. Current DERs under control include: BTM PV and storage, as well as utility-owned storage. However, other DERs within PG&E's territory, such as EV charging and DR are already participating in market operations, and may be included in the full DER portfolio for advanced grid management in the future. This project may also aim to demonstrate the orchestration of a comprehensive DER portfolio.

Furthermore, the existing DERMS is operating separately from other ADMS applications, such as VVO and Automated Restoration Switching, given lack of industry development of this sort of combined functional technology. Integrating the dispatch of DERs into these other advanced grid management applications is a clear next step in demonstrating that DERs can be incorporated into existing operations or used to enhance current systems and processes.

This project also may help address the new operational challenges for Distribution Operators (DOs) caused by emerging opportunities for DERs to participate in wholesale markets via the DERP tariff. For instance, the CAISO may dispatch DERs without knowing the impact those dispatches have on the distribution system, or whether those dispatches are feasible and supported by the distribution system given current conditions. These challenges are increasing with the increasing numbers of interconnected DERs on the grid; therefore, it is necessary and timely to identify technology solutions to enhance operational coordination at the T&D interface between DOs and the CAISO to ensure the reliable operation of the grid in a high-DER future.

Potential Benefits at Full Deployment

DERMS could potentially enable the dynamic control of DERs which may help mitigate against potential issues caused by high penetrations of DERs, thus potentially enabling higher penetrations of DERs on the distribution system without costly grid upgrades. Higher adoption of DERs could contribute to California's clean energy policy goals and reduce carbon dioxide emissions. At the T&D market interface, DERMS may support improvements to safe and reliable grid operations, while also enabling the presence of high penetrations of market participating DERs.

Project Number: 04

Project Title: Multi-Nodal Distributed Digital Ledger

Description of Technology or Strategy to Be Demonstrated

This project will seek to demonstrate and evaluate a multi-nodal digital distributed ledger (i.e., Blockchain) as an enabling technology that may facilitate greater efficiency, transparency, and security for customers. The project may help PG&E understand the opportunities and applications of a blockchain to energy utility use cases. PG&E could demonstrate the technical application of blockchain and gain insights into deployment

complexity, costs of implementation, market/participant behavior and the compatibility with PG&E grid operations systems.

Demonstration of blockchain technology and smart contracts may include use cases such as rate roaming, localized microgrid energy exchanges, asset data, and credit tracking (e.g., Cap and Trade, Low Carbon Fuel Standard). In each of these scenarios, the technology could be tested, leading to an automated, distributed transaction settlement. One example is an automated energy transaction settlement, whereby smart assets, such as load balancers, battery charge management systems, solar generation, or other assets, run smart contracts either individually or in aggregate and act on pricing signals to participate in DR dispatches and settle immediately. These smart assets could potentially utilize real-time locational marginal pricing, and interact in a secure and decentralized settlement mechanism. Here, advanced line sensors, supervisory control and data acquisition (SCADA), and SmartMeter™ data can serve to validate the blockchain transactions.

This project's results may illuminate certain blockchain use cases that provide the most benefit to the utility and its customers and provide greater understanding regarding challenges associated with technology scalability, the blockchain interface with the grid, and current business processes and the application of smart contracts and other similar algorithms in a distributed environment.

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

Concern, Gap, or Problem to Be Addressed

Current utility operations and energy markets are designed for centralized control systems (e.g., DERMS). As the grid sees an increased adoption of more DERs and customers look to reduce their environmental footprint by installing solar, purchasing EVs and joining programs, such as PG&E's Solar Choice Program, these technologies working in concert create new complexities. At the same time, new systems, such as blockchain, can help maintain simplicity and validate operational performance as part of the customer experience, in turn reducing costs and improving efficiencies throughout the value chain. It is imperative to understand the system engineering requirements to support these distributed transactions in a safe, reliable manner.

By demonstrating this technology, PG&E could help apply an innovative approach to an increasingly complex market, thereby facilitating a more affordable, transparent, secure customer experience. Using advanced applications, this technology has the potential to provide critical measurement, verification, and settlement confirmation capabilities. Therefore, this project should contribute to the body-of-knowledge needed to solve many of the topics raised in CEC's report entitled, *Microgrid Assessment and Recommendation(s) to Guide Future Investments*, which recommends future grid investment and support.[20]

Potential Benefits at Full Deployment

At full deployment, this project may provide increased efficiency and decreased customer costs by potentially eliminating intermediate steps in complex process and may also provide transparency in customer transactions. With advanced deployment, a distributed ledger network could contribute to PG&E's grid modernization efforts through a novel dispatch and market participation method for DERs, where affordability and reliability may be improved, potentially furthering clean energy solutions for customers.

Project Number: 05

Project Title: Virtual DER Markets for Capacity and Other Attributes

Description of Technology or Strategy to Be Demonstrated

This pilot will seek to demonstrate the feasibility and the technological and/or economic performance of autonomous distributed economic dispatch in the context of DER markets for capacity and other attributes. This could be achieved by a locally-sited optimization algorithm that could respond to various market signals that either exist today (e.g., Frequency Regulation, Resource Adequacy (RA)) or may potentially exist in the future (e.g., Locational Marginal Pricing (LMP), Fast Frequency Regulation) in coordination with neighboring DERs.

By developing a virtual DER attributes market, the pilot could leverage some of the existing DER installations in PG&E's territory, and consider adding more technologies, such as EV, Smart Home, Controls, and others. The objective of the project is to test flexible demand, generation and storage, and reward local people and businesses for being more flexible with their energy. The pilot may include the technologies, such as

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20 CEC-500-2015-071

those found in Connected Homes (includes EE, EVs, smart home devices, solar, energy storage and more) and Smart Businesses (Building energy management systems, Energy Efficiency, HVAC and lighting controls, battery storage, solar, CHP, fuel cells and more).

The proposed logic to dispatch resources is not centralized, but rather is geographically distributed. It responds to signals coming from utility and markets. From a software technology perspective, this pilot seeks to solve a multi-dimensional optimization problem across various DER technologies with the goal of finding the optimal solution to concurrently satisfy objectives, such as deferral of an actual or future distribution capacity upgrade, meaningful reduction of transmission-level congestion (LMP), providing financial benefit to customers with acceptable comfort/productivity penalty, and/or access to wholesale market participation. Since local capacity markets and transmission markets are not fully developed in California, a virtual market may be created or leveraged from existing industry resources using realistic assumptions.

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

Concern, Gap, or Problem to Be Addressed

There is no technology standard in the industry today for responding to multiple conflicting signals across the Generation-Transmission-Distribution-Customer (GTDC) value chain. PG&E and other utilities are running various pilots testing individual elements, but a holistic approach has not yet been attempted. A few examples of in-flight demonstrations and their limitations include the following:

- PG&E's DRP demos C and D are focused on distribution only, and do not consider transmission-level conversion and/or wholesale market; and
- PG&E's EPIC 2.02 DERMS project uses leveraged Third-Party aggregators to control DERs using a bid-ask-commit approach when responding to utility needs. This project proposes a logic in which resources or discrete groups of resources (e.g., behind a single meter) autonomously react to demand signals with embedded intelligence.

Potential Benefits at Full Deployment

This project could enable optimal DERs dispatch decisions that maximize value and reduce redundant costs across the entire value chain (from customer, distribution, transmission to generation). This project may also enhance reliability by optimizing DER dispatch to, for example: (1) ensure that various DERs are not committed multiple times into different programs, resulting in excessive compensation for the service (double dipping), (2) ensure there is a hierarchical order to resolve conflicting constraints (i.e., asking storage to discharge to reduce customer peak demand and at the same time to charge to prepare to shave the evening peak); and (3) ensure that zero sum actions are not taken (e.g., discharge EV and charge battery).

Project Number: 06

Project Title: Auto Identification (AutoID) of Behind-the-Meter (BTM) Storage

Description of Technology or Strategy to Be Demonstrated

This project would seek to utilize interval and voltage data to develop a tool to identify behind the meter storage devices and to understand their behavior with respect to charging and discharging, including but not limited to the amount and rate of charging and discharging, as well as patterns, randomness/predictability, and other important factors. This project builds on the learnings from PG&E's EPIC 1.21 AutoID of PV; however, this project targets identification of BTM storage rather than PV.

The project may include improved understanding of actual behavior of the BTM storage resources for customers, methods to use a probabilistic approach to analyze large data sets and charge and discharge behavior to detect presence of BTM storage, estimation of storage size and rate of discharge based on the charging and discharging pattern recognized; and/or development of a tool that can be run periodically to identify customers who could benefit from having storage installed (e.g., potential customer program targeting); and/or identify customers who are likely to have unauthorized storage installed.

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

Concern, Gap, or Problem to Be Addressed

BTM storage is an emerging technology for which the existing Net Energy Metering (NEM) policy does not require a separate sub-meter. This makes it difficult to identify BTM storage if an application for interconnection is not submitted to the utility. For example, if a NEM customer installs storage behind the meter and does not apply for the appropriate interconnection, the utility would not be aware of the presence of storage, which could potentially impact safety and reliability of the distribution network. Additionally, understanding of the "net" storage impact at the feeder-level and secondary circuit level is important as distribution planning engineers begin to include DERs in their load forecasts. In summary, this project may bridge the knowledge gap for storage's charge and discharge behavior in the field, as well as system impacts by analyzing storage charge/discharge patterns.

Potential Benefits at Full Deployment

This project may increase grid safety and reliability by providing a better understanding of storage usage patterns and predictability. Additionally, learnings may inform how BTM storage could help mitigate potential capacity overloads and provide new customer program offerings, for example by developing new rates/programs based on the results of this project.

Project Number: 07

Project Title: Utility Scale Storage for Load Balancing

Description of Technology or Strategy to Be Demonstrated

This project seeks to demonstrate phase load balancing by leveraging large, utility-owned batteries. The energy storage device could use a smart inverter connected to all phases that could be either remotely or automatically controlled. The project's desired outcome is testing and demonstrating the ability to use the load from the energy storage device to shift load between phases. Potential project use cases may include, but are not limited to: charging from an under-loaded feeder, discharging to an overloaded feeder, and/or power quality support.

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

Concern, Gap, or Problem to Be Addressed

Balancing load across phases usually requires a significant effort to physically move specific loads from one phase to another. This method is only preventative for a short time because loads become once again unbalanced due to normal load changes over the course of a day and load growth over time. Without balanced loads, the grid operates sub-optimally from an efficiency standpoint, leading to potentially higher costs.

Potential Benefits at Full Deployment

Removing manual work to rebalance loads improves operational efficiency by reduced manual hours spent, improves reliability by optimizing asset utilization across phases with faster adjustment of controls, and improves safety by removing manual labor for managing large loads. Currently, the process to rebalance loads requires a field crew to physically reconnect customer loads to different phases. By eliminating this work and automating it through the use of a battery, cost may be able to be significantly reduced.

Project Number: 08

Project Title: Second-Life Batteries for Grid Needs

Description of Technology or Strategy to Be Demonstrated

This project will seek to utilize EV and/or other hybrid vehicle battery systems that are beyond their useful vehicle life (typically when the battery has degraded to 70-80 percent of its original capacity) and determine if they are fully functional for stationary utility applications, or "second-life batteries." This project could demonstrate technology that enables second-life energy storage for key utility functions, such as DR and/or frequency regulation, which may lower energy storage costs and support EV business cases with residual value.

Technology may also be developed for ensuring that second-life batteries can successfully interface with the grid. Building off PG&E's prior energy storage EPIC pilots, this project may identify significant technical or performance differentiations between a second-life storage system and an installation with new batteries, and explore solutions to address technical deficiencies in second-life batteries. This project's results may illuminate what utility use cases are viable for second-life batteries, provide data the market can use to build business plans and product offerings, and help

PG&E ensure reliability in the future when procuring services from second-life battery projects.

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

Concern, Gap, or Problem to Be Addressed

PG&E supports California's goal to have 1.5 million ZEVs on the state's roadways by 2025. As EV adoption increases, so too could the availability of second-life batteries. The utility industry has yet to clearly define requirements for reusing second-life batteries for utility applications. Currently, there is little research on whether extensive cycling and other potential late-life performance issues affect the ability of second-life batteries to provide energy market and grid services.

PG&E's Plug-in EV DR pilot[21] (also called BMW iChargeForward Phase 1) validated that a behind-the-meter second-life battery can provide grid services. However, there are no current examples of these assets at the distribution or transmission levels. Utility scale requirements for second-life batteries have yet to be defined and use cases have yet to be validated. If this pilot is successful it may provide a path to new revenue streams associated with EVs. Results of this pilot may help inform the CPUC's ongoing transportation electrification efforts under SB350 and the Alternative Fuel Vehicle proceeding.[22]

Potential Benefits at Full Deployment

Second-life battery deployment could improve reliability by potentially being used for DR, while increasing affordability by participating in frequency regulation and capacity markets at a lower cost than pristine batteries. Additionally, using EV batteries could contribute to residual battery value, increasing deployment of electric vehicles based on a higher return on investment. They could also improve affordability by deferring alternative T&D upgrades.

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21 D.12-04-045 and Advice Letter 4077-E, filed on 6/29/2012.

22 R.13-11-007.

Project Number: 09

Project Title: Dynamic Near-Term DER Load Forecasting

Description of Technology or Strategy to Be Demonstrated

Beginning in September 2017, California's Rule 21 requires smart inverters for all new customer-connected generation and storage devices. Smart inverters are capable of generating new data streams regarding customer generation or storage operation that are not currently available to PG&E, which could create new insights and efficiencies that could support distribution planning and energy procurement. This project proposes to collect and combine smart inverter data with other data streams (e.g., local weather, customer demographics, and/or customer usage) to create an algorithm that can better predict customer gross and net usage/load, DER generation, back-feed at distribution assets, and impact on system level or local short-term energy supply needs.

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

Concern, Gap, or Problem to Be Addressed

This project aims to improve PG&E's load and capacity forecasting by integrating actual operational data from the distributed generation and storage systems into forecasts used by energy procurement and distribution planning. This information may also be further leveraged to improve the customer billing experience for solar customers. With nearly 300,000 distributed solar installations in PG&E's territory, PG&E has more rooftop solar systems than any utility in the country; however, without smart inverters and the enabling communication technologies or supporting policies, the utility has historically only had information on the net load for any given customer. The break out of gross onsite load and DER generation has been estimated, but never reliably confirmed—especially not at a weekly, daily or hourly time horizon.

Potential Benefits at Full Deployment

Having better insight into the impact of DERs on generation and distribution system needs, the utility, in coordination with the CAISO, may be able to reduce the generation purchasing buffer required. Further, the utility could better understand and model/predict the impact of DERs on the distribution system. This could reduce operating cost and in turn potentially lower customer bills. Understanding the net to

gross relationship for key customer segments may improve reliability by providing further insight for distribution planning, load forecasting and DER program administration. Improving the accuracy of near-term DER load forecasting can help accelerate improvements and increase accuracy for these downstream processes.

Project Number: 10

Project Title: Grid of the Future Scenario Engine

Description of Technology or Strategy to Be Demonstrated

This project would seek to develop a wide-scale distribution and/or transmission grid simulator for analyzing multiple scenarios and potential future stressors to the grid, such as changes in usage behavior, increased DER integration rates and more to facilitate better informed grid planning.

The objective of this project would be to create a large analytics engine mirroring the PG&E's distribution grid for testing multiple scenarios and future stressors. Scenarios to be examined could potentially include, but are not limited to: varying DER penetration rates by customer type, varying DER adoption rates under different DER valuation and incentive methodologies, analyzing impacts of differing rate structures on energy usage behavior, and/or analyzing impacts of variance in underlying rate components, such as gas input prices and customer price elasticity on energy usage behavior.

The project would potentially include integration of multiple internal datasets for creation of scalable scenario modeling. If combined with a measurement and verification methodology, such a model could also lead to more timely feedback to allow for more informed and accurate forecasting for distribution planning and asset upgrades. This information could be utilized not only by internal utility departments, but also by the CAISO in their transmission planning process or by the Western Electricity Coordinating Council when reviewing renewable integration plans.

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

Concern, Gap, or Problem to Be Addressed

Currently, PG&E performs multiple scenarios analyses focused on ensuring the reliability of the distribution grid. Currently, these processes require manual assembly and redundant work in many cases. With the increasing penetration rates of a growing number of DERs this type of modeling is likely to be required with increased frequency. A common model could allow for the pooling of information in one place, which could then be leveraged across departments for multiple program and grid management goals. It could also better capture interdependencies of different customer and grid features in one large and well-maintained central scenario planning platform.

Potential Benefits at Full Deployment

Benefits could include more accurate, better informed grid scenario planning that may improve load forecasting, which could lead to improved grid reliability and affordability of service for customers. Such a tool could also help identify portions of the grid that may be vulnerable to DER stressors. By being proactive, rather than reactive, PG&E can avoid having to halt future DER interconnections as has been required in certain locations in Hawaii and has the potential to occur in California. Additionally, there is the potential for the insights from this unified model to inform locational net benefits analysis (LNBA). LNBA is anticipated to be a critical part of locating and returning on investment of DERs.

Project Number: 11

Project Title: Location-Specific Options for Reliability and/or Resilience Upgrades

Description of Technology or Strategy to Be Demonstrated

This project will seek to create the processes and demonstrate the scoping, specification, and deployment of multiple DER technology configurations that could potentially serve as location-specific options for distribution system reliability and/or resilience upgrades.

Technology configurations to be evaluated for their ability to provide distribution service reliability and/or resilience may include distributed battery storage, distributed solar and other distributed generation, microgrid controllers, and isolation and protection equipment enabling islanding. If a microgrid alternative is identified and selected in the

distribution planning process, this project may include a field deployment and evaluation of the selected alternative.

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

Concern, Gap, or Problem to Be Addressed

Microgrids are generally promoted for their ability to provide energy reliability and resilience and to optimize locally-sited renewable energy. However, the relatively immature microgrid market is characterized by a wide range of custom projects with little standardization in technology and design. This project may help identify deployment options and test the efficacy of microgrid-related technologies (e.g., DERs, controllers, communications, and isolation and protective devices) in enhancing reliability and/or resilience in specific locations.

Potential Benefits at Full Deployment

Potential benefits may include reduced operating costs, reduction in wires down outages and/or improvements in other local reliability metrics with the potential for increased adoption of DERs for energy resilience.

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 16 million people, over 142,000 circuit miles of distribution lines with 20 percent of the lines located underground, over 18,600 circuit miles of transmission lines, 912 substations that include circuit breakers, transformers, voltage regulation equipment, and capacitor banks, over 1,300 substation transformers, over 3,200 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, which is also a significant challenge faced by many U.S. utilities. This modernization, however, 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 for PG&E's customers. California's SB350 established new clean energy, clean air and greenhouse gas reduction goals for 2030 and beyond. Aligning with the aggressive policies of SB350 requires significant electrification of current sources of GHG emissions (e.g., transportation). Shifting entire sectors of energy demand from fossil fuels to electricity may significantly increase gird usage over the upcoming decades, which places more stress on the grid, requiring innovative solutions to identify and mitigate system risk. Managing this grid renovation process in a well-planned manner is a major initiative for California utilities and imperative to meet aggressive California energy policy goals.

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. Furthermore, recent advances in data analytics have opened the door for the utilities to explore more data science approaches to grid planning and operation, including exploring how to move the utility from an inspection and/or reactive

"break/fix" asset maintenance model to a predictive approach, minimizing customer outages. 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 renovation, 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 begun to open the door to move the industry from a reactive approach to a more proactive approach that predicts potential risks and, therefore, maximizes PG&E's asset maintenance and replacement efforts. Optimizing these existing asset approaches should 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 enhanced asset monitoring, optimized data integration, uniform hardware specification and improved sensing technologies that can improve and optimize the underlying assets in service. Additionally, access to actionable data is building on the foundation of the work that's been completed in previous EPIC triennial cycles that has helped to leverage new data sources. This proposed triennial cycle's projects include a focus on delivering intelligence when and where it is necessary to be actionable by planners and operators. For example, projects that predict maintenance needs or proactively mitigate wires down may help grid operators and planners to cost-effectively get "ahead of the curve" in anticipating and preventing events which threaten grid stability.

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 and Optimization program area.

TABLE 3-2
SUMMARY OF PROJECTS BY PROGRAM AREA
GRID MODERNIZATION AND OPTIMIZATION

Investment Area: Grid Modernization and Optimization Technology Demonstration and Deployment				
Project #	**Project Name**	**Safety**	**Reliability**	**Affordability**
12	Advanced Volt/Var Optimization (VVO) Functionalities		x	x
13	Transformer Monitoring via Field Area Network (FAN)	x	x	x
14	Maintenance Prioritization for Imminent Asset Risk	x	x	x
15	Proactive Wire Down Mitigation	x	x	
16	Advanced Condition Monitoring for Remote Diagnostics		x	x
17	Generic Universal Distribution Controller (UDC) for Relay, Regulator, Load Tap Changer (LTC), Capacitor, Interrupter Control		x	x
18	Transformer Health Monitoring		x	x
19	Unified Network Solution	x	x	x
20	Data Analytics for Predictive Maintenance	x	x	
21	Advanced Vegetation Management Insights Using Prescriptive Analytics		x	x
22	Abnormal State Configuration Risk and Mitigations		x	
23	Enhanced Distribution Line Equipment Device Settings Management		x	x
24	Automatic Power Factor (PF) Management		x	x

Project Number: 12

Project Title: Advanced Volt/Var Optimization (VVO) Functionalities

Description of Technology or Strategy to Be Demonstrated

This project would seek to demonstrate enhanced algorithms to leverage VVO for grid management services. VVO is the process of modifying voltage and reactive power levels to reduce customer energy usage and/or provide grid stability services. The VVO Smart Grid Pilot in Fresno focused primarily on the customer energy usage reduction goals, and this project focuses on grid stability. Potential use cases may include but are not limited to:

- *Distribution Capacitors to Reduce Transmission Congestion:* Optimize capacitor bank settings based on the need for Vars (reactive power) to manage power factor and voltage.

- *Leveraging Distributed Smart Inverters:* Determine the optimal smart inverter settings to maximize power factor at a substation, or inject Vars for transmission issues.

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

Concern, Gap, or Problem to Be Addressed

The PG&E VVO Smart Grid Pilot[23] (completed December 2016) largely focused on the ability to modify voltage and reactive power in service of reducing customer energy usage through Conversation Voltage Reduction (CVR). This project would expand on those learnings to determine how VVO techniques could be further used to improve grid stability.

Potential Benefits at Full Deployment

The value of using VVO for grid services may improve both reliability and affordability. Improving stability in an increasingly dynamic grid environment is a fundamental element of reliability, and VVO may be a more affordable way to gain these benefits compared to traditional physical infrastructure investment.

Project Number: 13

Project Title: Transformer Monitoring via Field Area Network (FAN)

Description of Technology or Strategy to Be Demonstrated

This project will seek to demonstrate equipment that can be quickly and safely mounted on the casing of a pole-top distribution transformer to enable monitoring of equipment health. Additionally, it may test new communication devices and processes for delivering sensor data through PG&E's FAN. This project may include, but is not limited to, the following work streams:

- Testing of transformers at end-of-life to identify heat signatures that precede transformer failure, at a granularity that is higher than the three-tier status quo (normal / warm / too hot);

23 https://www.pge.com/tariffs/assets/pdf/adviceletter/ELEC_4990-E.pdf.

- Design and testing of a sensor and mounting package (e.g., bolt-on or magnetic) and communication enclosure to determine temperature signatures that indicate an imminent equipment failure;
- Development of processes to smoothly integrate sensors into PG&E systems during installation; and
- Demonstration of data analytics to enrich/contextualize the readings. For example, cross checking a temperature reading with the average temperature in the area (i.e., a given temperature reading on the transformer casing has different meaning if taken on a winter night versus a summer's day).

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

Concern, Gap, or Problem to Be Addressed

As transformers reach the end of their usable life, they may begin to heat up. PG&E currently uses heat-sensitive stickers to indicate this change. These stickers are one color initially, then change to another color when they reach a certain temperature (over warm), and a third color when they reach another temperature (too hot). However, this system relies on regular checks by field teams to identify that a sticker has changed color and assign the transformer for monitoring / replacement. A "smart" system would allow a sensor to report wirelessly when the temperature had reached key values.

Additionally, a dedicated utility pole or spacing on an existing pole is currently required to deploy a SCADA/Communication-related enclosure, with most of the installation work performed onsite. A new mounting package could be prepared offsite and quickly mounted under the transformer, reducing installation time. This project also provides an opportunity to further explore how to create "plug and play" equipment monitoring equipment that automatically connect to PG&E's FAN and data systems.

Potential Benefits at Full Deployment

The benefits of a successful solution deployed at full scale based on the learnings of this project may include:

- *Preventative Maintenance / Replacement of Transformers (Reliability, Safety)* PG&E has over one million distribution transformers in service, which are replaced

at a rate of ~2.5 percent per year. Identifying transformers that are approaching end of life could allow preventative replacement, reducing the chances of unplanned outages and potential safety concerns.

- *Improved Understanding of "Plug and Play" Equipment Installation (Affordability)* Developing new methods to attach sensors to field equipment easily, and streamline the process of connecting their outputs to centralized data management systems, is an important goal to reduce the cost of installation for new smart grid devices.

Project Number: 14

Project Title: Maintenance Prioritization for Imminent Asset Risk

Description of Technology or Strategy to Be Demonstrated

This project would seek to demonstrate a situational intelligence model and an operational dashboard to identify and display assets' health and Condition-Based Monitoring (CBM) information for prioritization of short-term operational, maintenance, and replacement activities. The project will focus on the unique network configuration and equipment, including underground cables, in select geographic locations. This asset management tool may allow optimization which could minimize safety risks and maximize system reliability through better understanding and visibility of assets.

This approach may require the development of a data analytics, dashboards and alarming package using data from various existing internal and external data sources. Such a system may aggregate data streams, perform analytics, and visualize the results in a way that makes the intelligence actionable. This project would ultimately seek to demonstrate the convergence of asset and operational data with historical maintenance information and proactive identification of potential equipment failures.

In addition, the project may survey the currently available operational data sources, rank them based on their value to proactive CBM, and recommend new data sources that would be valuable as they become available to inform PG&E's future CBM data strategies.

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

Concern, Gap, or Problem to Be Addressed

To minimize safety risks, increase affordability and improve reliability, the utility industry as a whole is pursuing ways to monitor and proactively identify equipment failures to perform preventative maintenance and avoid unplanned outages. However, no off the shelf products have combined all the necessary features to streamline this analysis. This project would seek to address the gap by taking a data analytics approach to short term risk and dynamically ranking each asset in terms of operational risk based on current environmental and operational factors.

Potential Benefits at Full Deployment

The utility industry is pursuing solutions to leverage internal and external data for proactive asset management. By identifying failing equipment before it fails in service using data and analytics, PG&E may be able to optimize asset utilization with targeted maintenance and replacement investments, while continuing to minimize safety risks and maximize system reliability.

Project Number: 15

Project Title: Proactive Wires Down Mitigation

Description of Technology or Strategy to Be Demonstrated

This project would seek to demonstrate technology that could identify a falling conductor in sub-second response time, to enable proactive circuit isolation. If proven successful, the algorithm could be integrated with grid management systems to minimize safety risks in wires down situations.

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

Concern, Gap, or Problem to Be Addressed

When an electric distribution conductor fails it creates a potentially dangerous condition for both customers and utility workers, and the risk of wild fire. Currently, there is no widely deployed protective device that de-energizes a conductor or feeder before it contacts the ground or object. By de-energizing the conduction before contact, the risk of injury, damage or fatality is greatly minimized.

Potential Benefits at Full Deployment

This technology, if effective, may be a major step forward in energized wire down safety. The ability to neutralize the dangerous aspect of an energized wired down at the moment of failure would minimize wire down safety risk for customers. While this technology may not solve all dangerous wire down conditions, it may address a high number of conditions, especially high impedance faults.

Project Number: 16

Project Title: Advanced Condition Monitoring for Remote Diagnostics

Description of Technology or Strategy to Be Demonstrated

This project will seek to demonstrate advanced real-time sensors for monitoring asset conditions, enabling an increasingly proactive maintenance and grid management operational model. Possible next-generation sensor devices may include devices, such as hydrogen gas sensors, light spectrum analyzers, partial discharge diagnostic devices, and other such equipment to provide new insights into equipment health. These sensors provide information that can be used to assess the health of a variety of equipment types, including but not limited to transformers, LTCs, regulators, circuit breakers, and/or gas insulated switchgear. If proven successful, these sensors could help PG&E estimate equipment's remaining service life, and predict when it may fail.

Real-time monitoring could be used to detect failures and isolate equipment or developing finer controls for dumping-load at a certain threshold. For example, if a substation distribution transformer showed a sudden increase in gasses above a certain level, the monitoring system could alert operators, and automatic systems could transfer or disconnect load and de-energize the transformer, preventing a catastrophic failure.

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

Concern, Gap, or Problem to Be Addressed

Today, in many cases, transformer equipment conditions are monitored through ad hoc measurements after on-site collection. Unexpected equipment failure and long outage times can potentially occur while operators diagnose the failure and reset equipment settings. Real-time monitoring technologies can provide additional insight into

equipment conditions, reduce equipment failure through proactive actions, and potentially enable wireless controls to reduce outage times.

Similar condition monitoring systems are available today for this purpose, and are being deployed by many utilities including PG&E for online transformer dissolved gas analysis (DGA) on critical distribution transformers in the system. PG&E is currently installing oil pressure, temperature and level sensors on assets in underground vaults in San Francisco and Oakland. However, these sensors are often costly and thus are typically only installed on extremely critical infrastructure. Labor and time adds to their cost, which typically requires an outage. The next-generation analyzers would be more affordable, potentially installing using less invasive methods (with installation while equipment is energized), and provide real-time decision making information.

Potential Benefits at Full Deployment

By enabling a larger scale deployment of condition based monitoring through improved affordability of the enabling technology, this project may lead to improved system reliability, reduced costs and improved safety. For instance, online monitoring provides a greater number of data points which can be used, in conjunction with other sensor data, to perform trend and causality analyses to identify poor performing assets. This information would improve maintenance and procurement practices. Additionally, online monitoring data provides an opportunity to understand, post mortem, the conditions of transformers before failure. This knowledge can be used by PG&E to improve its ability to identify problems before asset failure, enhance its capability to predict the timing of asset failures and optimize its retirement and replacement planning process.

Project Number: 17

Project Title: Generic Universal Distribution Controller (UDC) for Relay, Regulator, Load Tap Changer (LTC), Capacitor, Interrupter Control

Description of Technology or Strategy to Be Demonstrated

Design and demonstrate a Universal Distribution Controller (UDC) that can act as a generic controller for use in electric distribution line equipment. The UDC could be designed with enough generic Input / Output and software flexibility to be used as a capacitor controller, voltage regulator controller, an LTC controller, or a distribution relay. This approach could potentially standardize controller hardware across operational control functions insuring interoperability and reducing the need for

redundant maintenance and management for multiple vendors. It may also permit customization of features through software development control specific to the utility's needs.

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

Concern, Gap, or Problem to Be Addressed

In the modern utility, most distribution line equipment has a controller attached to it. In the past this controller was a customized electronic circuit specifically designed for the function it was to perform. Today, many of these devices have moved to micro-controller based electronics. The final step in this evolutionary process is to formally make the hardware for these controllers generic. This has already begun in other industries where open source hardware and software has permitted users to customize generic components into their own applications. The utility industry has been slow to adapt this approach because of the difficulty in disconnecting controller technology from its large capital investments (transformer, regulators, etc.) This proposed effort is a first step toward disconnection of the two technology streams.

Potential Benefits at Full Deployment

The use of this modern technology strategy has many direct benefits with the primary end result of improved affordability. A UDC could provide uniform hardware across all distribution line equipment, reducing the cost of maintenance and operational support of multiple devices. It could permit customizing of software functions and upgrading of software independent of vendor limitations. It may narrow security and quality control requirements from multi-vendors to single hardware, and open up hardware solutions from smaller vendors. Additionally, it may help to improve human performance and reduce expense with streamlined training.

Project Number: 18

Project Title: Transformer Health Monitoring

Description of Technology or Strategy to Be Demonstrated

This project will seek to develop and demonstrate new algorithms for determining and actively monitoring transformer health and performance based on Synchrophasor or

other technology to detect conditions, such as arcing, breaker mis-operation, or total fault energy over time. The project could enable higher accuracy asset monitoring and predictive failure analytics.

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

Concern, Gap, or Problem to Be Addressed

Existing transformer condition based maintenance is typically based on DGA. DGA is a secondary measure of insulation breaking down, and can generally predict failure over time but not necessarily identify the root cause of the issue. Synchrophasor (or other equivalent) data could provide additional information, such as fault energy over time, arcing, and other signatures which could provide useful analytics to determine insulation condition and other indicators. The use of algorithms to monitor Synchrophasor-type data paired with dissolved gas and other data to determine transformer condition is new to the industry. This data could be a more direct measure of or predictor of transformer health, and would not only predict failure, but potentially the extent of damage, possible reason for potential failure, and even potentially how much time there is before the failure occurs.

Potential Benefits at Full Deployment

At full deployment, this new technology could enable improved reliability and affordability by enhancing condition based monitoring practices. If these algorithms can identify not only if a transformer is at risk of failing, but also when, what the cause may be and the extent of damage, action can be taken in a more timely manner, further reducing the risk of failure.

Project Number: 19

Project Title: Unified Network Solution

Description of Technology or Strategy to Be Demonstrated

This project will seek to demonstrate a platform for unified communication among disparate networks both in the field, as well as across the enterprise. The project would explore using the service and availability of one network to the benefit of the other

networks, such as SCADA, land mobile radio, SmartMeter™, FAN, or other similar options.

The project may explore demonstrating a unified platform to provide communication for crews through a vehicle activated network. The network could potentially be capable of a Local Area Network via Wi-Fi between the vehicle and a portable device. The Wide Area Network could comprise of multiple backhaul options, such as Wi-Fi, Long-Term Evolution (LTE)[24] or Satellite.

The project may also explore potential use cases for this unified network. One potential use case could be the automatic rebooting of SCADA radios. Certain SCADA radios become dormant within a certain time period, and technicians have to be deployed to power cycle the radios. With a unified network, a signal could potentially be pushed out to signal to these devices to 'wake up'. This would potentially reduce the need to deploy radio technicians to activate the radios.

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

Concern, Gap, or Problem to Be Addressed

Currently, there are several 'independent' networks within PG&E, which is a similar problem at other utilities. These networks include SCADA, land mobile radio, SmartMeter™, FAN, and other similar network options. When there is an issue with the service and availability of one of these independent networks, resolution is limited within the network. A unified platform where service and availability could be leveraged across networks would strengthen the utility's ability to maintain reliability of network communications.

Additionally, in the field, communication among field crews can be hindered in locations where there is no proper radio coverage or cellular coverage. With this project, multiple communication platforms could potentially be integrated via the vehicle, enabling improved communications in those low coverage situations.

24 A 4G mobile communications standard.

Potential Benefits at Full Deployment

At full deployment, this project may improve reliability by ensuring communication service across multiple service platforms. This enables PG&E to reduce reliability risk by ensuring that the systems can rely on each other's backhaul for redundancy. Additionally, this project's technology may be able to improve safety by supporting crew members that operate in areas with little to no network coverage. This enables these crew members to rely on the new technology to communicate with other crew member or control center operators, thereby ensuring their safety in emergency situations. Finally, the project's technology may improve affordability, by offering a new platform for service delivery. Cost may be potentially reduced across any one platform because the backhauls from the other services can be leveraged to minimize cost.

Project Number: 20

Project Title: Data Analytics for Predictive Maintenance

Description of Technology or Strategy to Be Demonstrated

This project would seek to develop predictive maintenance algorithms for identifying potential asset failures before they occur by using SmartMeter™ voltage data and other utility data sources at service points downstream of equipment.

The project would define a set of failing equipment use cases that have impact on downstream voltage, and develop analytics algorithms to identify the voltage signatures associated with these upcoming failures. Examples of potential equipment use cases include primary side loose neutrals and overloaded or near-failure transformers, and stressed or near-failure cables.

The output of the project would be an analytics process that would correlate and detect pattern signatures that are associated to malfunctioning or failing system assets, a set of heuristics for identifying these signatures, and an evaluation of this technology's efficacy versus traditional condition based maintenance systems.

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

Concern, Gap, or Problem to Be Addressed

Assets experience wear and tear, and eventually break down. The most passive strategy is to wait for the equipment failure to address. An already-implemented improvement on this strategy is condition-based maintenance, and schedule maintenance using heuristics regarding expected useful life and level of utilization. This project would move one step further, to detect the signs of near-failure equipment through the distributing sensing network of SmartMeter™ devices.

Potential Benefits at Full Deployment

The project would potentially improve system reliability and safety by reducing unplanned outages by proactively identifying and mitigating equipment failure.

Project Number: 21

Project Title: Advanced Vegetation Management Insights Using Prescriptive Analytics

Description of Technology or Strategy to Be Demonstrated

This project will seek to demonstrate a prescriptive analytics model that predicts tree growth rates and areas at highest risk for vegetation-related outages by leveraging Light Detection and Ranging (LiDAR), other remote sensing data, and historical vegetation-based outages for proactive and targeted mitigation. The model could be used for routine maintenance activities, reliability-focused project planning, or planning and staging in anticipation of strong weather systems impacting the PG&E service system. The potential use of this model as a primary driver for routine maintenance could reduce field inspector work by using robust datasets to determine encroachment clearance work and to identify high priority tree work areas to proactively prevent vegetation-related power outages and downed power lines.

This project would potentially incorporate model components, such as LiDAR data to create a three-dimensional model of PG&E distribution assets; tree species data to assign a tree failure profile for selected trees; and environmental data, including weather, pedological (soil composition), and topographical data, to develop an initial tree growth and failure risk model onto which additional variables, such as vegetation management outage investigation data can be layered to more accurately identify areas of concern regarding routine maintenance, storm-related power outages or potential wildfire ignition.

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

Concern, Gap, or Problem to Be Addressed

Today, utility arborists patrol power lines and identify trees that require pruning to prevent tree-to-conductor contact. However, it is a challenge to consistently determine precisely which trees require pruning that can potentially result in overprescribing tree work or overlooking vegetation-based outage risks. By using prescriptive analytics to identify and assign tree work, algorithms could track the history of each tree and more accurately determine when a tree requires work, thus potentially reducing costs associated with the current inspection method.

Currently, historical data analysis from an outage management system is used as a predictor of the future. However, historical data may not be an accurate predictor of the future, and refreshing the data model is manual and can be cumbersome. This project may develop novel tree growth algorithms and a geospatial database for vegetation reliability planning, emergency preparedness and response, and algorithms that drive the prescriptive analytics software to identify what to do and where to mitigate vegetation-related outage risk.

Potential Benefits at Full Deployment

At full deployment, a prescriptive analytic platform could significantly reduce field inspection costs. The developed model would provide readily accessible insight into field conditions, optimizing reliability work planning, and an automated process would reduce the risk of errors. This would also provide better proactive mitigation of risk, thereby potentially increasing system reliability.

Project Number: 22

Project Title: Abnormal State Configuration Risk and Mitigation

Description of Technology or Strategy to Be Demonstrated

This project would seek to demonstrate an algorithm for understanding the comparative risk of abnormal state configurations to proactively prioritize mitigation of these issues. The project would explore the use of system data to analyze risk impact and attempt to demonstrate an algorithmic approach to automate the impact score. This project may

also explore the best approaches to integrate this algorithm into utility systems and processes, as well as potentially automate the resolution of these issues.

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

Concern, Gap, or Problem to Be Addressed

Abnormal system configurations exist for a variety of reasons, such as needing to open a breaker and isolate a portion of the system to do planned or unplanned maintenance. Such configurations increase system risk, as the abnormal states are less robust than the originally-engineered "as built" configuration. If the system is stressed, such as during a significant storm, abnormal configurations are at higher risk for timely restoration of all customers in the case of additional outages on that circuit. Currently, if a storm is coming in and there are too many abnormal states to resolve before it hits, grid operators need to use informal, qualitative prioritization techniques (either based on general expertise, or simply ranking the circuits based on how many customers they serve). Developing experience with algorithms to size and rank risk of abnormal circuits would help formalize this prioritization process.

Potential Benefits at Full Deployment

If deployed broadly, this technology would improve system reliability by identifying high-impact abnormal states and providing recommendations and/or automated response for mitigating risk and prioritizing switching back to normal configuration based on risk score. Allowing operators to focus on the highest-impact abnormal states may reduce the chance of an outage due to an unstable configuration and mitigate the risk of stranded customers due to secondary outages while in abnormal configurations.

Project Number: 23

Project Title: Enhanced Distribution Line Equipment Device Settings Management

Description of Technology or Strategy to Be Demonstrated

This project would seek to demonstrate the increased efficiency, quality assurance, and flexibility of technology to manage transmission and substation distribution protection relay device settings to all distribution line equipment relays and controllers.

The project will seek to select circuits to perform a demonstration on expanding PG&E's software used to manage and report on protection asset maintenance and engineering records for all distribution line equipment including adding:

- A software interface for distribution engineers to upload settings files, maintain, track, and manage settings files versions;
- The ability to import and parse relay/controller vendor software configuration files to extract limited required settings for applications, such as the Distribution Management System (DMS) and power systems modeling software;
- A software interface for Distribution Line Technicians (DLTs) to upload as-left and as-found settings directly from the field;
- A software interface for DLTs to upload device test reports and SCADA communications settings; and/or
- The ability for distribution engineering to maintain and modify device settings templates and data fields for existing and future controller types without software programming changes.

This project would require connectivity to be established between Electric Distribution Geographic Information System (ED-GIS) for the device hierarchy and asset information as well the ability for the database to export settings into DMS and power systems modeling software via database connections.

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

Concern, Gap, or Problem to Be Addressed

Presently, distribution line equipment relays and controllers have their settings stored in multiple repositories with limited versioning and managing capabilities. Transmitting settings files requires manual handoffs to transmit future, as-found, and as-left settings files.

PG&E's ED-GIS Webviewer has data entry fields to store a large amount of the featured settings for the various line equipment vendors, makes, and models. The main purpose of these fields is to provide a settings database for DMS and power systems modeling software to retrieve device settings. However, the ED-GIS Webviewer solution in many cases is missing data fields or has too many data entry fields. This process results in a

high level of engineering labor spent on data entry, validation, and manual version control.

There is also presently no ability for PG&E's ED-GIS Webviewer solution to be able to parse in vendor device settings files which would dramatically reduce the manual data entry required that is prone to input errors.

Potential Benefits at Full Deployment

The value of using a database designed for the specific purpose of maintaining, tracking, and managing complex relay and controller settings and test reports will directly improve affordability in eliminating manual data entry, handoffs, and time spent verifying settings versions. There will also be reliability benefits gained in assuring the device settings are accurately stored and maintained for distribution operations and future demand management and load flow modeling software. With the growing number of complex relay and device controllers on the advanced distribution grid, the need for this type of solution is becoming critical to grid planning and operations.

Project Number: 24

Project Title: Automatic Power Factor (PF) Management

Description of Technology or Strategy to Be Demonstrated

This project would seek to demonstrate a software algorithm to achieve Automatic Power Factor Management to keep power factor within the mandated CAISO guideline. The project may also include analysis of power factors by customer class in order to potentially improve power flow analysis and voltage profile throughout the feeder.

Once the software algorithm is proven, the project may select several distribution banks and perform a proof of concept on the software potentially including:

- Determining if all capacitors have to be automated or just a certain set.
- Demonstrating savings associated with automation of capacitors to manage power factor (PF) and other benefits, such as elimination or reduction of annual maintenance and inspections, fewer truck rolls, less engineering time to manage settings, or other similar items.
- Comparison of manual settings for long-term vs automation and control by software.

- Determining if a simplified low-cost capacitor control can be used and can be managed centrally by the software algorithm.
- Determining if the algorithm should be based on maintaining a specific range of leading-to-lagging power factors as per the CAISO mandate, or should be based upon a range of leading-to-lagging VAR flows in order to optimize results throughout the system, especially for larger transformer banks that can service large, problematic flows and yet stay within the mandated power factor range.

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

Concern, Gap, or Problem to Be Addressed

The PG&E VVO Smart Grid Pilot (completed December 2016) largely focused on the ability to modify voltage and reactive power for the purpose of reducing customer energy usage through CVR. This project would expand on those learnings to determine how centrally-located, software-driven techniques could be used to improve PF management. As SCADA and other remote control technologies become more widespread, there is an opportunity to fine-tune settings and update them in real-time in a way that would be impossible if attempted manually. By identifying the grid stability impact of certain settings, PG&E would be better able to make cost-benefit analyses of PF management techniques for grid stability.

Potential Benefits at Full Deployment

By achieving power factor guidelines mandated by CAISO, PG&E will fulfill its obligation at lower cost than current approaches. Improving stability in an increasingly dynamic grid environment is a fundamental element of reliability, and automatic power factor control may be a more affordable way to gain these benefits compared to traditional physical infrastructure investment.

3.3 Customer Service and Enablement

3.3.A Program Area Background and Current Challenges

Driven by California state energy policies and enabled by the emergence of new and/or newly cost-effective technologies, opportunities for California energy customers to be more than just consumers of electricity are increasing. PG&E customers can adopt energy efficient technologies and processes, buy electric vehicles or DR 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 their businesses in a more optimal manner.

To support California's ambitious goals to reduced GHG emissions, the challenge is to find compelling ways to inform, serve, and engage customers so that they understand and embrace these opportunities. The "Customer Service and Enablement" program area is designed to allow PG&E to get better at the basics through improvements, such as call center operations optimization and enabling more dynamic DER-oriented rates, while supporting customers to actively manage their bills and reduce their environmental footprint.

Current Challenges

Drive Customer Service Excellence by Leveraging Data

PG&E has deployed SmartMeter™ technology throughout a majority of its service territory, establishing a critical framework and foundational platform for further innovation in DR, EE and customer and grid services. Continuing to find new ways to leverage the deployed technology and Advanced Metering Infrastructure (AMI) communications network may maximize the value of this investment and further the capability to support new information-based services to customers, as well as new methods to manage grid assets. Furthermore, new metering technologies, such as data analytics to predict proactive meter replacement needs and power quality issues, can potentially lower the costs of maintaining the SmartMeter™ infrastructure.

Drive Customer Service Excellence by Offering Greater Billing Flexibility

The availability of granular energy usage information provides a growing opportunity to provide customers with cost-effective tools to manage their energy use and lower their bills. Demonstrations in this area would evaluate and prove the viability of technologies that support new rate-focused strategies and advance California energy policies. New

tools in this area would support more creative opportunities and choices for customers to pursue options that meet their specific needs, such as predicting their end usage costs to make better energy-saving decisions. Additionally, these tools and potential new pricing structures may also open up the potential for new customer focused products and service offerings.

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
SUMMARY OF PROJECTS BY PROGRAM AREA
CUSTOMER SERVICE AND ENABLEMENT

Investment Area: Customer Service and Enablement Technology Demonstration and Deployment				
Project Number	**Project Name**	**Safety**	**Reliability**	**Affordability**
25	Electric Grid Monitoring (EGM) Meter		x	x
26	Predictive Data Analytics for Proactive Meter Replacement		x	x
27	Multi-Purpose Meter (MPM)		x	x
28	Real-Time Load-Based Charging		x	x
29	Advanced Customer Bill Scenario Calculator			x
30	Connected Device Real-Time Pricing-Based Control		x	x
31	Real-Time DER Price Signals		x	x
32	System Harmonics for Power Quality Investigations	x	x	

Project Number: 25

Project Title: Electric Grid Monitoring (EGM) Meter

Description of Technology or Strategy to Be Demonstrated

This project would seek to develop and demonstrate a modular-designed meter with the capability to monitor electric grid operations and report real time outage and restoration, as well as function as a SCADA metering point during the critical and initial 10-30 minutes of a power outage. The project would explore a modular redesign of the electric meter and the corresponding head-end operations application.

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

Concern, Gap, or Problem to Be Addressed

Currently, when an outage occurs, the existing AMI meter sends a signal that is a “last gasp” message. This message may or may not be received by the network. For instance, in a situation where there is a whole area outage involving a few thousand customers, often only the AMI meters on the border of the outage area may be able to successfully communicate their last gasp, because they are able to connect to the network of neighboring circuits that are still online or have power. The meters in the middle of the outage area are less likely to have their message received. In this scenario, awareness of what’s occurring in the middle of an outage area is limited and reliant on customer communication. In the new meter, the base socket would be designed to have a means of sufficient energy storage that would enable the device to send pulsing messages with voltage data for up to 30 minutes after an outage, regardless of where they are located, increasing the chance of the meter being heard by the network and thus becoming a real time data point available for monitoring grid operations and scoping power outage areas during the critical restoration times. This may help keep PG&E distribution system operators well-informed of grid outage conditions and assist them in taking appropriate actions to restore customer power quickly.

Additionally, in today’s meters some components may fail more often than others. Yet, when a meter is exchanged due to failure or other maintenance reasons, the entire device is removed. The new meter demonstrated in this project could enable potential reduction of equipment costs for replacements due to its modular design. The base mechanical meter would more rarely need replacement, typically leaving just the replacement of the solid state meter and communication core component as needed.

Potential Benefits at Full Deployment

The AMI deployment began in 2006 (D.06-07-027 July 20, 2006). These AMI meters have an approximate 20-year lifespan, with existing meters currently in their eleventh year since the start of the deployment. The new design of this Electric Grid Monitoring (EGM) meter could help prepare the company for the lifecycle replacement of existing AMI meters with new revolutionized meter technologies that provide enhanced functionalities. The enhanced new functionalities enable the transmission of key voltage data after a power outage and during grid troubleshooting, which would help

system operators to quickly assess the scale of the outage and take prompt actions to improve restoration time.

Another key benefit is the modular design and separation of mechanical meter base and solid state metrology and communication core. Currently, when the meters are exchanged due to failure or other maintenance reasons, the entire meters are removed. For the new modular design of the EGM meter, only the solid state metrology and communication core (or a portion of the entire meter assembly) may be replaced. Such replacement could significantly reduce the material cost of the new meter compared to current available options.

Project Number: 26

Project Title: Predictive Data Analytics for Proactive Meter Replacement

Description of Technology or Strategy to Be Demonstrated

This project would seek to develop and demonstrate a predictive analytics tool for remotely diagnosing meter health, to target and prioritize proactive meter replacements. The project will seek to explore the development and demonstration of an algorithm, software application/tool, and/or system interfaces to predict when a meter has a potentially unsafe condition, identify service connection issues, and/or identify when a meter is failing.

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

Concern, Gap, or Problem to Be Addressed

Currently, multiple truck rolls or service calls may be performed on some customer premises in the event of meter issues. For example, initially meter field orders go to meter maintenance personnel. If service wire issues are identified, the meter maintenance personnel contacts a Troubleman to go out and fix the service wire issues. The proposed solution could use data analytics to determine the problem, ensuring the right specialist is sent out to address the problem.

Currently available tools are semi-automated for field order generation and manual for forecasting based on historical trends. A new predictive analytics tool would enable these capabilities to analyze meter data, flags, and alarm signatures, and then combine

them with current and future root cause analysis findings to automatically perform these prediction, trending and forecast functions.

Potential Benefits at Full Deployment

A predictive, automated meter health diagnostic tool could potentially significantly reduce the need for corrective maintenance truck rolls through accurate identification of meter issues and consolidation of same-premise truck rolls. It may lead to improved ability to dispatch the correct field personnel to fix the problems and prevent multiple unnecessary truck rolls. As a result, the predictive analytics tool/application may reduce service calls and improve worker safety, affordability with reduced issue resolution costs, and customer experience with better targeted meter issue resolution.

Project Number: 27

Project Title: Multi-Purpose Meter (MPM)

Description of Technology or Strategy to Be Demonstrated

This project would seek to develop and demonstrate a meter that can measure energy consumption for multiple customers and/or multiple uses/purposes, in the place of multiple single-use/purpose and/or sub-meters. The Multi-Purpose Meter (MPM) will include a combination of head-end operations applications, master meter, and individual meters (IDV). The master meter would conduct communications with all nearby IDVs. It would collect the data, such as voltage and current values from each IDV using one of the communication technologies, such as wire connection, Bluetooth and/or Wi-Fi. The master would calculate the necessary energy usage for each IDV and transmit IDV's usage data to the other master meter, data collector, or directly to the head-end application. The servant IDVs can hop between themselves to relay the voltage and current values to the master meter. The head-end operations application would collect interval usage, voltage, outage, restoration, and alarm data from the master meters, frame and pass the usage data to the meter data management system, then on to the billing and/or grid monitoring/operational systems. Several potential use cases may be explored, such as multi-tenant buildings, homes with multiple distributed energy resources, and/or streetlight poles with multiple tenants.

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

Concern, Gap, or Problem to Be Addressed

Current metering solutions require one meter per customer. If there are multiple customers' equipment on the same streetlight pole, or there are multiple dwelling in the same premise, it may require multiple meters. The new multi-purpose meter may reduce the need for multiple meters that are each equipped with individual, power supply circuits and radio transmission circuits on the same premise. This redundancy in equipment adds cost to the materials, installation and maintenance on site.

Currently, the metering industry has one full meter per dwelling, but does not have the multi-purpose meter technology. This technology could also be used as a more cost-effective submetering option, providing better insights into various DERs at a customer premise opening up the opportunity for new programs and/or rate options for customers.

Potential Benefits at Full Deployment

The new multi-purpose meter may reduce operational costs and asset costs with reduced metering equipment, such as individual power supply and radio transmission circuits. The separation of the high voltage and power disconnect circuits may improve worker safety when doing maintenance. Currently, there are over 330,000 buildings in PG&E service territory with multiple units, which have 1.9 million meters currently installed. These buildings typically have a meter room in which many meters are stacked in rows and on one or two walls. In this situation, the benefit of a multi-purpose meter is one meter replacing many meters, and the rest of the customer-owned sockets may have low cost servant IDVs. This will cut down the components inside electric meters and reduce the material costs, meter installation and maintenance costs at the same premise. The combination of power enclosure and MPM box will also be small and take less space inside the building.

Also, as Smart Cities and DER options grow, new technologies may be developed and will demand a growing number of small-load applications on electric streetlight poles and other shared locations. For example, a streetlight pole may have a LED streetlight, safety camera, EV charging point, Wi-Fi hub, telecomm cell site equipment, solar panel,

traffic signal, etc., each of which has a different owner and needs to pay for energy usage separately. The MPM can provide a simplified metering solution without hanging a metering panel on the streetlight pole or setting up a meter pedestal on the sidewalk.

Project Number: 28

Project Title: Real-Time Load-Based Charging

Description of Technology or Strategy to Be Demonstrated

This project will seek to demonstrate a "smart" EV charging application by coordinating and staggering residential EV charging with the aim of avoiding potential distribution system issues caused by numerous EVs in a local area that are charging at the same time. This project entails assessing of the costs and benefits of providing signals to EV owners or directly to the car or charging equipment indicating when to start charging to avoid issues with local distribution assets. These signals could be based on asset health and/or real-time distribution system information in order to yield value to the distribution system (e.g., avoid times when transformers or other equipment are at risk of over-capacity).

The project would attempt to develop a smart-charging algorithm based on time, capacity, locations, and other inputs. The algorithm would aim to coordinate EV charging so that specific grid assets are not overly taxed.

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

Concern, Gap, or Problem to Be Addressed

Under current utility standards when residential EV charging is installed, the new load is assessed to have a 100 percent power factor and is not diversified. This means that an EV charger is assumed to be in use at the peak hour for the local transformer, it also means that if there are multiple EV chargers on a residential feeder they are all assumed to be in use at the same time. These assumptions determine whether a transformer upgrade is needed regardless of the low likelihood that all EV chargers are in use at a transformer's peak hour. If this project is successful in demonstrating a cost effective method for ensuring residential EV charging occurs neither all at the same time nor at the peak hour for the local distribution asset, then utility standards may be able to be revised while maintaining the same level of reliability.

As EV adoption increases, distribution transformer or other local capacity constraints may result in increased distribution system costs for customers. EV chargers currently have no visibility into distribution system operations and constraints. This project could design controls to coordinate EV charging in a local area in order to facilitate higher EV adoption and charging without the need for distribution system upgrades.

Potential Benefits at Full Deployment

Data from the project may be used to estimate the costs and benefits to both the grid and the EV customer in order to determine the potential to scale this solution across any feeders where increasing EV adoption (and associated charger installation) may result in capacity constraints. Reliability and affordability benefits could be derived through avoided capacity upgrades and extended asset life. Coordinated charging may be an important and low cost strategy for accommodating increasingly large numbers of EVs whilst maintaining grid reliability and avoiding costly upgrades.

Project Number: 29

Project Title: Advanced Customer Bill Scenario Calculator

Description of Technology or Strategy to Be Demonstrated

This project seeks to demonstrate an online tool with a streamlined graphical user interface to allow customers to more easily understand how behavioral changes and technology investments may affect their energy bill. The project will seek to explore various design elements of the tool, such as the ability to toggle on and off the negative load curve of DER products and services to understand potential additional savings. These DER-related “what if” scenarios could be developed based on DER load shape impact data, combined with utility programs and rates.

Existing customer facing tools, such as YourAccount™, are intended for a general audience with less complex energy management needs. As such, they do they not include broad DER adoption optionality capabilities. The current online tool is meant to be user-friendly to the general population and not targeted towards users with greater DER experience and needs. The existing “what-if” tool asks general questions about energy shifting and energy reduction, as opposed to the more detailed usage alteration contemplated with this proposed tool.

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

Concern, Gap, or Problem to Be Addressed

Most utility customers are typically passive consumers of energy and do not fully understand how their actions impact bill savings. PG&E actively encourages residential customers to engage with on-line tools that provide energy usage, bill comparisons, rate comparisons, rate change capabilities, and access to tools, such as bill forecast alerts and balanced payment plan options. While the existing tools assist a majority of customers today, the energy technology landscape is quickly changing and customers are becoming more aware and engaged with DERs. The proposed tool is targeted towards this group of more engaged customers. PG&E's customer research shows that the more engaged customers want to understand how technologies may affect their bills. In response to this market need, this tool would allow consumers to engage with their energy usage and conservation options through an interactive and more in depth manner.

Potential Benefits at Full Deployment

Connecting the project's Customer Bill Scenario Calculator to online information about programs or the ability to sign up for alternative rates and services may allow more customers to engage with the utility through their preferred channel of choice, rather than forcing them to call or meet in person. Additionally, this project may increase transparency, while lowering the barriers to entry of customer engagement with their energy use and bill.

Customers, of all classes, have expressed interest in more information, understanding of optionality, and control over their energy bill. This can be observed by increased customer prompted outreach to PG&E's call centers and business energy services representatives on bill and DER related topics. This tool provides PG&E the ability to provide customers with complex energy management needs with a standard interface to interact with their energy choices.

Project Number: 30

Project Title: Connected Device Real-Time Pricing-Based Control

Description of Technology or Strategy to Be Demonstrated

This project will seek to demonstrate the technical feasibility, utility benefits, and customer value of real-time pricing services through evaluating how PG&E can send signals to connected devices to control their operation based on pricing signals and/or grid conditions. The project will analyze the benefits of transmitting real-time pricing to connected device technologies to tie real-time customer electricity usage (e.g., data represented by interval data) to real-time locational marginal electricity pricing for the purpose of enabling new load shedding and/or DER focused rates that incentivize customers for their smart device participation in grid needs.

Connected devices have the potential to leverage real-time price information for use in behavioral modification, automated consumption controls, building energy management and distributed energy resource management. This project aims to investigate the strategies for potential future dynamic pricing options enabled by recent communication infrastructure solutions that tie real-time locational marginal electricity price to retail real-time pricing transmission at the interval level. The project may include investigation of methods to interact with connected device and building control demand-side assets, demand elasticity of price of sites, and infrastructure required for scaling such system and services. Of particular interest is customer value and pricing options enabled by providing various dynamic pricing strategies.

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

Concern, Gap, or Problem to Be Addressed

As PG&E (and other utilities) adapt to the high volumes of DERs on the grid and the continued growth of Internet of Things (IoT) technologies, enhanced demand-side load balancing strategies, such as price-responsive control systems, need to be used to better manage grid reliability. Up to this point, most pricing tariffs up to this point do not operate at a high interval level of granularity and short enough latency needed to provide the customer incentive / grid optimization connection to properly leverage these DER and IoT resources as part of addressing grid needs. Therefore, shorter time scale

investigations are needed to better reflect and act on the time-varying marginal costs of the grid as promoted by R.14-10-003, the Distributed Energy Resources Action Plan. This, in turn, may help to better achieve alignment of customer and grid benefits.

Potential Benefits at Full Deployment

Potential benefits of this initiative at full deployment include improvements to reliability, affordability of energy supply, and improved environmental impacts through leveraging DERs and customer IoT equipment to help manage grid needs. In addition, demand-side actions based on real-time marginal costs, enabled by technology and service structure investigated in this project, may help drive value exchange between the customer and the energy markets, and therefore further enable a clear path to market driven adoption of DERs.

Project Number: 31

Project Title: Real-Time DER Price Signals

Description of Technology or Strategy to Be Demonstrated

This project would seek to design and demonstrate a locational net benefit rate design structure for DERs in order to valuate DER grid services to incentivize optimal DER siting and dispatch.

Valuation of DER grid services at high-resolution would require a robust, integrated analytics platform. The project would potentially first select a real-time valuation method. The project may also include identifying and addressing challenges arising from data quality and technology interoperability, assessing the resulting algorithm's ability to more accurately reflect grid value of DERs deployed to enable creation of a DER locational net benefit rate which leverages grid conditions and/or pricing signals to evaluate how to incentivize customers for the use of their DERs.

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

Concern, Gap, or Problem to Be Addressed

Pricing is a standard method of encouraging market participants to make optimal decisions. However, a rate-based real-time pricing solution for DERs has yet to be

evaluated. Providing exact price signals for DER benefits could enable engaged customers to make smarter decisions about their energy use.

DER valuation is currently provided via publicly accessible excel models, which are limited by minimal processing power and lack of interoperability with other utility datasets. This project would provide higher complexity and precision by integrating large datasets into a scalable engine for DER valuation, which supports the vision elements of the DER Action Plan to develop rates and demand charges that better reflect cost causation and capacity benefits of DERs.

Potential Benefits at Full Deployment

High-resolution DER valuation could incentivize optimal DER siting and dispatch for grid benefits, which support both affordability benefits, as well as carbon reduction benefits. This project at full scale may allow California and PG&E to continue to pursue carbon reduction goals in a cost-effective manner, while also aiming to keep rates more affordable during the transitioning to a low carbon future.

Project Number: 32
Project Title: System Harmonics for Power Quality Investigations
Description of Technology or Strategy to Be Demonstrated

This project will seek to leverage SmartMeter™ data to assist in identifying system harmonics that may cause power quality issues for customers. The project will seek to demonstrate algorithmic processes to analyze newly-available data from polyphase meters and may develop a dashboard to display and track harmonics issues. Project activities may include, but are not limited to:

- A “heat map” to visualize the identified harmonics issues, and communicate the magnitude of the issue.
- Benchmarking of the voltage signatures of circuits with healthy harmonics.
- A process to record historical harmonics levels and display how an issue has developed over time.
- Use of preset voltage triggers to detect voltage sags, flicker, power surges, transients, harmonics, and unbalance.
- The foundation for analytics tools to provide insight into the source of harmonics issues.

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

Concern, Gap, or Problem to Be Addressed

Harmonics are a distortion of the normal electrical current waveform, and are caused by timing differences in either generation (e.g., inverters) or demand (e.g., electric motors). If the harmonics of a circuit become too distorted, then other customers' power quality may be impacted to the point that their devices (whether demand sources, such as pumps, or generation sources, such as BTM solar) may not function. As new sources of generation (e.g., distributed solar) and demand (e.g., EVs) are added to the system, the potential for harmonics related problems increases.

Currently, power quality investigations are reactive to customer requests, at which point PG&E analyzes the circuit, determines the source of the harmonics, and installs voltage filters to mitigate the problem. If these issues could be identified proactively, it would be a valuable tool to fix issues before customers experienced the resulting power quality issues.

Potential Benefits at Full Deployment

Currently, power quality issues are not as transparent to PG&E because limited historical data is available, and issues are only addressed after the customer notifies PG&E. Improved power quality data might enable PG&E to more proactively identify and address power quality issues before they impact service, improving reliability and customer experience. Ideally, this aggregation and analysis of data would lay the groundwork to identify the source of, not just the existence of, power quality issues, improving operational efficiency by moving from manual investigation to algorithmic, at-scale analysis.

3.4 Cross-Cutting and Foundational

3.4.A Program Area Background and Current Challenges

PG&E's EPIC Investment Plan also 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, information system architecture, enhanced field operation tools, 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 Sections 8360-8369 to provide the following:

- New tools for field operations to improve the speed and safety (and reduced cost) of repairs and infrastructure enhancements, such as drone enablement and operational use, augmented reality and mobile access to system data.
- Support next generation cybersecurity to reduce the risk of potential attacks that may impact reliable delivery of electric service, such as identification of rogue wireless signals in secure facilities and convergence of cyber and physical access controls.

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

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

TABLE 3-4
SUMMARY OF PROJECTS BY PROGRAM AREA
CROSS-CUTTING/FOUNDATIONAL STRATEGIES

Investment Area: Cross-Cutting/Foundational Strategies Technology Demonstration and Deployment				
Project Number	**Project Name**	**Safety**	**Reliability**	**Affordability**
33	Cyber-Physical Integrated Security	x	x	x
34	Local Wireless Security For Critical Facilities	x	x	x
35	Advance Security of Internet of Things (IoT) Communications	x	x	
36	Cybersecurity for Industrial Control Systems	x	x	
37	Augmented Reality	x		x
38	Voltage Checks	x	x	x
39	Optimized Dispatch For Restoration Events		x	x
40	Advanced Field Reference Tool	x		x
41	Drone Enablement and Operational Use	x	x	x

Project Number: 33

Project Title: Cyber-Physical Integrated Security

Description of Technology or Strategy to Be Demonstrated

This project will seek to demonstrate a unified security solution which matches physical access to system access to aid in the blocking of unauthorized access to PG&E's critical infrastructure. Currently, physical access control systems and cyber access control systems operate independently from each other. The project will explore a tool to aggregate different types of security events to associate physical access to cyber access at PG&E's critical environments, such as substations, control centers, or data centers.

The project may test a solution to determine technological feasibility with existing control systems and demonstrate increased access control capabilities to applications. The project might also work with several current PG&E vendors to integrate their systems with the solution being tested.

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

Concern, Gap, or Problem to Be Addressed

Network security systems control access to a workstation, and physical security systems control access to a facility, but those systems do not necessarily work in

concert. Software could crosscheck the physical events (e.g., scanning into room) with the work order (e.g., logging into a system), to determine whether the access to a system is appropriate and expected. While these access checks are performed independently, this solution would be the first example of correlating physical and cyber events to reinforce the effectiveness of both.

Potential Benefits at Full Deployment

The potential benefits at full deployment are the potential reduction of attack vectors (that could cause equipment damage, outages, or theft of personal information), which improves system safety and reliability. At full deployment, this new technology could potentially reinforce the value of existing access control systems, streamline incident response activities and investigations, and may further reduce the attack surface within PG&E critical facilities and networks.

Project Number: 34

Project Title: Local Wireless Security for Critical Facilities

Description of Technology or Strategy to Be Demonstrated

This project will seek to develop and demonstrate a next-generation wireless security solution which would monitor airwaves around PG&E's electric facilities to detect rogue access points installed within physically secured generation / substation facilities, which could provide bad actors access to the critical infrastructure networks.

By potentially customizing this technology to Industrial Control Systems (ICS) signatures and protocols, the enhanced technology may detect if grid operation data, encapsulated within wireless protocols, are exposed over public airwaves, and PG&E may assess where further encryption of this data is needed.

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

Concern, Gap, or Problem to Be Addressed

A particularly concerning threat scenario for utilities involves an attack establishing a rogue access point inside a critical facility, allowing remote control of grid operation technology through wireless communications. The communication of operational data

over wireless channels can introduce potential cyber security risks, including the potential of eavesdropping and adversarial manipulation of the grid.

Current controls to address this issue rely on internal policy, standards, and processes to require encryption of communication or to prevent the inclusion of random access points within critical network systems, but these controls are only effective against employee misconduct or pre-deployment of systems, and not actors with malicious intent. The only way to ensure communications remains encrypted and rogue wireless access points do not occur is through monitoring technologies like those that would be tested and demonstrated through this project.

There are security platforms available today which scan for wireless protocols and perform deep packet inspection to parse for sensitive data, such as username and passwords. These platforms demonstrate value in wireless protocols commonly used by enterprise networks, such as Bluetooth and Wi-Fi, but it currently does not address security challenges, communication protocols, and applications associated with Industrial Control Systems. This project's technology would be the first of its kind to scan for and perform deep packet inspection of grid operation traffic.

Potential Benefits at Full Deployment

As the electric industry adopts and deploys more grid monitoring systems, the scale of accidental exposure of grid operational data increases. This issue is further emphasized as these monitoring systems are located across large geographical areas. The technology proposed may assist utilities in managing the scale of this problem, and therefore reduce attack opportunities by adversaries.

Project Number: 35

Project Title: Advance Security of Internet of Things (IoT) Communications

Description of Technology or Strategy to Be Demonstrated

This project will seek to demonstrate an open architecture standard for secure communications between a utility and customer devices using third party communication channels (e.g., home internet connections, cellular networks, private-built field area networks). This may include, but is not limited to:

- Interface standards and protocols for sending Internet of Things (IoT) communications to PG&E and cataloging security differences encountered through different communication channels.
- A process for third-party IoT devices to initiate secure communications with PG&E.
- A methodology and set of requirements for device makers to certify their device is compatible and secure when using third-party communications channels.
- An inventory of cybersecurity liabilities or potential risks when communicating with third party devices over open networks.
- A review of cybersecurity investments / gaps which must be addressed prior to introducing certain functionalities / interfaces.

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

Concern, Gap, or Problem to Be Addressed

As utilities begin to integrate BTM DERs into the grid, communication and control signals may need to be sent from and to operational data networks (whether through the AMI radio mesh network or otherwise). This increasingly diverse set of network connections could introduce new cybersecurity risks for the utility: as the number of legitimate communication points with a utility's secure networks increases, so does the size of the utility's "attack surface" (vectors of potential attack). This project would identify key risk areas and mitigation strategies around increased communications with DERs, and develop best practices and connection protocols for legitimate vendors to interface with PG&E without increasing the cyber-risk of the whole network.

Potential Benefits at Full Deployment

At full deployment, this new technology may improve safety and reliability in the future high DER grid state by advancing the security of IoT communications using third party networks, thereby reducing the risk of bad actors causing grid disturbances, such as outages.

Project Number: 36

Project Title: Cybersecurity for Industrial Control Systems (ICS)

Description of Technology or Strategy to Be Demonstrated

This EPIC project is proposed as a joint EPIC Administrator collaborative project that seeks to evaluate potential demonstrations that build on the foundation of machine to machine automated threat response, such as potentially including adaptive controls and dynamic zoning for industrial control systems and enhanced visual interfaces of simulation engines that include converged network and grid models.

The concept of dynamic zoning allows for isolation of threats to certain segments of the ICS and could include both vertical (isolating data flows from SCADA masters to substation endpoints) and horizontal (containing data flows between substations, for example, under a state of manual control when the SCADA master cannot be trusted). In addition to the dynamic zoning, zone-specific cybersecurity controls (e.g., network whitelisting, firewall rules, intrusion prevention engines, etc.) could be manipulated in order to contain or thwart a cyberattack.

Additionally, a streamlined process is important for adding a visual interface to define cybersecurity test scenarios dynamically and rapidly, allowing users to test new scenarios and responses in real time, and virtualize / enhance the simulations used for current cyber exercises. This may include translation software to convert grid models in common formats into new simulation engine formats, allowing utilities to upload existing, detailed models of grid configurations that have already been developed under other modelling packages, which may help to maximize the potential benefits obtained from these advance simulation approaches.

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

Concern, Gap, or Problem to Be Addressed

The frequency and sophistication of cyber-attacks is increasing, and as the grid advances and uses increased computing to automate controls, keeping it secure from cyber threats is of vital importance. In order to safeguard against these cyber-threats, it is crucial to further machine-to-machine threat response capabilities.

Potential Benefits at Full Deployment

This project provides clear customer benefits in safety and reliability by demonstrating an increased ability to respond to serious attacks by taking machine speed actions which could reduce the impact of a serious cyberattack. At full deployment, these solutions may act as a tool for cyber security professionals to prepare against ICS network attackers, and aid in protecting against serious impacts on customer outages.

Project Number: 37

Project Title: Augmented Reality

Description of Technology or Strategy to Be Demonstrated

This project will seek to demonstrate technology for visualizing grid and asset data integrated with the geographic information system (GIS) data, superimposed on a device to provide support and guidance for activities, such as asset investigations and maintenance. Potential work streams for such a project may include, but are not limited to:

- Integration of GIS and asset data with an augmented reality solution, to pull up specific tagged data based on where the device is pointing.
- Identification of specific equipment (and location on said equipment) by pointing the device at the location, and adding tags to that location.
- Display location of underground equipment (and related asset data) by pointing a device at the ground.

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

Concern, Gap, or Problem to Be Addressed

Augmented reality could assist field workers by providing (near) real-time guidance and instructions. While this asset information may be available through laptops in the field, there are efficiency / usability gains that could be made by using augmented reality, such as the display of underground assets which may provide a visual, geospatial view of otherwise-hidden information.

Potential Benefits at Full Deployment

Augmented reality is a broad technology category which could improve the efficiency and affordability of field operations by providing faster access to key asset information during inspections and maintenance. Just as importantly, this could eventually improve field crew safety by providing hands-free information displays (e.g., through a heads up display).

Project Number: 38

Project Title: Voltage Checks

Description of Technology or Strategy to Be Demonstrated

This project seeks to develop and demonstrate a tool for field workers to perform remote voltage checks and identify low or no-power line situations while on-site without the need to call the central office or manually measure the line. This could potentially enable a field or dispatch employee to identify Service Points and other voltage-checkable equipment in the surrounding area, click on one of the pieces of equipment, and request the current voltage flowing through this equipment to diagnose an issue.

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

Concern, Gap, or Problem to Be Addressed

Currently, voltage must be checked manually in the field or by calling the central office where an instantaneous voltage check can be run before any work is initiated. Additionally, after work is completed, field workers must repeat these steps to identify if a voltage problem has been solved. A remote voltage check would provide more flexibility to field workers by removing the need to call the central office for voltage checks, saving time from the process. Additionally, as distributed energy resource penetration and subsequent line energization increases, a remote voltage check would potentially streamline workflow in areas with DER assets.

Potential Benefits at Full Deployment

Providing faster access for voltage checks would increase workflow efficiency for both field workers and office employees. Additionally, remote voltage checks can be

integrated into field protocols, allowing field crews better ability to check the status of lines on which they are working. This type of situational intelligence could improve safety for field crews working with energized lines.

Project Number: 39

Project Title: Optimized Dispatch for Restoration Events

Description of Technology or Strategy to Be Demonstrated

This project would seek to optimize crew movements and responses during outage dispatch to support restoration operations. This would potentially involve machine learning to train an algorithm for automation of complex decisions, using components, such as weather, traffic, expected job length, and current crew locations. Analytics and Subject Matter Expert-based heuristics could identify restoration targets that may provide the highest value benefits (in terms of minimizing total customer outage time, or restoring service faster for community-critical locations like hospitals). This may also provide logistics support to emergency operations to improve calculation-based decision times.

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

Concern, Gap, or Problem to Be Addressed

During major storms and other significant events, there are many complex operations and decisions that must be made quickly by emergency operations to restore power to customers. Improving decision making at both a strategic and tactical level could allow PG&E to optimize its response to significant outages, and reduce customer outage time and emergency response costs.

Potential Benefits at Full Deployment

At full deployment, this technology may enhance reliability by optimizing crew efficiencies and assisting restorations, and may improve affordability by reducing overtime during storm events.

Project Number: 40

Project Title: Advanced Field Reference Tool

Description of Technology or Strategy to Be Demonstrated

This project seeks to develop a voice guided and/or free-form entry reference for field workers to ask questions and receive guidance based on PG&E's equipment libraries, safety practices, and other critical documentation. This technology solution may potentially include tagging of PG&E-owner technical content to enable computerized searching of key topics, natural language processing and a learning algorithm to improve access to frequently searched content, and other important characteristics, to maximize the effectiveness of the developed solution.

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

Concern, Gap, or Problem to Be Addressed

Currently, field crews bring a series of printed binders with them to the field, containing necessary documents from the Technical Information Library. Referencing this document in the field is time-consuming and cannot be done without stopping the maintenance operation. For users with the appropriate mobile access, digital versions are available but still require time to find the needed answers. Voice-guided information is an evolving technology area (e.g., Siri or Echo), but has not been adopted for utility use cases. An advanced personal guide may allow open-ended questions without needing knowledge of which reference to use and where to find it to quickly locate answers.

Potential Benefits at Full Deployment

Faster access to documentation may increase safety by providing streamlined access to field safety, asset, and other associated information, enabling more use of previously difficult-to-access documentation, and removing the distraction of manual phone input. Additionally, increasing documentation accessibility enables faster and more confident work output, thereby increasing operational efficiency and improving affordability.

Project Number: 41

Project Title: Drone Enablement and Operational Use

Description of Technology or Strategy to Be Demonstrated

This project will seek to develop and demonstrate a foundational utility-focused Drone enablement systems and initial use cases to form the foundation for future utility Drone operations. Several potential use cases will be explored leveraging the foundational technologies for management and operation of the drones. Initial use cases that may be explored could include, but are not limited to, items such as:

- Control Management System – Project may include control management systems, such as a Flight Management System, which could enable utility workers to design operations in a manner that manages operational risk, reduces risk exposure, and improves the safety and efficiency of these operations. The control system may include organizational and communications protocols for safe and policy compliant drone operations, planning, monitoring, policy enforcement, and records for audit. The control system would ensure aviation and/or other similar regulation compliance and potentially make drone operations much more accessible than today's manned helicopter, fixed wing aircraft, and/or other similar manned vehicle operations. Additionally, the control system may incorporate new maps with utility rights of way constructs for obstacle avoidance.
- Emergency first response – Leverage drones for initial assessment of emergency situations, such as storm damage. Use of drones in this capacity could potentially enhance worker safety and improve speed of response.
- Field Asset Inventory – Develop a drone-based solution for managing field asset inventory using technologies, such as infrared imaging and mapping. Currently, asset inventory approaches require manual and field work. This use case would seek to improve the affordability and safety of asset inventory exercises.
- Condition based monitoring – Explore image and sensing capabilities to measure ultraviolet, infrared, acoustic, and/or radio waves to identify hotspots, unauthorized connections and potential asset failures. The drones may inspect transmission lines, distribution lines, substations, towers, penstock insulators and/or other equipment. Currently, grid and asset inspections can rely on manual measurement procedures. New imaging/sensing technologies can improve the speed and accuracy of measurements while reducing labor required.

- Context capture for substation design tools – Current data gathering methods include helicopter and ground based context capture. Leveraging drones may enable a more cost-effective solution. Additionally, drones may enable the capture of new data that is currently unavailable to the electrical utility.
- Transmission line power harvesting – Explore capabilities to enable long-line inspection. Technologies may include line-based charging stations or magnetic field charging. Currently, unmanned vehicle opportunities may be limited because they cannot travel large distances without needing to recharge. This use case would seek to demonstrating capabilities to enable long-line inspection with reduced physical obstructions and manual involvement.

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

Concern, Gap, or Problem to Be Addressed

Currently, utilities use manned aircrafts and other manned vehicles for grid surveillance. The PG&E helicopter fleet, for example, facilitates the monitoring and maintenance of approximately 17,000 miles of electrical transmission, distribution and management assets. However, there are safety risks inherent in field related work, and manual monitoring creates opportunities for human error.

The development of automated drone fleets could improve the accuracy and efficiency of system operations while allowing for the introduction of new applications through advanced image collection processes and technology (e.g., LIDAR, photogrammetry, and video). Additionally, automated imaging and processing algorithms enable monitoring of electrical lines, electrical generation systems, substations, and other utility assets at higher duty cycles, improving preemptive maintenance resource allocation. Finally, drone implementation reduces safety risks for employees and customers by reducing direct human activity in the field.

Potential Benefits at Full Deployment

Drones are a promising technology for the utility industry, including PG&E with over 17,000 miles of diverse infrastructure to manage. These devices have the potential to revolutionize monitoring, inspection, and real-time awareness of pipeline and powerline infrastructure in normal or outage conditions.

The principal benefit of improved drone technology is increased safety and reliability using unmanned vehicles with improved operational management capabilities that enable the safe operation of drones for patrol, inspection, security, and repair of utility assets. In turn, these operations also increase safety and reliability of electrical distribution lines, generation facilities, and other vital utility assets by minimizing the frequency and duration of electrical outages through improved coverage, quality, and consistency of system inspection and preemptive repair.

Chapter 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 execution of the current Investment Plans and in the development of the Third Triennial Investment Plan, 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 coordinating a number of in-person or phone-based joint portfolio review meetings to coordinate Investment Plans and ensure funding initiatives were complementary and not unnecessarily duplicative.

The EPIC Administrators also jointly met with the Electric Power Research Institute (EPRI) to have an in-depth discussion on gaps that exist in the utility industry that could potentially be filled by technology demonstrations and deployments, while also obtaining feedback for potential areas of unnecessary duplication across the industry. EPRI determined that these industry gaps could be addressed by the technology demonstrations and deployments proposed by the EPIC Administrators and that no unnecessary duplication exists between investment plans.

Together, the Program Administrators have identified topics where more technical 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 all California customers of the IOUs. Areas of coordination may include RD&D activities related to cybersecurity, distribution optimization and fault detection, microgrids, predictive analytics-related projects and other initiatives. In fact, many working groups, cross-utility and industry collaborative efforts already exist in these categories and are leveraged regularly as part of how the IOUs execute their technology demonstrations.

In the Third Triennial Investment Plan, the Administrators propose to take this collaboration a step further by collaboratively executing a project related to cybersecurity that would facilitate a more comprehensive approach to grid security that aims to maximize the potential benefits across all customers in California (EPIC Project 3.36 Cybersecurity for Industrial Control Systems). This project would be jointly managed and would build on the existing accomplishments of the California Energy

Systems for the 21st Century (CES-21) Program,[25] further demonstrating machine-to-machine cyber threat response by evaluating the adaptive controls and dynamic zoning for ICS and improving visual interfaces for the simulation engine. This proposed collaborative approach to executing level of coordinated project that embodies these foundational commonalities is a testament to the growing level of maturity and effectiveness of the EPIC portfolio implementation across the Administrators.

Beyond this jointly executed proposed project, the EPIC Administrators have agreed to pursue the following key principles for cooperating and collaborating for EPIC funded projects, which furthers the guiding principles and goals of the EPIC Program as set out by the CPUC, and maximizes the benefits of the program to electric utility customers.

Information Sharing and Coordinated Planning

The EPIC Administrators will continue to 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. Additionally, the EPIC Administrators will continue to coordinate scheduling, solicitation, and responses to comments and advice from stakeholders on their respective proposed and ongoing RD&D plans and programs. To this end, the EPIC Administrators plan to share information regarding this EPIC Investment Plan, as well as the EPIC 1 and 2 portfolios, As projects complete, the Administrators will continue to meet to discuss project learnings, as practically as possible, which helps to maximize the efficient use of program funds and facilitate the dissemination of the results of the program efforts for the benefit of all California customers.

Furthermore, PG&E consistently shares knowledge gained and lessons learned with the industry through presentations or white papers at conferences or electric groups/committees, such as DistribuTECH, Institute of Electrical and Electronics Engineers (IEEE), and Edison Electric Institute.

.[25] The CES-21 Program is a joint research and development cybersecurity collaborative project between PG&E, SCE, SDG&E and Lawrence Livermore National Lab (LLNL) that examines machine-to-machine cyber automated threats.

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 8360-8369, and to leverage the EPIC funding for the benefit of all electric utility customers. Frequent discussions among the EPIC Administrators help to avoid duplication, identify potential projects and facilitate knowledge sharing. Furthermore, when developing projects for this plan, PG&E evaluated RD&D projects included in other regulatory filings (e.g., General Rate Cases, Transportation Electrification, DRP, Demand Response and EE programs, CES-21) to avoid unnecessary duplication.

In line with the need to maximize how funding is leveraged and ensure projects across all Administrators have a strong path to production, PG&E also respectfully requests modification to D.12-05-037 (OP 5) for CPUC approval to confirm that IOUs may receive CEC funds to participate in CEC-funded EPIC projects as a sub-contractor. This would enable the utilities to engage more substantially in the CEC's projects, and contribute to testing and demonstrations that may ultimately improve the large scale implementation of the project results. This could entail PG&E providing a letter of commitment in response to a CEC PON, whereby PG&E may help any of the grant recipients as a CEC funded sub-contractor for their contribution to the project.

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.[26]

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 and Second Triennial Plan execution and has followed a similar process for its Third Triennial Plan:

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26 D.13-11-025, at OP32, OP 34, and OP 50

Step 1: Performed an internal ideation process to identify priority demonstration needs for PG&E customers that advances EPIC guiding principles to improve safety, reliability, and the achievement of state energy policies cost-effectively.

Step 2: Obtained external stakeholder feedback and performed a gap analysis of PG&E's 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: Continued 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 approaches.

Step 4: Following the steps noted above to define the initial proposed portfolio, 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.

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 approaches with enhancements or modifications. While PG&E is required to signal to the CPUC any significant material scope changes to projects or new projects being added to the EPIC portfolio,[27] PG&E believes the internal governance mechanisms outlined above are appropriate for less significant project changes.

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."[28] 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, which currently limits the IOUs to just TD&D.

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27 D.15-09-005, at OP 1 indicates PG&E, SDG&E and SCE are "authorized to submit Tier 3 advice letters for new Electric Program Investment Charge (EPIC) projects between triennial EPIC applications and for material changes to existing approved projects."

28 D.13-11-025 Section 3.1 (pg. 100).

PG&E would file a petition if it were to propose a new category of expenditures, consistent with the Decision.

4.3 Proposed 2018-2020 EPIC Budget and Funding Allocation

D.12-05-037 authorized EPIC statewide funding collections at $162 million annually, from 2013-2020. The CEC is designated as Administrator for approximately 80 percent of the EPIC funds with approximately 20 percent of program funding administered by the IOUs.[29] OP 7 of D.12-05-037 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. CPUC D.15-04-020 (Table 5) clarified the total statewide funding collections for the 2015-2017 EPIC Triennial Plan at $169.9 million annually, which included the compounded triennial escalation rate of 4.89 percent.

CPUC D.15-04-020 also requested the Administrators provide a program budget included in table format, broken down by each budget area, including grand totals. The budget tables below show the proposed escalated budgets based on the updated proposed CPI value of 2.065 percent with collections (for the IOUs) and oversight amounts presented for both annual and triennial periods. To calculate the updated CPI, PG&E applied the same calculation approach as leveraged by the CPUC in D.15-04-020.[30] For 2018-2020, PG&E updated the approach to reflect the new CPIs from 2014-2016 using the following method: The CPIs for Urban Wage Earners and Clerical Workers for the third quarters of 2014, 2015, and 2016 were as follows: 234.242 in 2014, 233.278 in 2015, and 235.057 in 2016.[31] Using the CPI from 2013 (230.327) to determine the change in these indices for the three year period yields an

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

30 The following approach was leveraged by the CPUC to calculated the approved CPI index in D.15-04-020: “The CPIs for Urban Wage Earners and Clerical Workers for the third quarters of 2012, 2013, and 2014 were as follows: 226.540 in 2012, 229.879 in 2013, and 233.791 in 2014. Using the same CPI from 2011 (222.884) to determine the change in these indices for the three year period yields a compounded annual growth rate of 1.605 percent. This annual growth rate is then compounded by three years (for the 2015-2017 triennial period) as follows: 1.605^3 – 1 = 4.89%.”

31 Social Security Administration CPI for Urban Wage Earners and Clerical Workers; https://www.ssa.gov/oact/STATS/cpiw.html.

average annual growth rate of 0.684 percent. This annual growth rate is then compounded by three years (for the 2018-2020 triennial period) as follows: (0.684% + 1)^3 – 1 = 2.065%. Thus, the proper compounded triennial escalation rate by which the EPIC program collection and budget amounts shall be increased is 2.065 percent. As outlined in Table 4-1, applying the CPI factor results in an escalated triennial collection amount of $520,309,700, and an annual collection amount of $173,436,600 for 2018-2020 for all Administrators.[32]

CPUC D.15-04-020[33] also provides guidance regarding the treatment of accumulated interest. Through the Annual Electric True Up (AET) advice letter process, PG&E reflects in rates the under or overcollected balance in the Electric Program Investment Charge Revenue Adjustment Mechanism (EPICRAM), including interest authorized for recovery, pursuant to Electric Preliminary Statement Part FU.[34] PG&E is, therefore, in compliance with these orders, thus does not need to reduce its 2018-2020 investment plan budget by the 2012-2017 EPIC accumulated interest for the following reasons:

1) Interest accumulated in the EPICRAM is already included in PG&E's customers' rates through the AET process;
2) Interest accumulated in the Electric Program Investment Charge Balancing Account (EPICBA) from 2012-2017 program cycle years will be included in overcollected balances, and transferred to EPICRAM at the end of the 2015-2017 program cycle year, upon authorization by the Commission in an advice letter, pursuant to Electric Preliminary Statement FY;[35] and
3) PG&E expects this current existing recovery mechanism would apply to the 2018-2020 EPIC program cycle.

Tables 4-1 and 4-2 include the escalated approved triennial and annual budgets, respectively. These tables include the applied the CPI adjustment amount (2.065%) to

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32 2.065 percent annual escalation rate is based on data available at the time of this filing, for third quarters of 2014, 2015 and 2016. 2017 CPI data for the third quarter of 2017 rate was not available at the time of writing this application; therefore, this rate may be updated by the CPUC to reflect the third quarter 2017 rate.

33 Id., at OP 12, 13, and 15.

34 https://www.pge.com/tariffs/tm2/pdf/ELEC_PRELIM_FU.pdf.

35 https://www.pge.com/tariffs/tm2/pdf/ELEC_PRELIM_FY.pdf; Tariff Line 3.

the CPUC approved budgets in EPIC 2 (D. 15-04-020 Table 5); however, it does not include the expected accumulated interest deducted from the 2018-2020 Investment Plan proposed by the other IOUs. The final budgets are provided below in thousands.

TABLE 4-1
PG&E'S 2018-2020 TRIENNIAL INVESTMENT PLAN
TRIENNIAL PROGRAM BUDGET (ESCALATED)
(THOUSANDS)

Triennial Escalated Program Budget	CEC	PG&E	SCE	SDG&E	Total
Utility Collection/Funding Allocation	n/a	50.1%	41.1%	8.8%	100%
Authorized EPIC Funding Collection	n/a	$260,675	$213,847	$45,787	$520,310
Program Administrator Budget by Funding Element					
Applied RD&D	$161,433	$0	$0	$0	$161,433
TD&D	$154,395	$46,661	$38,279	$8,196	$247,531
Market Facilitation	$56,714	$0	$0	$0	$56,714
Program Administration	$41,625	$5,214	$4,277	$916	$52,031
CPUC Program Oversight	$2,081	$261	$214	$46	$2,602
Total	$416,248	$52,135	$42,769	$9,157	$520,310

TABLE 4-2
PG&E'S 2018-2020 TRIENNIAL INVESTMENT PLAN
ANNUAL PROGRAM BUDGET (ESCALATED)
(THOUSANDS)

Annual Escalated Program Budget	CEC	PG&E	SCE	SDG&E	Total
Utility Collection/Funding Allocation	n/a	50.1%	41.1%	8.8%	100%
Authorized EPIC Funding Collection	n/a	$86,892	$71,282	$15,262	$173,437
Program Administrator Budget by Funding Element					
Applied RD&D	$53,811	$0	$0	$0	$53,811
TD&D	51,465	15,554	12,760	2,732	82,510
Market Facilitation	18,905	0	0	0	18,905
Program Administration	13,875	1,738	1,426	305	17,344
CPUC Program Oversight	694	87	71	15	867
Total	$138,749	$17,378	$14,256	$3,052	$173,437

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 and 4-2, which is based on the escalated triennial program budget, PG&E is authorized to collect $260,675,200 for the three-year triennial cycle. PG&E is also authorized to allocate $46,660,900 to the TD&D investment area only for TD&D project-related spend. In addition, the EPIC Decision authorizes approximately $5,213,500 for general PG&E administration of the EPIC 3 Program and $260,700 for PG&E's portion of the CPUC

program oversight budget.[36] PG&E and the IOUs are not authorized for expenditures in other program areas.

Additionally, Administrators are also 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 where appropriate.

Furthermore, CPUC D.13-11-025 provides guidance regarding the treatment of unspent funds.[37] With almost 90 percent of PG&E's EPIC 1 project portfolio complete, PG&E forecasts there will be approximately $7 million in remaining funding that will be unspent of the EPIC 1 program funding. In D.13-11-025, the CPUC requests an explanation for the cause of the unspent funds in prior Investment Plans. The reasons for this underspend include:

- Internal prioritization ultimately deprioritized projects for reasons including: Technology was not yet ready for demonstration; project was determined to have lower priority based on changing grid, customer, and/or policy needs, and risk identified to ensure viable path to production if the technology is successful.
- PG&E maintained diligence throughout the execution of projects to continue industry benchmarking to reduce risk of unnecessary duplication. For instance, PG&E's project EPIC 1.19, Enhanced Data Techniques and Capabilities via the SmartMeter™ Platform, sought to explore a use case to create meter health event traps, specifically the temperature alarms. The project team identified a very similar project use case in flight at another major utility, which provided essentially the same outcome. Ultimately, this utility provided PG&E with the results of their project, whereby they were able to bring back temperature data intervals, but determined it was unnecessary due to the volume of data coming back to the system. It chose to bring back reads twice a day. The use case of meter health event traps was ultimately removed from the project, and the EPIC program funds for this use case were saved from duplicating the same efforts done by this utility.

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

37 D.13-11-025, at OP38.

- Project teams responsibly administrated customer funds by identifying project savings opportunities, including negotiating of contract costs to milestone based contracts, scaling project scope to minimize cost impact while ensuring adequate learnings, and right-sizing project approach based on the value of the expected benefits.
- Different technologies have emerged that could produce better insights for the industry and PG&E customers, making some of the original proposed projects no longer the best use of available program funds.
- The vendor interest dropped due to the small-scale pilot size of the project or the vendor revises their business model, such that it is no longer aligned with the projects' objectives.
- Technology costs reduced between the time of the original project was proposed and budgeted to the time of finalizing contracting with vendors (e.g. batteries)
- Projects were formally withdrawn with the CPUC due to the GRG already addressing one project, and another having been incorporated in the CEC Program.

The unspent funds in EPIC 1 demonstrate responsible administration of customer dollars—ensuring projects are prioritized based on their technology readiness, internal prioritization and cost/benefit value, and the ability to make impactful changes that lead to a viable and cost-effective full scale production of the demonstrated technology if it is proven successful.

With a robust proposed portfolio planned for the EPIC 3 Investment Plan, PG&E respectfully requests that the CPUC approve a modification to D.12-05-037 (OP 7) and D.13-11-025 (OP 38 and 39) by authorizing PG&E to leverage the forecasted unspent project and administrative funds remaining from PG&E's EPIC 1 Investment Plan (estimated to be approximately $7 million) to be used as additive to PG&E's total EPIC 3 triennial TD&D project budget request (Table 4-1). This would increase the total PG&E EPIC 3 triennial program budget from $52.1 million to approximately $59.1 million without increasing collections from PG&E customers. This approach would allow PG&E to maximize overall EPIC authorized program funding towards the most current customer needs and California policy objectives, which is reflected in the EPIC 3 portfolio mix outlined in Chapter 3 of this Application. All other funding policies would continue to apply, including PG&E staying within the authorized 10 percent administrative cap.

The funding collections established by the Commission in D.12-05-037 authorized the EPIC Program through the end of 2020. Being the last Investment Plan period that is approved through the existing funding mechanism established in EPIC, PG&E proposes the Commission initiate a stable funding structure for RD&D activities to minimize any program funding gap after the end of the approved EPIC program cycle in 2020. As part of this, the CPUC should leverage the outcomes of completed EPIC projects to also re-evaluate the funding allocation across the three areas of RD&D and across the Program Administrators. Alternatively, the CPUC could consider the continuation of the existing EPIC portfolio structure to minimize the gap between program periods while a larger program structural assessment is underway. While a number of the current grid challenges today are aiming to be addressed by the current EPIC Program and in the market, there will continue to be new grid challenges that will require RD&D funding. PG&E proposes a stable funding structure to be approved by the Commission, which will allow Program Administrators to address and test opportunities to enhance the utilities' ability to deliver safer, more reliable and more affordable energy services to customers. Beyond the inefficiency of starting and stopping the administration of a program, this proposal for stable funding also supports the long certainty of the need for innovation, which brings value to interested technology companies, utilities, and electric customers. PG&E does not propose a revision in the Application funding process, but instead emphasizes the need to reduce the risks of timing lapse in the RD&D portfolio.

Additionally, given the dynamic nature of RD&D, PG&E respectfully proposes a revision to the approval process for new EPIC projects during an in-flight program cycle as established in CPUC D.15-09-005. The decision states that IOUs cannot add new projects to an approved Investment Plan without an approved Tier 3 advice letter, which requires Commission resolution for approval to proceed. In February 2017, PG&E identified six new, compelling project opportunities to be considered for the EPIC 2 Investment Plan. These projects were established after identifying new technology demonstration opportunities that align with the EPIC principles, yet were not requested for approval in the EPIC 2 Application, given the technology development that occurred in the three years since filing the EPIC 2 Application in 2014.[38] In response to D.15-09-005, PG&E therefore participated in the Tier 3 advice letter approval process,

38 A.14-05-003

submitting a Tier 3 Advice Letter 5015-E on February 7, 2017. PG&E has not yet seen a resolution to proceed with the six new proposed projects, which impacts PG&E's ability to be nimble in addressing electric grid related technology challenges/ opportunities in support of California's aggressive policy goals and the needs of PG&E's customers.

The nature of RD&D carries more risk and uncertainty, and is fast paced as it sits at the beginning of the product life cycle. EPIC Administrators continue to need additional flexibility to manage RD&D portfolios as effectively as possible and to address the changing landscape of technology drivers that cannot always be predicted three or four years in advance. It is impossible for PG&E and Administrators to predict in 2017 all of the technology needs and demands that will be in place by 2020 that may help to meet California's aggressive policy goals. PG&E also recognizes and appreciates the need to transparently inform the Commission and stakeholders of modifications to its EPIC portfolio and therefore recommends the Commission modify D.15-09-005 to update the current Tier 3 advice letter process, which has shown to not be timely, using a Tier 2 advice letter process.[39]

As stated above, at the time of filing this Application, PG&E's Advice Letter 5015-E has not yet been approved by the Commission (see Appendix C). If at the time of issuing the EPIC 3 Decision in response to this EPIC 3 Application a resolution has not yet been issued for the advice letter, PG&E requests that the advice letter decision is made inclusive with the decision for the EPIC 3 Application, thereby authorizing those projects to move forward leveraging remaining EPIC 2 portfolio funding.

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

PG&E intends to continue to consult regularly with other interested 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 bi-weekly meetings with the Program Administrators. In addition,

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39 PG&E and SCE previous requested approval of new projects or material scope changes through a Tier 1 advice letter process, which was denied in the CPUC D.15-09-005.

PG&E has established a website to inform interested parties of PG&E's EPIC portfolio,[40] as well as bidding opportunities for specific projects.[41]

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 (RFI) and Request for Proposal (RFP), in order to draw upon 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.[42] Where a unique or specific expertise or capability is identified for an individual project, PG&E may employ sole source procurement procedures following PG&E's established procurement processes.

Funding Mechanisms

PG&E does not expect to utilize grants or loan-type contracts for EPIC projects, but does not rule them out. PG&E may include "performance-based" incentives or requirements in its contracts, such as demonstrating a minimum level of operating experience and performance when demonstrating a particular technology, facility or process in the field. As is usual for utility contracts in general, PG&E's EPIC contracts will retain audit rights for both PG&E and the CPUC.

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40 www.pge.com/epic.

41 https://www.pge.com/en_US/for-our-business-partners/purchasing-program/bid-opportunities/bid-opportunities.page.

42 D.13-11025, Attachment 3.

Chapter 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 continue to 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 D.13-11-025,[43] the CPUC adopted project metrics and potential areas of measurement that Administrators could choose based on the scope and objectives for an investment area proposed by the EPIC Administrator. Administrators are allowed the flexibility to choose metrics on a project-by-project basis and the list is not exhaustive. In the project's final reports, PG&E provides a discussion for how these metrics are evaluated and achieved as applicable for the project. Once this Investment Plan is approved, PG&E can determine the appropriate metrics applicable to each proposed project during the initiation or planning phase for the project.

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 customer project costs through external funding or contributions committed by others.

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43 Attachment 4.

Where practicable, PG&E will also apply metrics detailed in its Smart Grid Annual Report[44] 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; and
- 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.

[44] www.pge.com/pge_global/common/pdfs/safety/how-the-system-works/electric-systems/smart-grid/AnnualReport2016.pdf.

TABLE 5-1
SUMMARY OF 2018-2020 EPIC INVESTMENT PLAN

PG&E's 2018-2020 EPIC Project Portfolio									
Project Name		**Primary EPIC Guiding Principles**			**Complementary EPIC Guiding Principles**				
Investment Area: Renewables and DER Integration Technology Demonstration and Deployment									
Project #	**Project Name**	**Safety**	**Reliability**	**Affordability**	**Societal Benefits**	**GHG Emissions Mitigation/ Adaptation**	**Loading Order**	**Econ. Dev.**	**Efficient Use of Ratepayer Monies**
01	Automated DER Impact and Long Term Dynamics Evaluation		x	x					x
02	Utility Aggregated Resources with Market Participation			x					x
03	DERMS and ADMS Advanced Functionality	x	x	x		x	x	x	x
04	Multi-Nodal Distributed Digital Ledger		x	x	x			x	x
05	Virtual DER Markets for Capacity and Other Attributes		x	x		x			x
06	Auto Identification (ID) of Behind-the-Meter (BTM) Storage		x	x	x	x	x		x
07	Utility Scale Storage for Load Balancing	x	x	x			x		x
08	Second-Life Batteries for Grid Needs		x	x		x	x	x	x
09	Dynamic Near-Term DER Load Forecasting			x	x	x	x		x
10	Grid of the Future Scenario Engine	x	x	x		x	x		x
11	Location-Specific Options for Reliability and/or Resilience Upgrades		x	x	x		x		x
Investment Area: Grid Modernization and Optimization Technology Demonstration and Deployment									
Project #	**Project Name**	**Safety**	**Reliability**	**Affordability**	**Societal Benefits**	**GHG Emissions Mitigation/ Adaptation**	**Loading Order**	**Econ. Dev.**	**Efficient Use of Ratepayer Monies**
12	Advanced Volt/Var Optimization (VVO) Functionalities		x	x					x
13	Transformer Monitoring via Field Area Network (FAN)	x	x	x					x
14	Maintenance Prioritization for Imminent Asset Risk	x	x	x					x
15	Proactive Wire Down Mitigation	x	x						
16	Advanced Condition Monitoring for Remote Diagnostics		x	x	x				x
17	Generic Universal Distribution Controller (UDC) for Relay, Regulator, Load Tap Changer (LTC), Capacitor, Interrupter Control			x					x
18	Transformer Health Monitoring		x	x	x				x
19	Unified Network Solution		x	x	x				
20	Data Analytics for Predictive Maintenance	x	x	x					x
21	Advanced Vegetation Management Insights Using Prescriptive Analytics	x	x	x	x				x
22	Abnormal State Configuration Risk and Mitigations	x	x		x				x
23	Enhanced Distribution Line Equipment Device Settings Mgmt.		x	x					x

TABLE 5-1
SUMMARY OF 2018-2020 EPIC INVESTMENT PLAN
(CONTINUED)

PG&E's 2018-2020 EPIC Project Portfolio									
Project Name		**Primary EPIC Guiding Principles**			**Complementary EPIC Guiding Principles**				
Investment Area: Customer Service and Enablement Technology Demonstration and Deployment									
Project #	**Project Name**	**Safety**	**Reliability**	**Affordability**	**Societal Benefits**	**GHG Emissions Mitigation/ Adaptation**	**Loading Order**	**Econ. Dev.**	**Efficient Use of Ratepayer Monies**
25	Electric Grid Monitoring (EGM) Meter		x	x					x
26	Predictive Data Analytics for Proactive Meter Replacement		x	x					x
27	Multi-Purpose Meter (MPM)		x	x					x
28	Real-Time Load-Based Charging		x	x	x	x	x		x
29	Advanced Customer Bill Scenario Calculator			x			x		x
30	Connected Device Real-Time Pricing-Based Control		x	x			x	x	x
31	Real-Time DER Price Signals		x	x		x	x		x
32	System Harmonics for Power Quality Investigations	x	x		x				
Investment Area: Cross-Cutting/Foundational Strategies									
Project #	**Project Name**	**Safety**	**Reliability**	**Affordability**	**Societal Benefits**	**GHG Emissions Mitigation/ Adaptation**	**Loading Order**	**Econ. Dev.**	**Efficient Use of Ratepayer Monies**
33	Cyber-Physical Integrated Security	x	x	x	x				x
34	Local Wireless Security For Critical Facilities	x	x		x				
35	Advance Security of Internet of Things (IoT) Communications	x	x		x				x
36	Cybersecurity for Industrial Control Systems	x		x					x
37	Augmented Reality	x	x	x					x
38	Voltage Checks		x	x					x
39	Optimized Dispatch For Restoration Events	x		x					x
40	Advanced Field Reference Tool	x	x	x		x	x		x
41	Drone Enablement and Operational Use	x	x	x	x				x

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

PG&E intends to continue to use formal and informal means for widely disseminating EPIC program and project information and results to stakeholders and the public.[45] 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 and post final project reports.[46] On a more informal basis, PG&E will continue to coordinate and/or engage in informal working groups, conferences, and other forums for exchange of information and RD&D results among leading RD&D institutions and stakeholders. The goals of these information dissemination protocols are to maximize the sharing of RD&D insights, innovations and results so the lessons learned and benefits of the EPIC Program can be leveraged for the benefit of 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.

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45 D.12-05-037, OP 12(c)(iii).

46 www.pge.com/EPICFinalReports.

Chapter 6. Conclusion

PG&E is pleased to submit the Application for its Third EPIC Triennial Investment Plan, which includes 41 proposed technology demonstration projects that further advance California's aggressive clean energy policies, while addressing emergent needs for the electric grid and PG&E's customers. The proposed Plan is based 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's Plan not only builds upon the lessons learned from the successful completion of the majority of the EPIC 1 portfolio, but continues to mature as a program to adapt best practices for governance and project execution, while having demonstrated valuable results and lessons learned. This includes the completion and publication of fifteen EPIC 1 projects, which are relevant to not only PG&E, but also other stakeholders, such as utilities, research organizations, third party vendors, and other interested stakeholders.

PG&E continues to be strongly committed to the EPIC Program and the value it provides to its customers, as it offers the opportunity to cost-effectively develop and demonstrate innovative technologies which can advance PG&E's core values of safety, reliability, and affordability while also enabling more customer choice and enabling increased clean energy adoption. As such, PG&E respectfully requests Commission approval of its Third Triennial (2018-2020) EPIC Investment Plan, which not only includes the approval of the 41 proposed projects, but also requests CPUC consideration to modify the following Decisions:

- Approval for PG&E to leverage funding currently not expected to be spent in EPIC 1, resulting in an increase in PG&E's EPIC 3 total budget by $7 million;
- CPUC consideration to revise the approval process for "new projects" from a Tier 3 to a Tier 2 advice letter;
- Approval for IOUs to receive CEC-EPIC funding for CEC PON initiatives, such as in-kind support, use of facilities, or specified services, to act as a sub-contractor on a CEC-funded EPIC project; and

- CPUC consideration to modify its prior EPIC program authorization in order to provide a stable, longer-term funding structure for RD&D activities to minimize any gap after the end of the currently approved EPIC program cycle in 2020.

Additionally, PG&E also requests approval of PG&E's Tier 3 Advice Letter 5015-E if not yet approved by the date of this Decision.

Ultimately, PG&E believes that the proposed policy recommendations are reasonable and justifiable and that each project proposed in this portfolio is important and has the potential, at broader deployment, to benefit California electricity customers and the State of California through improvements made to safety, reliability, and affordability, while also contributing to California's ambitious clean energy policy goals.

PACIFIC GAS AND ELECTRIC COMPANY

APPENDIX A

SUMMARY OF STAKEHOLDER FEEDBACK

PACIFIC GAS AND ELECTRIC COMPANY
APPENDIX A
SUMMARY OF STAKEHOLDER FEEDBACK

Overview

As mentioned in Section 1.1 of PG&E's Third Triennial Investment Plan Application, public stakeholder workshops are required at least twice per year,[1] during the development of the Administrators' respective investment plans and during the execution of those plans. The purpose of these workshops are to contribute to ongoing coordination and understanding among administrators, external stakeholders, interested parties, and the California Public Utilities Commission (CPUC), while also raising awareness and visibility of Electric Program Investment Charge (EPIC) investments and promoting EPIC program transparency. Interested stakeholders may include: California legislature, government agencies, utilities, California Independent System Operator (CAISO), consumer groups, environmental organizations, agricultural organizations, academic experts, business community, energy efficiency (EE) community, and clean energy or other industry associations.

The general themes of the stakeholder comments received during public webinars and workshops focused on general EPIC-related information, notifications for bidding opportunities, and in some cases specific questions related to individual vendor product offerings. The answers from each investor-owned utility (IOU) can be found in full using the audio recordings from the webinars and workshops. Workshop slide presentations are available on PG&E's EPIC webpage at www.pge.com/epic.

In addition to documents from the webinars and workshops, a copy of PG&E's 2012-2014 and 2015-2017 EPIC Investment Plans, PG&E's EPIC Annual Reports, as well as links to the other Administrators' EPIC information, can be found on this webpage. A summary of PG&E's answers to main stakeholder inquiries are captured below with a more detailed explanation in Table A-1.

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1 D.12-05-037, at Ordering Paragraph (OP) 15.

Bid Opportunities

Public bid opportunities related to technology vendors as part of EPIC will be posted on PG&E's Bid Opportunities webpage.[2] Interested vendors are encouraged to regularly monitor the webpage for updated postings. In cases of sole sourcing (or direct award), as allowed in the decision, PG&E will not post Requests for Proposals, but will use PG&E's sole sourcing/direct award processes.

Vendor Registration

Vendors interested in partnering with an EPIC project are encouraged to review the EPIC 3 Investment Plan and identify the CPUC-approved project(s) they are interested in. Once they have identified the project or projects, they should register as a vendor on PG&E's supplier website[3] under the "Supplier Profile Registration and Maintenance" link. After completing the supplier registration, vendors should send an e-mail to PG&E's EPIC program e-mail address (EPIC_Info@pge.com) noting the project(s) that their company may be able to provide services for and providing a brief description of their company's capabilities for those projects. Vendors that are parties to the proceedings and interested in EPIC 3 (2018-2020) project opportunities are welcome to submit comments related to specific projects in PG&E's EPIC 3 Investment Plan. Once the CPUC has approved the EPIC 3 Investment Plan, vendors should then contact PG&E using the same methods described above.

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2 www.pge.com/en/b2b/purchasing/bidopportunities/index.page.

3 www.pge.com/b2b/purchasing/suppliers.

TABLE A-1
SUMMARY OF STAKEHOLDER FEEDBACK

Date	Forum	Stakeholder	Topic	Feedback/Question/Comment	PG&E Response
3/9/2017	IOU Workshop	Member of the Public	Reactive to Proactive Vegetation Management	Comment - There are a few companies in San Francisco that are doing image recognition that might be a useful component to add to this project, leveraging satellite imagery and algorithms.	PG&E would be interested to learn more and will further consider this detail after the project's approval. Additionally, we have very good LiDAR (Light Detection and Ranging) data at PG&E that is regularly utilized by our vegetation management. Currently it is static (based on one point in time) and for specific geographies, but if we were to apply the right algorithms, we could start to see how the situation will change over time and start to do proactive maintenance.
3/9/2017	IOU Workshop	California Public Utilities Commission	Reactive to Proactive Vegetation Management	Comment - Will PG&E consider factors other than the growth of a tree?	Yes, PG&E plans to explore inclusion of several factors, such as weather patterns, environmental conditions, geospatial data and more. We will leverage both internal and external data resources to help determine the type of data to be utilized.
3/9/2017	IOU Workshop	Member of the Public	Reactive to Proactive Vegetation Management	Feedback - Generally, there are many challenges with trees and wildfires. Suggest that the project consider which types of trees are appropriate under power lines.	PG&E appreciates the input and will consider this feedback during the planning stage of the project.
3/9/2017	IOU Workshop	Member of the Public	Reactive to Proactive Vegetation Management	Question - Besides the power lines, will the project also look at substations and switchyard, not just power lines?	Yes, PG&E plans to explore / consider any type of asset that may be impacted by vegetation.
3/9/2017	IOU Workshop	Member of the Public	DERMS and/or ADMS Advanced Functionality	Question - A key vision of the ADMS vision is the integration of different analytics, resources and systems (i.e., OMS, DMS, GIS, State Estimator etc.). Does this align with what this project is doing? There is currently a working group with several vendors looking at this future vision (key functionality, what does this integrated DERMS/ADMS look like).	This project is a step/building block along the way to this vision. The eventual solution may be a combined DERMS/ADMS or may be two separate systems that work together. It has yet to be seen what the market will do with these technologies. This project is more of a foundational one about the communication and control of additional resources, as there are unique challenges with every type of resource that is connected. In our first DERMS project (EPIC 2.02), PG&E focused on solar and storage. In this project, PG&E will consider evaluating Plug-In Electric Vehicles (PEV), interaction with Demand Response (DR), and/or the interaction with operational systems such as Volt/Var Optimization (VVO).

TABLE A-1
SUMMARY OF STAKEHOLDER FEEDBACK
(CONTINUED)

Date	Forum	Stakeholder	Topic	Feedback/Question/Comment	PG&E Response
3/9/2017	IOU Workshop	San Diego Gas & Electric	DERMS and/or ADMS Advanced Functionality	Question - Will the project include both third party and utility owned?	Ultimately, the goal is to test the system technology and the ownership should not necessarily be an impact. Owning new resources directly is not necessarily on the table within this project, but potentially looking at aggregation of customer-owned resources combined with utility-owned resources is in scope. For instance, where we have the initial DERMS pilot deployed currently (EPIC 2.02), it is also connected to our Yerba Buena utility scale storage system that was tested in EPIC 1.01.
3/9/2017	IOU Workshop	California Public Utilities Commission	DERMS and/or ADMS Advanced Functionality	Question - Some energy storage project issues stem from interacting with CAISO rules. Will this project encounter similar issues, how do you think you might address it?	PG&E's Yerba Buena battery is actively bidding into CAISO markets right now, which is where a lot of those learnings came from. There is a lot we can do with this project, but we are not at the point yet where we are finalized on the use cases that will be part of this project. The interaction between DERMS and CAISO and how that aggregated control system bids into the market is of high interest to explore.
3/9/2017	IOU Workshop	Member of the Public	DERMS and/or ADMS Advanced Functionality	Question - What the smallest size Distributed Energy Resource (DER) resource that PG&E operates and how does the future look as far as EPIC 3?	A lot of what DERMS is working with currently is customer residential rooftop solar, so we go all the way down to the customer level for resources for this project. One consideration is the aggregator in between—there are only a few solar energy storage companies today that have an aggregator platform and right now the DERMS system needs to work through that aggregator platform to be able to control those end resources. That will likely change in the future because not everybody will have an aggregator platform, but that is one of the things PG&E would like to continue to touch on as we look at other use cases for DERMS in EPIC 3.

TABLE A-1
SUMMARY OF STAKEHOLDER FEEDBACK
(CONTINUED)

Date	Forum	Stakeholder	Topic	Feedback/Question/Comment	PG&E Response
3/9/2017	IOU Workshop	Member of the Public	Drone Enablement – Utility Drone Flight Management and Drone Charging	Have any of the IOUs in California piloted drones or are using drones in any of their operations? Outside of California, or among the municipal utilities in California, is there any drone use today?	PG&E has high interest in expanding the capabilities of drone technology. We have completed a couple of small test runs, but have not pursued production-level operations. This is an area that is moving very quickly in the industry. For instance, a company just released technology to do substation mapping using a drone. This is how the market is starting to evolve. Given what it can do for the utilities, especially from an affordability standpoint (with less crews walking lines), it is a valuable area to target to help advance how we manage our grid.
3/9/2017	IOU Workshop	Member of the Public	Drone Enablement - Utility Drone Flight Management and Drone Charging	We are developing a battery that can get up to 700 watt hours/kilogram, which could be a very long flight time for the drone project proposed.	PG&E appreciates the input and will consider this feedback during the planning stage of the project.
3/9/2017	IOU Workshop	Southern California Edison Company	Drone Enablement - Utility Drone Flight Management and Drone Charging	Is the focus on rural areas or also urban areas, and also are there different challenges for each one of them?	PG&E is looking at it from a full system standpoint. San Diego Gas & Electric Company has done some great foundational work on drones. PG&E is now looking at the next phase, especially as Federal Aviation Administration rules evolve.
3/9/2017	IOU Workshop	Member of the Public	Drone Enablement - Utility Drone Flight Management and Drone Charging	Comment – It would be good to ensure that the language is clear that we are not confining ourselves to one particular technology, but it's more about automatic charging of the drones. There are at least two or more ways to automatically charge drones—magnetic induction and robotic conductive charging. Robotic conductive may potentially be more efficient and can be easily expanded to refueling gas.	PG&E agrees. We are not limiting to one specific approach.

TABLE A-1
SUMMARY OF STAKEHOLDER FEEDBACK
(CONTINUED)

Date	Forum	Stakeholder	Topic	Feedback/Question/Comment	PG&E Response
3/9/2017	IOU Workshop	Member of the Public	Open Q&A	Have you already finalized the vendors to participate?	No, we are at the ideation stage of our portfolio planning, which is completely vendor agnostic and solely focused on the technology and the problem we are trying to solve, not on the vendor or who has the solution at this point. Once we are to the point of project execution, PG&E follows a competitive bid process, unless there is a justifiable exception which requires a Direct Award as authorized in the Program rules.
3/9/2017	IOU Workshop	Member of the Public	Open Q&A	What is the timeline of EPIC 3? And are all projects going to happen at once or are they phased?	The Administrators have approved funding between 2018 and 2020 and are planning for a three year portfolio cycle. Administrators will submit our the EPIC Application in May 2017 to the CPUC, which then goes through an approval process that may take six to twelve months to reach a Decision. Each IOU manages the timing of project execution differently. PG&E goes through an internal phasing and prioritization process (looking at factors such as strategic drivers, resources, etc. from the utility perspective). Ultimately, we may not execute every project that is approved in the application, which can happen for a number of reasons: technology changes, landscape or policy changes, vendors back out, and/or priority changes.
3/9/2017	IOU Workshop	Member of the Public	Open Q&A	Can you discuss the coordination of IOUs and California Energy Commission (CEC), especially with common themes? Additionally, how much of the CEC research can be transferred and leveraged in the IOU EPIC projects?	The IOUs stay connected by meeting bi-weekly to discuss logistics but also to look at our project ideas and any potential areas of unnecessary duplication. We also do industry vetting, as well. For instance, the IOUs met with Electric Power Research Institute (EPRI) recently to review project ideas and gain an industry perspective on the potential areas of overlap outside of PG&E. Therefore, the cross-collaboration goes beyond the IOUs and CEC to the national scale. To date, CEC has yet to close EPIC projects, therefore, that IOUs cannot yet leverage the results and learnings from CEC projects in this application, but will be tracking the results to leverage findings moving forward.

TABLE A-1
SUMMARY OF STAKEHOLDER FEEDBACK
(CONTINUED)

Date	Forum	Stakeholder	Topic	Feedback/Question/Comment	PG&E Response
3/9/2017	IOU Workshop	California Public Utilities Commission	Open Q&A	Beyond the projects we shared in detail today, are the IOUs planning to release anything beyond what was released today until filed?	No. There is a difference between how the CEC and how the IOUs file. The CEC proposes initiatives at a higher level, which the IOUs covered their overarching strategies today. The way that the IOUs file is at the project level, which will not be released in detail before the plan is released. Stakeholders that are parties to the proceeding may be able to comment after the detail proposed application submitted on May 1.
3/9/2017	IOU Workshop	Member of the Public	Open Q&A	Is there a way to be discussing medium to longer term visions beyond three to five years out and whole system strategies?	CEC is able to do a lot more in the early research stage—allowing them to hit on some of those far reaching technologies. Also, the CPUC and IOUs get together for regular workshops and symposiums where some of these ideas are discussed. Additionally, the state has the Integrated Energy Policy Report, for which there are public workshops to provide input. The purpose of that report is a 10-20 year view and the document is coordinated throughout the state.
3/13/2017	DER Action Plan Workshop (CPUC)	California Public Utilities Commission	DER Action Plan	Plan Elements That Could Benefit from EPIC Research: Electric Vehicles - EV charging systems, and mobility and driving behaviors, can be predicted and overseen in the grid operations - Non-discriminatory market rules and regulations for mobile electric transportation resources (addressing registration, interconnection, and physical connectivity) are established to support customer mobility	PG&E has a robust portfolio in flight or planned that addresses EVs. In EPIC 1, PG&E explored Direct Current (DC) fast charging mapping that developed approaches that help determine the optimal location of DC fast chargers based on traffic patterns and distribution grid infrastructure (EPIC 1.25), Vehicle to Grid Integration that enabled a source of mobile power to connect directly to distribution circuits, minimizing the impact of a planned or unplanned outages (EPIC 1.16), as well as EV submetering (EPIC 1.23) that tests a subtractive metering process and Electric Vehicle Service Provider (EVSP) business models. In EPIC 2, PG&E is exploring EV home integration (EPIC 2.03B), which will evaluate the performance of the EV energy flow capabilities to support residential load during DR and hard islanding events. Additionally, in EPIC 3, PG&E may explore leveraging EVs in DERMS (EPIC 3.03), as well as real-time load-based charging (EPIC 3.28) and fast charging applications for ridesharing (proposed in PG&E's Tier 3 Advice Letter 5015-E).

TABLE A-1
SUMMARY OF STAKEHOLDER FEEDBACK
(CONTINUED)

Date	Forum	Stakeholder	Topic	Feedback/Question/Comment	PG&E Response
3/13/2017	DER Action Plan Workshop (CPUC)	California Public Utilities Commission	DER Action Plan	Plan Elements That Could Benefit from EPIC Research: Smart Inverters - By 2020, fully operationalize advanced (beyond Phase 1) smart inverter functionalities to enhance the integration of DERs into the grid.	PG&E is currently testing the functionality of aggregated, customer-sited smart inverters in its second triennial EPIC portfolio (EPIC 2.03A).
3/13/2017	DER Action Plan Workshop (CPUC)	California Public Utilities Commission	DER Action Plan	Plan Elements That Could Benefit from EPIC Research: Data Communications and Cybersecurity - Markets for distribution grid services are enabled through data communications and cybersecurity requirements.	PG&E is proposing several cybersecurity projects for EPIC 3, including those exploring advancement of the security of the Internet of Things communications, integrated cyber-physical security, local wireless security for critical facilities and cybersecurity for industrial control systems (EPIC 3.33 – 3.36).
3/13/2017	DER Action Plan Workshop (CPUC)	California Public Utilities Commission	DER Action Plan	Plan Elements That Could Benefit from EPIC Research: Distributed Energy Resource Management Systems By 2017, begin to consider the role of DERMS to enhance grid management and maximize the value of DER deployment.	PG&E conducted an initial DERMS demonstration to monitor and control third-party aggregated behind the meter resources in its second triennial EPIC portfolio (EPIC 2.02). Additionally, PG&E proposes to explore the continued advancement of DERMS and ADMS in EPIC 3 (EPIC 3.03).
3/13/2017	DER Action Plan Workshop (CPUC)	California Public Utilities Commission	DER Action Plan	Plan Elements That Could Benefit from EPIC Research: Distribution Infrastructure Deferral Framework - [Develop a] distribution infrastructure deferral framework, including reforms to consider Distribution Resource Plan results in General Rate Case, Phase 1 proceedings. - [Consider] EE (R.13-11-005), including locational targeting to avoid or defer grid upgrades, and normalized metered energy consumption evaluation methods to increase visibility.	PG&E is currently testing the integration of DER load shapes into distribution planning tool to potentially enable deferment of grid upgrades in its second triennial EPIC portfolio (EPIC 2.23). Additionally, EPIC 2.22 is identifying customer demand reduction needs (individually and aggregated at asset level), and is developing cross DER customer targeting to address forecasted capacity challenges at specific assets, for specific days and times of year.

TABLE A-1
SUMMARY OF STAKEHOLDER FEEDBACK
(CONTINUED)

Date	Forum	Stakeholder	Topic	Feedback/Question/Comment	PG&E Response
3/13/2017	DER Action Plan Workshop (CPUC)	California Public Utilities Commission	DER Action Plan	Plan Elements That Could Benefit from EPIC Research: Demonstrate Value of Additional Grid Services - E.g., conservation voltage reduction, equipment life extension - Cost-effectiveness and valuation frameworks accurately and impartially reflect the full grid services, renewables integration, and Greenhouse Gas value of DERs.	PG&E leverages conservation voltage reduction where it is the appropriate assessment tool, as we did with our VVO Smart Grid Pilot as part of the Smart Grid Pilot Program recently completed by PG&E (Advice Letter 4990-E). We will continue to use other valuation approaches, as needed. In EPIC 3, PG&E has proposed to design and demonstrate a locational net benefit rate design structure for DERs in order to valuate DER grid services to incentivize optimal DER siting and dispatch (EPIC 3.31).
1/30/2017	EPRI-IOU EPIC 3 Overview	Electric Power Research Institute	Real-Time Pricing	Question - Would customer be held harmless of adverse impact on the bill, or they made whole and do they know about it?	Similar to historical TOU pricing, PG&E would evaluate the need to likely have one year “made whole” to true up consumers on a trial. However, it is important to note that this may impact the behavior changes if they know they'll be refunded. Exact project design will be scoped to consider these variables.
1/30/2017	EPRI-IOU EPIC 3 Overview	Electric Power Research Institute	Dynamic DER Forecasting	Feedback - Two part problem exists that should be addressed first: (1) Where is PV and other DER adoption most likely to occur based on customer demographics without utility intervention; and (2) What would be the optimal locations for utility to provide an intervention. Want to see where adoption is likely to occur and provide targeted location.	PG&E’s in-flight EPIC 2 project (2.22) is currently addressing this problem through identifying feeder-level capacity constraints that would be optimal targets for PG&E or third-party programs to target to mitigate load risk. The project then will develop cross-DER customer targeting to address forecasted capacity challenges at specific assets, for specific days and times of year, leveraging interval data and other customer attributes.
1/30/2017	EPRI-IOU EPIC 3 Overview	Electric Power Research Institute	System Harmonics	Feedback - EPRI has the modeling tools to test system harmonics/surgical analysis where DER penetration is increasing. If problems found early, could be impactful to mitigate before potential systemwide issues.	PG&E will consider this approach in the proposed EPIC 3.32 System Harmonics for Power Quality Investigations.

TABLE A-1
SUMMARY OF STAKEHOLDER FEEDBACK
(CONTINUED)

Date	Forum	Stakeholder	Topic	Feedback/Question/Comment	PG&E Response
2/17/2017	Written Comments	Third-Party Vendor	Written Comments	Feedback - Proposed two additional projects for PG&Es consideration in EPIC 3: Electric Water Heating Study - identify the absolute and relative costs and benefits of deploying electric resistance and heat pump water heaters under various consumption and water heater control profiles, as an alternative to natural gas water heaters. Transmission Deferral Pilot - Develop a pilot program to study the ability of energy storage and potentially storage paired with renewables to defer transmission projects.	The Electric Water Heating study is an EE-focused project that is also heavy focused on applied research, which the IOUs cannot pursue. This project may be considered in the Energy Efficiency Emerging Technology Programs. The proposed Transmission Deferral Pilot is currently being demonstrated in PG&E's EPIC 2.22 project which identified potential non-wires alternatives (and the propensity of customer adoption) to defer potential transmission upgrades.
2/17/2017	Written Comments	Third-Party Vendor	Written Comments	Feedback - Proposed two additional projects for PG&Es consideration in EPIC 3: Community Grid Services and Emergency Support for EV Mobility - Integrate second-life batteries into EV charging stations with both DC fast charging and alternating current level 2 stations. This concept could offer a host of potential grid services, including outage support and the ability to temporarily charge EVs during a power outage—allowing for continued mobility during an emergency. Combined Battery Electric and Hydrogen EV Solar Charging Station Deployment - Combine a typical Battery Electric Vehicle (BEV) charging station connected to the grid and storage, but in addition would have a dedicated solar input. A water tank is connected to the battery source that allows electrolysis to occur. Oxygen can be off-gassed, while hydrogen stored in a compressed tank on site. The station can fuel both BEV and Hydrogen Battery Electric Vehicle (HBEV). The BEV charges in a typical fashion, while through redundancy the HBEV can utilize solar, battery, or grid electricity to perform electrolysis even while a BEV is charging.	PG&E has proposed to demonstrate a similar project in EPIC 3.08 Second-Life Batteries for Grid Needs

TABLE A-1
SUMMARY OF STAKEHOLDER FEEDBACK
(CONTINUED)

Date	Forum	Stakeholder	Topic	Feedback/Question/Comment	PG&E Response
3/24/2017	IOU Workshop	Member of the Public	Open Q&A	Question - Do you have any Vehicle to Grid integration projects?	Yes. PG&E's EPIC 2.03B Vehicle to Home project is enabling dispatchable charging and discharging of the EV in response to DR or hard islanding events. Additionally, PG&E completed an EPIC 1 project that leveraged plug-in hybrid vehicle technology in PG&E's fleet to generate utility-grade power, supporting distribution circuits during planned or unplanned outage events.
3/24/2017	IOU Workshop	Member of the Public	Open Q&A	Question - Do you have any in flight projects to pair EV, storage and PV for demonstration?	Yes. PG&E's EPIC 2.02 DERMS project is aggregating behind the meter solar resources through smart inverters and behind the meter storage to aggregate these resources to leverage at peak times.
3/24/2017	IOU Workshop	Member of the Public	Open Q&A	Question - What's the process for participating in a bid?	Vendor's should follow our sourcing bid opportunity website, and become an approved vendor (if not yet already) to be qualified to bid.
3/24/2017	IOU Workshop	Member of the Public	Open Q&A	Comment - The proposed Vegetation Management project has some similarities to a Department of Energy (DOE) project that is in flight.	Upon further evaluation of the potential overlap, it was determined that there was limited overlap in the projects' scope, since the DOE project sought to inventory transmission assets in the California territory, but it lacked the data analytics layer to predict tree growth and pair this information with environmental data.
3/24/2017	IOU Workshop	Member of the Public	Open Q&A	Question - Of the proposed project list, do you expect all of them will be implemented?	Historically, not all proposed EPIC projects in previous EPIC Application have been implemented, and this may likely be the case in this proposed portfolio. Upon CPUC approval of the proposed projects, PG&E will internally prioritize the projects and assign more detailed scope, schedule and budgets after prioritization.

PACIFIC GAS AND ELECTRIC COMPANY

APPENDIX B

INFORMATIONAL SUMMARY OF ENERGY EFFICIENCY AND DEMAND RESPONSE RESEARCH, DEVELOPMENT AND DEMONSTRATION ACTIVITIES

PACIFIC GAS AND ELECTRIC COMPANY
APPENDIX B
INFORMATIONAL SUMMARY OF ENERGY EFFICIENCY AND DEMAND RESPONSE RESEARCH, DEVELOPMENT AND DEMONSTRATION ACTIVITIES

The Electric Program Investment Charge (EPIC) Decision (D.) 13-11-025 requires informational summaries of the investor-owned utilities' (IOU) Research, Development and Demonstration (RD&D) activities undertaken as part of their approved Energy Efficiency (EE) and Demand Response (DR) portfolios. Pacific Gas and Electric Company's (PG&E) understanding is that the California Public Utilities Commission (CPUC) requests this information to confirm non-duplication of efforts, as well as to demonstrate that projects rejected as part of the EE or DR Program are not funded in EPIC.

PG&E's EE, DR and EPIC Programs Are Distinct Programs with Separate Objectives

PG&E established its EE Program in 1976 and its DR Program in 1959. Each program has a distinct program focus, which is described in further detail below and is separate from EPIC's focus. Both the EE and DR programs provide program updates to the CPUC on the progress of these projects through either written reports or in-person meetings. A summary of RD&D-type activities, including the purpose, funding, deliverables and progress to date, has been provided below in Tables B-2, B-3 and B-4, including the EE-Emerging Technology Program (ETP) projects, the DR Emerging Technology (DRET) projects, and the DR pilots, respectively.

PG&E maintains coordination between the EE, DR and EPIC programs to avoid duplication, while also identifying potential complementary efforts. While each program has a different intent and focus area, the programs owners meet, as needed, to review projects to confirm there is no duplication and also identify potential areas for collaboration. The program owners have developed program guidelines to delineate the differing focus areas, which will be used and refined on an ongoing basis, and is provided in Table B-1.

Summary of EE and DR RD&D–Type Activities

EE Portfolio and EPIC

PG&E's EE Portfolio is part of California's statewide initiative to achieve the state's EE goals by providing EE products, services and process improvements to end customers, through the use of rebates and incentives, energy analyses, and workforce training and education. Activities in the Energy Efficiency–Emerging Technology Program (EE-ETP) are not generally considered "RD&D," as they are focused on assessing, demonstrating, and deploying commercially deployed technologies. This approach differs from the focus for EPIC which targets demonstrations for pre-commercial technologies. The EE-ETP facilitates customer adoption of commercially available new and underutilized EE technologies, practices, and tools. The program is designed to help California customer-funded EE programs meet the state's energy reduction needs by identifying cost-effective measures that deliver reliable energy savings.

In general, the distinction PG&E makes between EE-ETP and EPIC programs is that EE-ETP's focuses on customer-side EE technologies and individual customer adoption via incentives, whereas the IOU's EPIC program covers non-EE initiatives and/or initiatives that incorporate/integrate EE, as well as other types of demand management (e.g., Integrated Distributed Energy Resources). The market facilitation of new technologies, a component of EE-ETP, is explicitly disallowed in EPIC for the IOUs, thereby further delineating IOU EE and EPIC programs. Finally, while EE-ETP is for both electric and gas applications, the IOU EPIC program is for electric Technology Demonstration and Deployment (TD&D) only.

DR Emerging Technology Program and EPIC

PG&E's DRET Program and DR Pilot Program are part of California's statewide program, which provides an opportunity for customers to play a significant role in the operation of the grid by changing their electricity consumption during peak periods in response to either economic or reliability signals. PG&E's DRET Program explores new technologies and applications that have the potential to enable or enhance DR capabilities and can include hardware, software, design tools, strategies, and services. PG&E's DR Pilot Program tests new concepts or program design that addresses a specific area of concern or gap in existing DR programs or advances a new DR policy

or operational requirement. The EPIC program avoids DR-only technology demonstrations, and instead focuses on integrating multiple Distributed Energy Resources (DERs), such as solar, behind the meter storage, electric vehicles (EV), and potentially DR (or EE) as a resource.

EPIC Has a Distinct and Mandatory Focus Area on Safety, Reliability and/or Affordability/Cost-effective Policy Advancement as It Relates to the Grid

The EPIC program is primarily focused on the demonstration of pre-commercial technologies and strategies to enable the safe, reliable operations of the grid while advancing California policy goals cost-effectively. IOU EPIC funds are used for TD&D that map to the Electric Value Chain areas: (1) Grid operations/market design, (2) Transmission, (3) Distribution, and (4) Grid integration of Demand-side management elements, such as EE and DR.

In order to further delineate the focus of each program, Table B-1 summarizes the differences and similarities of the EE-ETP, DRET/DR Pilots, and EPIC programs described above.

TABLE B-1
SUMMARY OF PROGRAM DIFFERENCES

Program Considerations	EE-ETP	DRET/DR Pilots	EPIC
Does the program demonstrate grid optimization technologies or customer side technologies?	Customer Side	Customer Side	Both
Does the program demonstrate pre-commercial/not yet widely commercialized or commercialized technologies?	Not yet widely commercialized & commercially available	Commercially available	Pre-commercial or not yet widely commercialized
Does the program support electric or gas applications?	Electric & Gas	Electric only	Electric only
Does the program have a demand side focus or grid integration focus?	Demand-Side	Both (demand side for ultimate grid integration)	Both
Does the program focus on the site specific net effect on load or aggregated effect on load?	Site Specific	Both	Aggregated
What aspect of technologies does the program evaluate?	Energy savings & peak demand performance verification	Depends on assessment; Often load impact	Broad Range (Stronger focus on demonstration)
Does the program evaluate the existing program and process?	No	Sometimes	Sometimes
Does the program assess the technology capability of peak load reduction or load shifting?	Load reduction	Both	Both
Does the program have a focus of market facilitation of new technologies?	Yes	Yes	No

Table B-2 summarizes the activities most similar to “RD&D” in PG&E’s approved EE portfolio, which encompasses the EE-ETP projects. This table includes the EE_ETP projects’ description/purpose, funding, deliverables and progress to date. The EE-ETP projects listed in Table B-2 are a subset of ETP activities and could appear similar to potential EPIC projects; however, are differentiated and unique. The EE-ETP team provides updates to the CPUC to share progress and achievements that are reflected in Table B-2. The projects evaluate demand-side technologies and strategies, such as residential and small and medium business (SMB) energy management systems and real-time energy usage strategies. The EE-ETP Program focus for these projects is on

site specific-load reduction, verification of energy savings claims and incentive/rebate program development or product testing.

Tables B-3 and B-4 summarize the DRET projects and DR pilots, respectively, which includes the projects' description/purpose, funding, deliverables and progress to date. Both the DRET program and the DR pilots have been approved on June 16, 2017 by CPUC D.16-06-029. The DRET projects listed in the table can be referenced from page 3 to 11 of the *Emerging Markets & Technology Demand Response Projects 2017 Semiannual Report* (submitted to the CPUC on March 31, 2017).[1] Further details of the DR Pilot projects listed in the table can be found on pages 20-22 of PG&E's *Bridge Funding Proposal for Demand Response Programs for the 2017 Transition Year* (Rulemaking (R.) 13-09-011).[2]

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1 The Emerging Markets & Technology Demand Response Projects 2017 Semiannual Report can be accessed at the following site: https://pgera.azurewebsites.net/Regulation/ValidateDocAccess?docID=406747.

2 The Bridge Funding Proposal for Demand Response Programs for the 2017 Transition Year can be accessed at the following site: https://pgera.azurewebsites.net/Regulation/ValidateDocAccess?docID=361973.

TABLE B-2
TABLE OF EE-ETP PROJECTS

Project	Purpose	Funding	Deliverables	Progress to Date
Energy Efficiency Emerging Technology Program				
Smart Thermostats Lab Testing and Evaluation, Measurement and Verification (EM&V) Studies	Evaluate load reduction potential and associated energy savings potential of smart thermostats at customer sites. Conduct comprehensive Smart Thermostat evaluations to determine the energy savings potential for a vendor agnostic residential incentive program.	$190,000	An ET report	Stopped
Packaged Heating, Ventilation and Air Conditioning (HVAC) Advanced Controls and Sensors Scaled Field Placement	Assessment of HVAC controls and sensors to allow SMB customer access to functionalities previously only available to large Energy Management System (EMS) for large buildings. This project may speed the introduction and adoption of technology and enable response to Peak Day Pricing (PDP) or time-of-use (TOU) rates.	$66,520	An ET report	Completed
Small Commercial EMS (Siemens EcoView)	Scaled field placement to evaluate energy savings in small commercial buildings with Siemens EcoView EMS.	$470,000	An ET report	Completed
ET Home Energy Management Scaled Field Placement of Smart Thermostats	Four phase project to track customer interaction, satisfaction, and energy savings from normative/behavioral messaging via mobile app and web portal as it relates to customers programmable communicating thermostat.	$866,247	An ET report	Completed
Expanded West Village Monitoring Project (Ramp-Up From 24-150 Units)	Monitor major residential and non-residential end uses at the community and building level against planned performance specifications for Zero Net Energy (ZNE).	$740,000	An ET report	Completed
PG&E/Honda Smart Home Demonstration Showcase	Partnered with Honda and University of California, Davis to monitor the performance and the interaction with the grid of a single family Zero Net Energy model home at West Village. EE-ETP was focused on monitoring EE technologies and end uses, while the EV and Distributed Generation teams focused on the grid interaction.	$390,000	An ET report	Completed
Deep Root Irrigation (DRI)	The project would replace standard drip irrigation with DRI on a new almond planting. The energy savings come from reducing the amount of water delivered to the trees, thereby reducing the amount of groundwater pumped, which reduces kilowatt-hour.	$150,059	An ET report	Ongoing project, 80% progress

TABLE B-2
TABLE OF EE-ETP PROJECTS
(CONTINUED)

Project	Purpose	Funding	Deliverables	Progress to Date
Energy Efficiency Emerging Technology Program				
Closed Loop Irrigation Management	Complete 10 field evaluations to determine the energy, water, and operating cost savings potential from "closed loop irrigation management" best practices deployed under typical farm conditions.	$150,000	An ET report	Ongoing project, 80% progress
Clothes Dryer Non-Energy Benefits	Clothes dryers are the biggest remaining appliance opportunity. Two major manufacturers are bringing a new heat pump clothes dryer to American market in Q4 2014. This proposal was to quantify non-energy benefits of this emerging technology.	$50,000	An ET report	Completed
Technology Resource Innovation Program (TRIP) Thermostat Optimization	Weather Bug Home was one of two winners of the TRIP Request for Abstract (RFA) that was released in October 2015. This one-year project involves deployment of Thermostat Optimization software to residential customers with existing smart thermostats. Savings measured at the meter, and utilizes billing and interval data.	$350,000	An ET report	Ongoing project, 50% progress
TRIP Nest Seasonal Savings	Nest was one of two winners of the TRIP RFA that was released in October 2015. This one-year project involves deployment of Thermostat Optimization software to residential customers with existing smart thermostats. Savings measured relative to impact to HVAC runtime, and utilizes device-level data.	$350,000	An ET report	Ongoing project, 40% progress
Smart Residential HVAC Zoning	The technology evaluated is an automated, smart, internet-connected zone control system for residential HVAC. This first phase of a two phase project will complete lab tests to verify that the zone control system can regulate comfort while not degrading overall system efficiency, while also complying with Title 24 HVAC equipment acceptance rules. Based on initial findings, a potential Phase II project will involve field testing with a sample size to identify statistically significant energy savings in a variety of climate zones.	$55,000	An ET report	Ongoing project, 80% progress

TABLE B-2
TABLE OF EE-ETP PROJECTS
(CONTINUED)

Project	Purpose	Funding	Deliverables	Progress to Date
Energy Efficiency Emerging Technology Program				
Combo Space and Water Heat	Carbon dioxide refrigerant heat pumps installed and monitored, while providing combined space and water heating in existing homes. Two study sites located within PG&E service territory, representing Northern California climate zones for the broader Pacific Northwest sample. Performance will be monitored, analyzed and reported. Expected outcomes include overall system efficiency, estimated space and water heating efficiencies, and benefit to cost ratio. This system design offers an efficient, affordable replacement for electric space and water heating with a low climate change profile.	$60,000	An ET report	Ongoing project, 80% progress
Aquanta Water Heater Controller	The Aquanta smart water heater controller is a smart, learning controller that easily installs on existing gas/electric storage water heaters, providing both efficiency savings and significant DR potential. The unit enables remote monitoring and control of hot water energy use, provides system optimization, reduces standby loss by learning usage patterns, and engages consumers with messaging including equipment schedule suggestions, leak detection, and maintenance alerts. This project is conducting a lab study to validate product performance/capabilities and quantify direct energy savings, with a potential Phase II review of DR functionality.	$65,000	An ET Report	Ongoing project, 80% progress
Anaerobic Digestion for Waste Water Treatment	Study of Anaerobic Digestion technology (Contact type, with Upflow) for waste water treatment facilities. System designed to treat facility's entire waste water stream. System never stabilized after many months and adjustments, therefore project was cancelled.	$111,000	An ET Report	Cancelled
Refrigeration Heat Reclaim	This project evaluated heat recovery from refrigeration system for space heating in supermarkets. Project identified opportunities to capture savings, select optimal configuration that minimizes impact on refrigerant charge and validate thermal savings.	$80,000	An ET Report	Completed

TABLE B-2
TABLE OF EE-ETP PROJECTS
(CONTINUED)

Project	Purpose	Funding	Deliverables	Progress to Date
Energy Efficiency Emerging Technology Program				
Electric Power Research Institute Variable Refrigerant Flow (VRF) Technology Assessment	Used detailed measurement of field performance of VRF with Heat Recovery systems to help characterize actual yearly energy savings potential, and to provide quality data for use in energy modeling verification.	$125,000	An ET Report	Completed
California Lighting Technology Center (CLTC) Exterior Occupancy Survey	CLTC behavior study to assess savings potential of exterior occupancy lighting controls.	$45,000	An ET Report	Completed
Business Energy Report (BER) Project	BERs is an assessment that uses a Randomized Control Trial design whereby a homogeneous group of small and medium size business (SMB) customers are assigned either to receive paper-based energy analysis reports (treatment condition) or not (control condition).	$570,000	An ET Report	Ongoing project, 95% progress
Solar Jack Oilfield Pump Jack EMS	Assessed energy savings on a pump jack retrofit. The Solar Jack system features a Variable Speed Drive with capacitor banks and modest solar array that captures and temporarily stores the energy created by the down-stroke, to power the up-stroke.	$101,000	An ET Report	Completed
Sub Wet Bulb Evaporative Cooling (SWEC)	The SWEC technology uses evaporation to chill water to below the ambient wet-bulb temperature, producing a chilled water stream that can be distributed through radiant or fan-coil systems.	$60,000	An ET Report	Ongoing project, 95% progress
Smart Thermostats Lab Testing	Complete smart thermostats lab testing.	$80,000	An ET Report	Completed
Water Leak Detection and Control	Quantify water and energy savings achieved through reducing leakage rates from pressurized supply pipelines. This effort contributed to emerging statewide water/energy nexus programs.	$125,000	An ET Report	Completed
Advanced Power Strip (APS) Tier 2 IR	Assessed behavioral component, including user satisfaction and experience, with Advanced Power Strip Tier 2 IR delivered through a direct install program.	$150,000	An ET Report	Completed

TABLE B-2
TABLE OF EE-ETP PROJECTS
(CONTINUED)

Project	Purpose	Funding	Deliverables	Progress to Date
Energy Efficiency Emerging Technology Program				
Field Assessments of Remote Terminal Units Equipped With Evaporative Technologies, Both As-Built and Retrofit	Field test of the Munters EPX 5000 dedicated outdoor air supply unit. The unit comes from Applied Technology Services (ATS) lab testing and was installed at a big box grocery store, thereby providing a cross check of lab and field results. The ET Coordinating Council report was produced along with best practices for design, installation and commissioning. The testing of economizers and evaporative pre-coolers is now focused within Project ET13PGE1241, being conducted at PG&E's ATS facility.	$400,000	5 ET Reports	Completed
Retail Plug Load Portfolio Program Trial	A two-phase project to create baselines and validate a new calculated mid-stream incentive model addressing plug load products sold through retailers as a "Whole Store" portfolio. Retailers are paid incentives on a periodic basis according to the savings achieved on a weighted average from the previous year. The trial tested and validated the measurable outcomes of the Whole Store program model.	$620,000	An ET Report	Completed
Kaiser Genset Retrofit	Assessment of emergency backup generators use electrical resistance heating to keep engine warm, ready to start and be able to take full power in mandated 10 seconds.	$40,000	An ET Report	Completed
Marketplace Study	Assessment of online tool that helps customers identify and select EE consumer products.	$150,000	An ET Report	Ongoing project, 80% progress
Xenon Technical Assessment Lifecycle Testing	Ongoing lifecycle testing of Xenon lighting technology.	$79,688	An ET Report	Complete
Remote Building Analytics Platform Assessment	To document the implementation and user experience of an analytics platform for supporting continuous engagement with targeted customers within load constrained areas.	$500,000	An ET Report	On hold

TABLE B-2
TABLE OF EE-ETP PROJECTS
(CONTINUED)

Project	Purpose	Funding	Deliverables	Progress to Date
Energy Efficiency Emerging Technology Program				
Rule Sets Development for Whole Building Energy Simulation Tools	The project includes the development of Utility Rule Sets with input parameters, definitions, logical operators, and syntax compatible with California Building Energy Code Compliance (CBECC) and Simergy. The report compared CBECC and Simergy tools, comparing outputs, level of effort and modeling accuracy.	$246,000	An ET Report	Completed
Business Energy Reports (BERs)	This project is evaluating the potential energy savings of Business Energy Reports (with Opower).	$1,194,000	An ET Report	Ongoing project, 90% progress
Microchannel Heat Exchange	Assessment of microchannel heat exchange technology, which has wide applicability to PG&Es customers with significant refrigeration, cooling or drying requirements. Decreasing the channel size improves the rate of heat transfer by 10% or more and lowers refrigerant charge by 70%.	$150,000	An ET Report	Completed
Integrated Controls for SMB	Field test of wireless and networked systems designed for small buildings.	$255,000	An ET Report	Ongoing project, 80% progress
SMB Benchmark Toolkit	Created building models for SMB Energy Savings Retrofit Projects.	$3,500	An ET Report	Completed
Liquid Cooling Market Study	Obtaining more up to date information on market potential for immersion and contact plate technologies in large to medium data centers. Consultant shall reach out to various contacts to provide PG&E with this data.	$50,000	An ET Report	Ongoing project, 50% Progress
Conveyor Dishwashers	Field testing of energy and water savings associated with flight style commercial dishwashers.	$90,000	An ET Report	Ongoing project, 80% Progress
Light-Emitting Diode (LED) T8 Lab Evaluations	Lab testing of bare and in-fixture LED T8 lamps in various types.	$118,000	An ET Report	Ongoing project, 70% Progress
Energy Efficient Broilers	Field and lab testing of various styles of advanced energy efficient underfired broilers.	$60,000	An ET Report	Completed
GridPoint Energy	Field evaluation of programmable building controls focused on food services.	$110,000	An ET Report	Ongoing project, 30%

TABLE B-2
TABLE OF EE-ETP PROJECTS
(CONTINUED)

Project	Purpose	Funding	Deliverables	Progress to Date
Energy Efficiency Emerging Technology Program				
Home Energy Management Systems (HEMS) 2	Market evaluation of current state of residential network connected products.	$347,000	An ET Report	Completed
Automated Lighting Control System (ALCS) Calculator Alpha Testing	Field testing of the ALCS Calculator.	$71,000	An ET Report, and next software release	Completed
HEMS Market Research	Initial scoping study and roadmap development for Residential HEMS projects.	$60,000	An ET Report	Completed
Pool Pumps for Multi-Family Facilities	Co-funded field study to evaluate energy savings potential for variable speed pool pumps in multi-family facilities.	$55,000	N/A	Stopped (Used data from other studies to complete EM&V project report)
Ductless Mini-Split Heat Pumps: Best Practices and Field Demonstration	Field evaluation of residential mini-split heat pumps.	$200,000	An ET Report	Completed
High Performance Integrated Building Control Solutions	Quantify the magnitude of potential total energy use reductions available through traditional and novel integrated HVAC, Lighting and Envelope based controls solutions; Demonstrate a variety of high performance integrated HVAC and Lighting solutions for office and retail customers that meet or exceed current Title 24 requirements.	$485,000	An ET Report	Ongoing project, 80% Progress
High Performance Envelope with Optimized Lighting, Daylighting, and Office Equipment Loads	Demonstrated and assessed high performance envelope strategies for commercial buildings and how they interact with lighting, daylighting and office equipment loads to better T24 2013 Code compliance by 20-40%.	$485,000	An ET Report	Completed
Behavioral Landscape Analysis	Assessed opportunities for identifying, improving, and expanding behavior-based energy programs across a utility EE portfolio.	$500,000	An ET Report	Completed

TABLE B-2
TABLE OF EE-ETP PROJECTS
(CONTINUED)

Project	Purpose	Funding	Deliverables	Progress to Date
Energy Efficiency Emerging Technology Program				
Submersion Cooling of IT Servers	Technology development support for immersion cooling of IT servers will determine how IOUs can help increase uptake of this EE and DR technology. Project assessing positioning in server market the increased cooling efficiency and flop rate improvement s of ~90% and 20%. Project to address industry barrier issues such as: colocation, reliability, versatility and lack of IOU support, which builds on successful 2014 ET technology assessment project that validated EE and flop rate improvement.	$70,800	An ET Report	Ongoing project, 70% Progress
Center for Energy Efficient Laboratories Market Study	(1) Estimate the number and types of labs in California; (2) Estimate the number and types of energy-consuming and water-consuming equipment used in California labs; (3) Assess operational and behavioral opportunities for efficiencies in how laboratory equipment in California is used; and (4) Estimate the amount of energy used by lab-related facilities systems (e.g. HVAC).	$30,066	An ET Report	Completed
Human Centric Lighting	The lighting team proposed an ET project for LED-based Human Centric Lighting. Human Centric Lighting focuses on the non-visual biological benefits of lighting. Since most of our time is now spent indoors, the health effects of lighting are becoming more and more important.	$100,000	An ET Report	On-Hold
Ultra-Low Temperature (ULT) Freezers	Validate the energy savings associated with ULT freezer systems. ULT freezer systems, which normally operate at -80°C ranges, are a large or often the largest energy consuming equipment in university, hospital, and other commercial biotech laboratories.	$97,000	An ET Report	Completed
Multifamily On-Demand Central Domestic Hot Water (CDHW) Circulation Controls	The measure addresses installation of demand controls on CDHW systems with recirculation loop in the MF retrofit market. An ET study would support creation of PG&E workpaper and address any concerns/data gaps for Engineering Services.	$100,000	An ET Report	Stopped

TABLE B-2
TABLE OF EE-ETP PROJECTS
(CONTINUED)

Project	Purpose	Funding	Deliverables	Progress to Date
Energy Efficiency Emerging Technology Program				
Conveyor Dishwasher With Heat Pump	The scope of the project would comprise installation, monitoring, and showcasing the technology in two facilities. Real-world savings would be measured to develop utility incentives and Return on Investment information. It is a must-use technology in the dish room to help approach net-zero energy in large commercial kitchens.	$90,000	An ET Report	Stopped
Advanced Heat Recovery from Walk-In Refrigeration	This technology preheats water (saving gas) and reduces compressor and condenser load (saving electricity). The scope of the project would include installation, monitoring, and showcasing the technology in two restaurants.	$90,000	An ET Report	Stopped
Four Pin to LED Lamp	ET assessment and market analysis of LED replacement products for traditional four-pin lamps	$49,000	An ET Report	Completed
Waste Water Treatment for Dairies and Wineries	Second of three ET projects funded via Ag Water Center with California State University (CSU) Fresno.	$41,000	An ET Report	Completed
Soil Moisture Sensors	First of three ET projects funded via Ag Water Center with CSU Fresno.	$81,250	An ET Report	Completed
Sweetwater ZNE Monitoring	ZNE monitoring at a residential and multi-purpose new construction.	$107,000	An ET report	Completed
Cottle House ZNE Monitoring	ZNE monitoring at a residential new construction home.	$64,000	An ET report	Completed
DeYoung Property - Fresno ZNE	ZNE monitoring at a residential new construction home.	$84,000	An ET report	Ongoing project, 90% Progress
Measurement and Verification for the ZNE Stevens Library	The objective of the ET project is to evaluate how the Sacred Heart Schools Stevens Library performed with respect to its ZNE design goal, and to identify issues, challenges, problems, and lessons learned to inform and guide the design of future ZNE buildings.	$88,000	An ET report	Completed

TABLE B-2
TABLE OF EE-ETP PROJECTS
(CONTINUED)

Project	Purpose	Funding	Deliverables	Progress to Date
Energy Efficiency Emerging Technology Program				
ZNE Builder Demonstration	To move motivated production builders toward the state's ZNE goals and help them to get ahead of the curve, PG&E is running a ZNE Production Builder Demonstration project. Demonstrations started with 7 projects and continue with new projects. The overall goal is to help production builders to develop a new ZNE prototype or to upgrade one of their existing prototypes to ZNE by providing support from start to finish. This includes design support, construction inspections, incremental cost assistance, and performance monitoring of the completed home.	$675,000	An ET report	Ongoing project, 80% Progress
ZNE Retrofits at University of California (UC) Davis	The goal of these retrofit projects was to understand the costs and energy savings attributable to retrofit ground-source heat pumps for heating and cooling applications and to assess performance under different climate conditions typically found in California.	$344,500	An ET report	Completed
Residential ZNE Ready Project (R-25 Walls)	This project collects energy savings, incremental costs, feasibility, and conflict with other building practices for the top 3 measures under consideration for the 2016 T-24 standards: R-25 walls.	$128,000	An ET report	Completed
Residential ZNE-Ready (Phase 5 - Hydronic Ductless Radiant Heating & Cooling)	To achieve lower cost, ZNE dwellings radiant space heating and cooling using cool and warm water to deliver comfort is needed. Even with ducts in conditioned spaces, forced air systems are 20% less efficient than water based systems. Advances in hydronic space conditioning in Europe and North America have brought to the market the components needed for low cost and reliable systems.	$14,500	An ET report	Completed
Energy Savings Opportunities via Rapid Energy Modeling	Field test of developed tools and associated workflows to determine the viability and efficacy of rapid building physics-based building energy models for use in EE measure identification and energy use analysis.	$100,000	An ET report	Completed

TABLE B-2
TABLE OF EE-ETP PROJECTS
(CONTINUED)

Project	Purpose	Funding	Deliverables	Progress to Date
Energy Efficiency Emerging Technology Program				
NEXT LED T8 Replacement Lamps and Integrated Controls	This project evaluated the lighting performance and energy savings potential of NEXT Lighting linear LED replacement lamps (a solution with separate lamp and driver), combined with an Enlighted wireless advanced control system to achieve additional energy savings and DR capability.	$250,000	An ET report	Completed
Small Commercial EMS	Scaled field placement to evaluate energy savings in small commercial buildings with Siemens EcoView EMS.	$470,000	An ET report	Completed
Calculator for Advanced Lighting Control Systems	Developed a simplified calculation method for estimating savings from highly variable advanced lighting control systems for use in utility incentive programs.	$198,000	An ET report, and Beta software release	Completed
Residential ZNE Ready Project (High Efficacy Lighting)	This project collected energy savings, incremental costs, feasibility, and conflict with other building practices for the top three measures under consideration for the 2016 T-24 standards: High Efficacy Lighting.	$159,000	An ET report	Completed
Residential ZNE Ready Project (High Performance Attic Ducting)	This project collected energy savings, incremental costs, feasibility, and conflict with other building practices for the top three measures under consideration for the 2016 T-24 standards: High Performance Attic Ducting.	$47,000	An ET report	Completed
TLED T8 Replacement Lamps With Wireless Controls	This project evaluated the performance and savings potential of driver integrated linear LED tubes (~22W per lamp) at one demonstration site as a potential retrofit for existing linear fluorescent T8 fixtures (28-31W per lamp). The project also integrated the use of wireless lighting controls to achieve additional energy savings and DR capability.	$150,000	An ET report	Completed
Zeno Net Energy Home (ZNEH) Retrofits at UC Davis	Develop and test Zero Net Energy Home (ZNEH) retrofit strategies at a single-family home at Aggie Village and a student coop residence at UC Davis. Partner with UC Davis Energy Innovation Hub, EEC, and Geothermal Collaborative.	$275,000	An ET report	Completed

TABLE B-2
TABLE OF EE-ETP PROJECTS
(CONTINUED)

Project	Purpose	Funding	Deliverables	Progress to Date
Energy Efficiency Emerging Technology Program				
Demonstration of Controls Embedded Lamps	Conducted market research and a technical study of LED replacement lamps with embedded controls/ smartphone apps for user control. Demonstrated the viability of this solution for the hospitality sector in a scaled placement across a sample of restaurants and/or hotels. This could serve as a lighting controls system for small businesses that could not otherwise afford the color switching, vacancy sensing, scheduling and security features that these lamps provide.	$100,000	An ET report	Completed
Demand-Controlled Ventilation (DCV) & EMS for Commercial Kitchens	Scaled field placement evaluated the electrical and thermal savings for these systems in order to provide workpaper updates and inform new measures.	$200,000	An ET report	Completed
Packaged HVAC Advanced Controls and Sensors Specific Fan Power	Assessment of HVAC controls and sensors to allow SMB customer access to functionalities previously only available to large energy management system for large buildings. This project could speed the introduction and adoption of technology and enable response to PDP or TOU rates.	$216,000	An ET report	Completed
2x4 LED Panels Plus Controls	Scaled placement of Advanced Lighting Controls platform and 2x4 LED panels.	$250,000	An ET report	Completed
Advanced Window Films TA 2 (Daylighting Blinds)	Study of the integration of daylighting, window treatments, lighting controls, electrochromics, occupant blinds usage, automated interior and exterior shading devices, and low-cost reflective coatings leading to workpaper development.	$165,000	An ET report	Completed
Lidded Gas Char-Broiler	Monitored energy consumption, operating conditions, and hours of operation at three sites, and analyzed the energy and cost saving potential when standard technology broilers are replaced with lidded char-broilers.	$98,000	An ET report	Completed

TABLE B-2
TABLE OF EE-ETP PROJECTS
(CONTINUED)

Project	Purpose	Funding	Deliverables	Progress to Date
Energy Efficiency Emerging Technology Program				
Refrigerated Prep Tables	Monitored baseline energy consumption in up to eight locations, and replaced with high-efficiency unit. Monitored energy consumption at up to four locations. Also provided analysis on air-cooled prep tables versus glycol loop chilled tables, and compare results with laboratory data.	$98,000	An ET report	Completed
Multi-Tenant Light Common Buildings Integrated Audit	California Energy Commission (CEC) Public Interest Energy Research Project headed by UC Davis Energy Efficiency Center/CLTC/WCEC. http://eec.ucdavis.edu/events/mtlc.php; PG&E provided in-kind labor resources and facilities use.	$118,000	An ET report	Completed
Embedded Energy in Water	Assessment of the statistical variance of embedded energy in space and time across hydraulic systems. Improved confidence in these calculations is necessary to advance the quality of design and ease of deployment of projects that save energy through targeted water conservation.	$100,000	An ET report	Completed
Permanent Magnet Air Conditioning (PMAC) Motors	The motor is currently available in sizes from 1 Hp to 20 Hp. PMAC motors claim to operate at efficiencies 25-35% over code compliant (NEMA Premium) induction motors. The project would be to test the improved efficiency claim at PG&Es ATS lab using existing test rig and motors lent by Marathon.	$70,000	An ET report	Completed
Advanced Window Films	Newly-developed advanced films claim to improve the thermal performance and light transmittance of the previously offered window films. The ET assessment evaluated the validity of the manufacturers' claims and quantified the potential benefits of the new advanced film products for PG&E customers.	$190,000	An ET report	Completed
Submersion Cooling for Data Centers	Assessment of efficient removal of heat from servers.	$40,000	An ET report	Completed
Follow Up Linear Panel and Controls Study	Test scalability of LEDs and lighting controls.	$195,000	An ET report	Completed

TABLE B-3
TABLE OF DRET PROJECTS

Project	Purpose	Funding	Deliverables	Progress to Date
Demand Response Emerging Technologies [(a)]				
Lab and Field Test of Two-Way Load Control Receivers in Connection with PG&E's SmartAC™ Program	Test and evaluate the performance of various 2-way communicating Load Control Receivers used by the SmartAC Program.	Budgets are set at program level. The approved budget for 2015 to 2016 was $2,814,565. Approved budget for the 2017 Bridge year is $1,404,528.	Final report and key inputs for 2017 and beyond program technology decisions.	Completed in Q4 2016
Third Party Bring Your Own Thermostat Study	Assess how already acquired and installed smart thermostats could be leveraged to provide residential DR resources, and to measure the load impacts of a third party to provide localized DR.		Final report and key inputs for 2017 Residential ADR offering and 2018 CBP Program proposal.	Completed in Q4 2016
White Paper and Lab Test to Understand Existing Technologies' Ability to meet California Independent System Operator (CAISO) Telemetry Requirements for PDR	Explore the technical feasibility of using a ZigBee to broadband gateway communicating to a cloud RIG in order to cost effectively meet CAISO's telemetry requirements, and thereby unlock more DR to be bid into the wholesale market.		A final report describing the lab study, key findings, and recommendations on how to further expand this proof of concept.	Ongoing project, 95% Progress
Title 24 – Marketing Education and Outreach	Educate key market actors who may be impacted by the DR Title 24 requirements about the requirements, while using the experience to determine the best approach to disseminate DR-related information within each group.		A final report with recommendations for effective outreach to DR compliance community, as well as a set of materials used for the outreach.	Ongoing project, 95% Progress

TABLE B-3
TABLE OF DRET PROJECTS
(CONTINUED)

Project	Purpose	Funding	Deliverables	Progress to Date
Demand Response Emerging Technologies[(a)]				
Testing Statistical Sampling Methodologies and Alternative Baseline	To develop and analyze a Type-II baseline methodology so residential customers may be able to participate in CAISO's wholesale markets.		A sampling methodology that was submitted and approved by the CAISO for a residential DR resource.	Ongoing project, 40% Progress

_____

(a) The Emerging Markets & Technology Demand Response Projects 2017 Semiannual Report can be accessed at the following site: https://pgera.azurewebsites.net/Regulation/ValidateDocAccess?docID=406747.

TABLE B-4
TABLE OF DEMAND RESPONSE PILOT PROGRAM PROJECTS

Project	Purpose	Funding	Deliverables	Progress to Date
Demand Response Pilot Program[(b)]				
Supply Side II DR Pilot	• Inform the design of future DR programs by testing the interests and capabilities DR participants to provide DR into the wholesale energy market. • Give DR participants more flexibility to elect their own hours of availability and level of energy payments. • Identify and work through wholesale market integration issues. • Expand wholesale DR to provide distribution services.	$2,104,617	Field demonstration and final report. Findings will be used to inform the design of future DR programs.	Ongoing project. Customers currently bidding into CAISO wholesale energy market.
Excess Supply DR Pilot	Inform the design of a future program by conducting field testing of the actions required from PG&E, customers, and third-party aggregators so that load can be increased when excess supply conditions exist due to the increase in renewable generation.	$599,921	Field demonstration and final report. Findings will be used to inform the design of future DR programs.	Ongoing project. Currently calling events and testing customer response.

_____

(b) Approved in 2017 Decision R.13-09-011.

PACIFIC GAS AND ELECTRIC COMPANY

APPENDIX C

PG&E ADVICE LETTER 5015-E

Pacific Gas and Electric Company

Erik Jacobson
Director
Regulatory Relations

Pacific Gas and Electric Company
77 Beale St., Mail Code B10C
P.O. Box 770000
San Francisco, CA 94177

Fax: 415-973-1448

February 7, 2017

Advice 5015-E
(Pacific Gas and Electric Company ID U 39 E)

Public Utilities Commission of the State of California

Subject: **Request for Approval of New Electric Program Investment Charge (EPIC) Projects between Triennial EPIC Applications**

Purpose

In compliance with Ordering Paragraph (OP) 1 of California Public Utilities Commission (CPUC or Commission) Decision (D.) 15-09-005, Pacific Gas and Electric Company (PG&E) seeks Commission approval of six new EPIC projects between triennial EPIC applications.

Background

Rulemaking (R.) 11-10-003 was instituted to address funding and program issues related to utility research, development, and demonstration projects. D.11-12-035, in Phase 1 of R.11-10-003, established the EPIC Program to fund public interest investments in applied research and development, technology demonstration and deployment, and market facilitation of clean energy technologies and approaches for the benefit of electricity customers of PG&E, San Diego Gas & Electric Company (SDG&E), and Southern California Edison Company (SCE).

The Commission conducts a public proceeding every three years (known as the triennial review) to consider EPIC investment plans for clean energy technologies and approaches, pursuant to a schedule set in D.12-05-037. That Decision directed the California Energy Commission (CEC) and the three IOUs, as Administrators of the program, to present their investment plans for the triennial program periods for joint consideration by the Commission. The CEC's investment plan included Strategic Objectives made up of Strategic Initiatives, and the IOUs' investment plans included projects under four Investment Areas.

D.13-11-025 capped the collection of EPIC funds at $162 million annually and approved the first triennial investment plans for the collection years 2012-2014. D.15-04-020 approved 2015-2017 EPIC budgets. D.15-09-005 authorized EPIC Administrators to file

Tier 3 advice letters (or equivalent business letters for the CEC) to request approval of new EPIC projects between triennial funding cycles.

Request

PG&E requests CPUC approval of the following six new EPIC projects for its EPIC 2 triennial plan – amounting to an estimated total of $7.9M - $9.6M out of PG&E's previously approved 2015-2017 EPIC triennial budget of $51,080,000:

1. Aggregated Behind-The-Meter Storage Market / Retail Optimization
   This project will demonstrate how aggregated behind-the-meter energy storage systems that are operated by a third party dispatcher may address wholesale market needs, while also operating as a customer resource to reduce customers' retail electric bills.
2. Service Issue Identification Leveraging Momentary Outage Information
   Demonstrate approach to proactively identify potential service issue problems related to locations with frequent momentary outages, which may be caused by imminent failures of conductors, insulators, transformers and/or vegetation contact.
3. Predictive Risk Identification with Radio Frequency (RF) Added to Line Sensors
   Demonstrate approach to integrate real-time radio frequency (RF) monitoring technologies into Line Sensor devices to potentially improve outage prediction and identify areas for grid reliability improvement.
4. Call Center Staffing Optimization
   Create and demonstrate an algorithm to optimize call center staffing to better match call volumes (including for major events) through predictive modeling, incorporating data from historical volumes correlated with data such as general news, PG&E announcements, regulatory proceedings, rate schedule seasons, weather information, restoration times, and/or other data sources.
5. Electric Load Management for Ridesharing Electrification
   Understand and demonstrate grid impacts from Electric Vehicle (EV) charging used for ridesharing fleet applications and assess the ability to manage the resulting electric load using active demand management.
6. Dynamic Rate Design Tool
   Develop and demonstrate new analytical solutions and modeling to bring increased flexibility and speed to designing more dynamic rates while understanding the impact on customer bills, as well as better understanding of potential customer load changes as a result of different rates.

Further project detail can be found in Attachment A, which includes a description of the technology or strategy to be demonstrated, the concern, gap, or problem to be addressed, the potential benefits at full deployment, and the project-specific reason each proposed project should be considered immediately.

In compliance with OP 3 of D.15-09-005 and as presented in Attachment A, PG&E confirms the following:

a. Each project is within the scope of EPIC investment areas approved for funding in PG&E's EPIC 2 triennial plan, including: Renewables and Distributed Energy Resource (DER) Integration, Grid Modernization and Optimization, Customer Service and Enablement, and Cross-Cutting / Foundational Strategies and Technologies (as identified in Attachment A);
b. The funding for the new proposed projects does not cause the overall EPIC funding to exceed the total funds authorized in the applicable and effective EPIC triennial plan;
c. This advice letter (as shown in Attachment A) contains at least the same level of detailed description and support for the projects as the Commission has approved for other projects included in the applicable and effective EPIC triennial plan;
d. The new projects do not result in any adverse expected changes in funding for other approved projects;
e. This proposal should be considered immediately and not simply included in the next cycle for EPIC funding consideration by the Commission for the key overall reasons noted below:
    - New research and development priorities as well as technological / market advances have developed since filing the EPIC 2 Investment Plan on May 1, 2014.
    - Waiting until the approval of the Third Triennial Investment Plan will delay the ability to use the knowledge and/or benefits gained from these high-potential proposed projects, including areas where future potential EPIC 3 proposed projects can build on these learnings.
    - Sufficient funding to cover all projects proposed here remains available in the EPIC 2 investment plan after internal prioritization of the approved EPIC 2 investment plan[1].
f. All other requirements applicable to EPIC projects under PG&E's EPIC 2 triennial plan continue to apply to the new projects.

Protests

Anyone wishing to protest this filing may do so by letter sent via U.S. mail, facsimile or E-mail, no later than February 27, 2017, which is 20 days after the date of this filing. Protests must be submitted to:

CPUC Energy Division
ED Tariff Unit

[1] Per CPUC Staff request, PG&E has included a list of EPIC 2 Projects approved in D.15-04-020 which are currently on hold as of the date of this Advice Letter (Attachment B).

505 Van Ness Avenue, 4th Floor
San Francisco, California 94102

Facsimile: (415) 703-2200
E-mail: EDTariffUnit@cpuc.ca.gov

Copies of protests also should be mailed to the attention of the Director, Energy Division, Room 4004, at the address shown above.

The protest shall also be sent to PG&E via either E-mail or U.S. mail (and by facsimile, if possible) at the address shown below on the same date it is mailed or delivered to the Commission:

Erik Jacobson
Director, Regulatory Relations
c/o Megan Lawson
Pacific Gas and Electric Company
77 Beale Street, Mail Code B10C
P.O. Box 770000
San Francisco, California 94177

Facsimile: (415) 973-1448
E-mail: PGETariffs@pge.com

Any person (including individuals, groups, or organizations) may protest or respond to an advice letter (General Order 96-B, Section 7.4). The protest shall contain the following information: specification of the advice letter protested; grounds for the protest; supporting factual information or legal argument; name, telephone number, postal address, and (where appropriate) e-mail address of the protestant; and statement that the protest was sent to the utility no later than the day on which the protest was submitted to the reviewing Industry Division (General Order 96-B, Section 3.11).

Effective Date

PG&E requests an expedited review process, such that this Tier 3 advice filing becomes effective upon Commission approval within 30 days of receipt. D.15-09-005[2] concluded that an expedited approval process for new EPIC projects is reasonable, as long as due process rights (including full Commission review) are provided.

[2] Pages 14-15

Notice

In accordance with General Order 96-B, Section IV, a copy of this advice letter is being sent electronically and via U.S. mail to parties shown on the attached list and the parties on the service list for A.14-05-003. Address changes to the General Order 96-B service list should be directed to PG&E at email address PGETariffs@pge.com. For changes to any other service list, please contact the Commission's Process Office at (415) 703-2021 or at Process_Office@cpuc.ca.gov. Send all electronic approvals to PGETariffs@pge.com. Advice letter filings can also be accessed electronically at: www.pge.com/tariffs.

/S/
Erik Jacobson
Director, Regulatory Relations

Attachments

cc: Service List A.14-05-003
Maria Sotero, Energy Division

CALIFORNIA PUBLIC UTILITIES COMMISSION

ADVICE LETTER FILING SUMMARY
ENERGY UTILITY

MUST BE COMPLETED BY UTILITY (Attach additional pages as needed)

Company name/CPUC Utility No. **Pacific Gas and Electric Company (ID U39 E)**

Utility type:	Contact Person: Kingsley Cheng
☑ ELC ☐ GAS	Phone #: (415) 973-5265
☐ PLC ☐ HEAT ☐ WATER	E-mail: k2c0@pge.com and PGETariffs@pge.com

EXPLANATION OF UTILITY TYPE

ELC = Electric GAS = Gas
PLC = Pipeline HEAT = Heat WATER = Water

(Date Filed/ Received Stamp by CPUC)

Advice Letter (AL) #: **5015-E** **Tier: 3**

Subject of AL: **Request for Approval of New Electric Program Investment Charge (EPIC) Projects between Triennial EPIC Applications**

Keywords (choose from CPUC listing): Compliance

AL filing type: ☐ Monthly ☐ Quarterly ☐ Annual ☑ One-Time ☐ Other _____

If AL filed in compliance with a Commission order, indicate relevant Decision/Resolution #: D.15-09-005

Does AL replace a withdrawn or rejected AL? If so, identify the prior AL: No

Summarize differences between the AL and the prior withdrawn or rejected AL: _____

Is AL requesting confidential treatment? If so, what information is the utility seeking confidential treatment for: No

Confidential information will be made available to those who have executed a nondisclosure agreement: N/A

Name(s) and contact information of the person(s) who will provide the nondisclosure agreement and access to the confidential information: _____

Resolution Required? ☑Yes ☐No

Requested effective date: **Upon Commission Approval** No. of tariff sheets: N/A

Estimated system annual revenue effect (%): N/A

Estimated system average rate effect (%): N/A

When rates are affected by AL, include attachment in AL showing average rate effects on customer classes (residential, small commercial, large C/I, agricultural, lighting).

Tariff schedules affected: N/A

Service affected and changes proposed: N/A

Pending advice letters that revise the same tariff sheets: N/A

Protests, dispositions, and all other correspondence regarding this AL are due no later than 20 days after the date of this filing, unless otherwise authorized by the Commission, and shall be sent to:

California Public Utilities Commission
Energy Division
EDTariffUnit
505 Van Ness Ave., 4th Flr.
San Francisco, CA 94102
E-mail: EDTariffUnit@cpuc.ca.gov

Pacific Gas and Electric Company
Attn: Erik Jacobson
Director, Regulatory Relations
c/o Megan Lawson
77 Beale Street, Mail Code B10C
P.O. Box 770000
San Francisco, CA 94177
E-mail: PGETariffs@pge.com

Attachment A – Project Descriptions

Below are the new proposed project descriptions, including the description of the technology or strategy to be demonstrated, the concern, gap, or problem to be addressed, the potential benefits at full deployment, and the reason the proposed project should be considered immediately. Each project has been described with the same level of detailed description and support for the projects as the Commission has approved previously, with two additions: 1) the reasons the proposed project should be considered immediately; and 2) an estimated funding amount for each project.

Table 1 summarizes how each of the six new proposed projects align with the Investment Areas. The table organizes the projects by investment area and identifies the primary benefits that PG&E believes the projects may demonstrate to increase safety, promote greater reliability and/or improve affordability. Each of these planned projects has undergone initial benchmarking to avoid duplication. Additionally, each planned project has consulted and collaborated with stakeholders, including coordination with the EPIC Administrators and others in the Research, Development and Demonstration (RD&D) community. These efforts were conducted in order to leverage the benefits of similar projects and to maximize potentially complementary efforts.

Table 1. New Projects Proposed to PG&E's 2015-2017 EPIC Project Portfolio

New Projects Proposed to PG&E's 2015 -2017 EPIC Project Portfolio			
Investment Area: Renewables and DER Integration [Technology Demonstration & Deployment] Objectives in this category: • Integrate DER, Generation, and Energy Storage • Improve Transparency of Resource Information • Increase Generation Flexibility			
Project	**Safety**	**Reliability**	**Affordability**
31. Aggregated Behind-The-Meter Storage Market / Retail Optimization		✓	✓
32. Electric Load Management for Ridesharing Electrification		✓	✓
Investment Area: Grid Modernization and Optimization [Technology Demonstration & Deployment] Objectives in this category: • Optimize Existing Grid Assets • Prepare for Emerging Technologies • Design and Demonstrate Grid Operations of the Future			
Project	**Safety**	**Reliability**	**Affordability**
33. Service Issue Identification Leveraging Momentary Outage Information	✓	✓	✓
34. Predictive Risk Identification with Radio Frequency (RF) Added to Line Sensors	✓	✓	✓
Investment Area: Customer Service and Enablement [Technology Demonstration & 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			

Project	Safety	Reliability	Affordability
35. Call Center Staffing Optimization			✓
36. Dynamic Rate Design Tool			✓

Project Title: Aggregated Behind-The-Meter Storage Market / Retail Optimization
Project #: 2.31
Investment Area: Renewables and Distributed Energy Resources Integration
Estimated Funding: $2.25M - $2.75M

Description of Technology or Strategy to Be Demonstrated
This project will demonstrate how aggregated behind-the-meter energy storage systems that are operated by a third party dispatcher may address wholesale market needs, while also operating as a customer resource to reduce customers' retail electric bills[1]. In this proposed EPIC project, PG&E will evaluate the multi-use application of behind-the-meter energy storage by analyzing the tradeoffs a resource makes when dispatching to meet bids into the wholesale market, potentially utilizing meter data from energy storage systems, customer meter data and/or CAISO data. Additionally, PG&E will demonstrate to what extent the multi-use application of behind-the-meter energy storage provides value to both customers and the grid and potentially whether customer economic interests align with wholesale market price signals.

Applicable Electricity Value Chain Elements	
☒Grid Operations / Market Design	☐Distribution
☐Generation	☒Demand-side management
☐Transmission	

Concern, Gap, or Problem to Be Addressed
Third parties are currently installing behind-the-meter energy storage systems for customer retail bill management. These third parties work to reduce a customer's electric bill through peak shaving or energy arbitrage. They are responsible for charging

[1] In Decision 16-12-004 in the CPUC's energy storage rulemaking, the CPUC rejected a behind-the-meter storage project that it determined was not cost-effective, even though PG&E stated that the project provided a low-cost means to gain experience utilizing behind-the-meter energy storage to deliver resource adequacy. In rejecting the project, the CPUC agreed that there was value in gaining experience to support behind-the-meter storage, and that enabling multi-use storage applications, particularly as they relate to participation of behind-the-meter storage assets in the wholesale market, is one of the key issues being considered by the Commission. In urging rejection of the project, the Office of Ratepayer Advocates (ORA) argued that the "learning experiences" on behind-the-meter storage from the project were not sufficient justification to approve the project, asserting that such learning experiences should occur other than in the commercial storage program, such as instead in an EPIC demonstration project. Although PG&E disagrees that the storage project rejected in D.16-12-004 was not a commercial project and instead should only be approved as a demonstration project, nonetheless PG&E agrees with the CPUC and ORA that storage projects that provide learning experiences and useful data about multi-use applications of behind-the-meter storage can and should be encouraged, including under the EPIC program.

(drawing more energy) and discharging (load reduction) the energy storage unit based on their forecasts/data of a customer's energy usage. Currently, it is unclear how much value these resources can provide to the wholesale market, while simultaneously optimizing retail bill management. This project seeks to test the valuation of the multi-use application of behind-the-meter energy storage, particularly in how a resource responds to different price signals.

Potential Benefits at Full Deployment
Aggregated behind-the-meter storage market/retail optimization could potentially improve affordability by reducing energy procurement costs if the multi-use application of energy storage can provide sufficient efficiencies.

Reason Proposal Should Be Considered Immediately
The DER market is expanding rapidly with multi-use applications being a key part of enabling this expansion. The lessons learned from this project may inform future procurement decisions, and with these procurements happening in the near term[2], waiting an additional year will delay the ability to use the knowledge gained from this project on customers' behalf. In light of PG&E's prior competitive procurement of the similar storage project which would support this EPIC project, and to directly and expeditiously procure meaningful and useful data from a multi-use, behind-the-meter storage application, PG&E requests a waiver from the EPIC criteria for competitive procurement as appropriate, in order to support this project.

Project Title: Electric Load Management for Ridesharing Electrification
Project #: 2.32
Investment Area: Renewables and Distributed Energy Resources Integration
Estimated Funding: $1.125M - $1.375M

Description of Technology or Strategy to Be Demonstrated
This project seeks to evaluate grid impacts from Electric Vehicle (EV) charging used for ridesharing applications, and to assess the ability to manage the resulting load using active demand management. The project will explore the load shape for the developing use case of rideshare EVs that use Direct Charge Fast Charging (DCFC). Additionally, the project will demonstrate the extent to which load can be shaped through active demand management.

PG&E will work with project partners to develop load management strategies, which may include mock rates or programs, such as fixed pricing structures, variable pricing schemes with direct notification to drivers, reservation systems, and ride/route

[2] Decision Adopting Energy Storage Procurement Framework and Design Program (D.13-10-040) in R.10-12-007; Decision Addressing Competitive Solicitation Framework and Utility Regulatory Incentive Pilot (D.16-12-036) in R.14-10-003; Order Instituting Rulemaking Regarding Policies, Procedures and Rules for Development of Distribution Resources Plans Pursuant to Public Utilities Code Section 769 (R.14-08-013).

management to optimize timing and amount of charging. Depending on site specific conditions and cost feasibility, battery storage and solar photovoltaic (PV) may also be utilized to manage the overall load profile.

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

Concern, Gap, or Problem to Be Addressed

Currently, companies are exploring EVs for ridesharing applications and seeking fast charging opportunities that minimize operating cost and maximize utilization of the vehicles. It is currently estimated by the San Francisco Treasurer's Office that there are up to 45,000 rideshare drivers in San Francisco alone. Due to the high supply and demand of ride sharing in the San Francisco Bay Area this geography has high potential to be effective for this demonstration.

The load profile of this new EV charging use case has yet to be seen and could present both challenges and opportunities for the grid depending on the timing and flexibility of charging needs. It is important to understand the impacts of this new and potentially significant load, in order to develop new load management programs and/or rates that encourage optimal charging behavior. Additionally, new programs and/or rates may be able to lower the cost of fast charging. The commercial rates currently applied to DCFC deployments can result in high cost of electric fuel if operators have to recoup a monthly demand charge from a relatively few number of charging sessions, this is seen as a barrier to EV adoption for the growing rideshare market.

Compared to the pilots proposed in PG&E's SB 350 Transportation Electrification Application[3] and those underway under the iCharge Forward Pilot[4], this project addresses different use cases, customer types, vehicle types, and charging types. In the SB350 Application, PG&E proposed the following four demonstration projects, which are different in nature and scope from what is proposed to be explored in EPIC:

- Medium/Heavy Duty Fleet Customer Demonstration – Assists customers' operating a fleet of Medium/Heavy Duty vehicles (e.g. transit buses, short haul delivery, etc.) to deploy EVs in place of fossil fuel vehicles.
- Idle Reduction Technology Customer Demonstration – Assists customers' operating fleets to demonstrate idle reduction technologies (e.g. truck stop electrification, truck refrigeration units, etc.) for a customers' operating fleet instead of electric drive technologies

[3] PG&E Application A.17-01-022, PG&E Senate Bill 350 Transportation Electrification Application, in response to Assigned Commissioner's Ruling, R.13-11-007, September 14, 2016.
[4] iCharge Forward Pilot, D.12-04-045.

- Electric School Bus Renewables Integration Pilot - Work with a school district that is deploying electric school buses to test managed charging to consume electricity during peak renewables generation periods.
- Home Charger Information Resource Pilot - Pilot will develop a web-based information resource, enabling EV drivers to research residential charging equipment and search a database of certified electrical contractors who can perform safe installations of charging equipment.

Likewise, the iCharge Forward Pilot is also different in nature and scope from what is being proposed here as it focuses on a Residential, personal use focused use case. Each of these projects provides valuable learnings for this emerging industry and thus are valuable to move forward.

Potential Benefits at Full Deployment

If the rideshare industry utilized EVs, this electrification would help California meet its greenhouse gas emission goals, and could support PG&E reliability and affordability if this project is successful in developing active load management strategies that effectively shift rideshare EV charging to hours of lower generation cost or less grid stress.

Full deployment would involve utilizing the demonstration results about the profile and the ability to ultimately shift EV rideshare charging load to potentially develop new commercial EV rates, demand response programs, or other programs. Successful rates or programs would benefit PG&E customers by shifting Transportation Network Company (TNC) related EV charging load to the most optimal hours for the grid. Additionally, this project may help develop rate structures and incentives that result in lower overall costs to the rideshare drivers (if they charge at optimal times) thus helping TNCs make the business case to accelerate the use of EVs rather than conventional vehicles.

Reason Proposal Should Be Considered Immediately

Transportation Network Companies (TNC) have experienced incredible growth in recent years and have attained maturity in the Bay Area; however, the electrification of this transportation market option is nascent. At least one TNC in San Francisco is in the process of deploying a feasibility pilot with electric vehicles. If PG&E acts now, there is a unique opportunity to both support fuel switching that reduces GHG emissions, while also learning about the potential to manage this load type with ridesharing programs from the onset. If TNCs determine electrification is a benefit to them and their stakeholders, this EV load pattern use case could be quickly adopted in a shorter period of time. The lessons learned from this project may inform PG&E's load management decisions in the near term if electrification of TNCs progresses; therefore, waiting an additional year will delay the ability to use the knowledge gained in this pilot on behalf of California customers.

Project Title: Service Issue Identification Leveraging Momentary Outage Information
Project #: 2.33

Investment Area: Grid Modernization and Optimization
Estimated Funding: $660K - $815K

Description of Technology or Strategy to Be Demonstrated
This project seeks to leverage multiple sources of data, including but not limited to SmartMeter™, time of day, location and weather data, to proactively identify potential problems in the Electric Transmission and Distribution (T&D) system, specifically related to identifying locations with high incidences of momentary outages which may be caused by imminent failures of conductors, insulators, transformers and/or vegetation contact. This project will explore development of an algorithm to identify patterns to predict future outages, potentially by leveraging momentary outage and distress data from SmartMeter™ devices (e.g., last gasps), aggregated to the transformer level, and applying additional data attributes.

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

Concern, Gap, or Problem to Be Addressed
Equipment failure outages can occur at unpredictable times, often during peak loading or storm situations. These unplanned outages can result in ad hoc restoration work, potential safety issues, and longer outage duration. The current technology to address these types of outages is based largely on responding to a sustained outage. At that point it becomes a restoration event handled by a troubleman or maintenance and construction crew. This project addresses that current condition of waiting for actual failure to identify issues, by enabling the identification of potential sustained outages that could likely happen in the near future.

PG&E's original SmartMeter™ Application[5] provided functionality for PG&E to integrate more advanced, real-time sustained outage detection through the enablement of service point / meter specific outage notification (called SmartMeter™ "last gasp traps," which notify PG&E of an outage). PG&E has incorporated these real-time meter traps into its outage management tool to help identify the scale of sustained outages and potential restoration options. This proposed EPIC project seeks to build upon this outage detection functionality by using repeated sub-second momentary outage information with advanced data analytics to proactively identify potential future sustained outages in advance. This project may enable PG&E to derive additional value from the data made available from the SmartMeter™ investment, through proactive identification of issues prior to sustained outages.

[5] D.06-07-027, approving PG&E Application A.05-06-028, Application of Pacific Gas and Electric Company for Authority to Increase Revenue Requirements to Recover the Costs to Deploy An Advanced Metering Infrastructure.

Potential Benefits at Full Deployment
At full deployment, proactive identification of issues could potentially enable PG&E to more quickly respond to outages and/or schedule repair work in advance (improving customer reliability). Fewer customer outages could also potentially result in improved affordability and enhanced safety from reduced restoration work during storm season and peak loading conditions, and shifting from unplanned corrective work to planned maintenance work.

Reason Proposal Should Be Considered Immediately
Much of the foundation for this technology is now available (e.g., SmartMeter™ devices), making this an ideal time to explore this technology approach. By accelerating this project, the technology can be more quickly tested and then potentially implemented for improved customer experience, shorter outage times, and reduced costs to customers. Given the potential benefits, it is important that this project be pursued now to avoid unnecessary delay to the benefits for our customers if the technology is proven.

Project Title: Predictive Risk Identification with Radio Frequency (RF) Added to Line Sensors
Project #: 2.34
Investment Area: Grid Modernization and Optimization
Estimated Funding: $1.62M - $1.98M

Description of Technology or Strategy to Be Demonstrated
This project seeks to integrate radio frequency (RF) analysis into communicating "smart" line sensors and demonstrate the ability to use that Line Sensor platform to monitor the grid and possibly predict potential outages. The project will explore development of a smart line sensor capable of RF detection and analysis, potentially including demonstrating the technology in the field.

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

Concern, Gap, or Problem to Be Addressed
Currently, technology exists to use RF detection as a way to monitor instability and risk in the grid and to predict potential outages before they occur. However, this technology requires trucks or helicopters to patrol the feeders frequently, which is not cost effective at large scale. This project would seek to combine RF analysis technology with communicating "smart" line sensors to determine the potential to reduce the need for more costly patrolling with RF scanners. Additionally, by utilizing permanently installed RF smart line sensors, RF measurements could be taken on a regular basis, instead of just once or twice a year with current technology.

Potential Benefits at Full Deployment
At full deployment, this new technology could potentially enable affordability benefits, such as reduction in the operation and maintenance of patrolling and inspecting lines with RF scanners. Additionally, if the technology is proven capable to predict potential outages before they occur, full deployment could potentially result in improved affordability from shifting from unplanned corrective work to planned maintenance work. This technology would also seek to drive reliability benefits by identifying, and therefore potentially repairing equipment before an outage occurs, resulting in few customers experiencing unplanned outages.

Reason Proposal Should Be Considered Immediately
PG&E recently completed piloting Line Sensor technology as part of the Smart Grid Pilot Program, which was shown to help PG&E locate and address a fault more quickly, which ultimately shortens customer outage time.[6] One of the key recommendations from the pilot was to deploy the sensors on a larger scale, while also supporting the continued advancement of the line sensor technology to build upon reliability and affordability benefits. Following the pilot, multiple points of feedback were provided to the line sensor industry on additional potential enhancements to the technology, including the integration of additional grid monitoring and stability capabilities. By moving forward with this EPIC project now, the technology can be better shaped earlier in the interest of customers, building on the learnings from the Smart Grid Pilot Program in a way that increases the benefit from future smart Line Sensor deployments.

Project Title: Call Center Staffing Optimization
Project #: 2.35
Investment Area: Customer Service and Enablement
Estimated Funding: $655K - $810K

Description of Technology or Strategy to Be Demonstrated
This project seeks to further optimize call center staffing by developing a real-time algorithm that integrates with and improves upon existing call center staffing software to potentially predict variability in call volume impacts in near real-time. The project expects to develop a more granular understanding of factors impacting call volume, including utility-specific influences such as regulatory proceedings, rate schedule seasons, weather information, restoration times, and other associated events that may drive call volume. Based on that data, the project will explore development of a learning algorithm, which would leverage identified call volume factors to devise a more accurate staffing model and integrate with the existing staffing software. The model may then be demonstrated at a subset of call center locations as a field trial to explore assessing the improved accuracy of the call center staffing forecast curves.

[6] Advice 4990-E. PG&E Smart Grid Pilot Program Final Status Reports Pursuant to Decision 13-03-032

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

Concern, Gap, or Problem to Be Addressed
PG&E call center operations currently has an understanding of factors that impact volume based on leveraging traditional methods and data points; however, there is opportunity for improvement in predicting and validating the wide range of potential influences to call volume, particularly at a more granular level. This call center staffing optimization project could help address this improvement opportunity, identifying additional utility-specific factors impacting call volume and integrating them into a learning algorithm. Such improvements could potentially reduce the variability in expected versus planned call volume, which can impact cost and customer service levels.

Potential Benefits at Full Deployment
Optimizing call center staffing to better match call volumes focuses on affordability goals by improving call center operational efficiency, as well as customer experience. For instance, by improving the forecast of call volumes, PG&E may reduce instances of temporary overstaffing, ultimately saving operational expense. With 51 million minutes of call time spent annually by PG&E call centers, there is a significant opportunity to make operational efficiencies through this new learning algorithm.

Additionally, improving call volume forecasts may support improvement in customer service levels and customer satisfaction by helping to reduce instances of understaffing, which would ultimately shorten customer wait time and improve customer experience.

PG&E estimates that these improvements could potentially positively impact up to 1.4 million customers per year (based on number of distinct Person ID's in 2015 live agent call data).

Reason Proposal Should Be Considered Immediately:
This project will explore new data analytics improvements that have the potential to increase affordability for customers. The sooner the project starts, the sooner the potential benefits can be realized for the operational efficiencies expected to be gained. This is particularly timely given the upcoming rate reform changes. In 2019, most residential electric customers will be automatically enrolled in a Time-of-Use rate plan where the price of electricity will depend on the time of day[7]. These rate changes will likely impact call volume, though it is relatively unknown what specifically the impact will be at a granular level. An opportunity to begin on this proposed project as soon as possible would enable

[7] D.15-07-001, *Decision on Residential Rate Reform for PG&E, SCE, and SDG&E and Transition to Time-of-Use Rates* in Rulemaking (R.)12-06-013; CPUC General Rate Case Plan (Phase 2 General Rate Cases and Rate Design Window applications, generally.)

PG&E to potentially better understand the impacts of the rate reform pilots on call volume and thus improve the customer experience for the full roll out in 2019.

Project Title: Dynamic Rate Design Tool
Project #: 2.36
Investment Area: Customer Service and Enablement
Estimated Funding: $1.605M - $1.895M

Description of Technology or Strategy to Be Demonstrated
This project seeks to improve on current rate design tools by demonstrating an exponentially more dynamic rate design tool approach for modeling the customer bill and impact to utility revenue requirements from changes to rates, as well as impact from the inclusion of next generation billing determinants in tariff design and adoption of distributed energy resources. This project will explore how to potentially leverage advanced approaches that can be applied to the rate design process, potentially including distributed computing or parallel processing. Functionalities may include additions such as machine readable tariff tables (residential and non-residential), an expanded billing determinate generator, holistic bill calculator backend (for customer and revenue requirement impact), DER load impact simulator, sample usage database, user and summary interface, and other potential improvements to help enable future rate design.

The tool would have front end / user interface components, as well as back end / bill calculation components. The project seeks to obtain user input on the front end, while developing a standardized and machine readable rate table on the backend. This could include energy charges by hour, as well as demand charges and other billing determinants. As part of the project, a comparison of methods will be explored using qualitative and / or quantitative criteria to assess impact of the improvements developed. Example criteria may include speed to complete analysis, barriers to and ease of use (including technical ability/training required), ability to experiment and develop new billing determinants, ability to export and share results via visualizations in a timely and meaningful way, and/or other associated criteria.

The development of billing calculation capabilities for various audiences (Residential, Small and Medium Business (SMB), large Industrial, large Commercial, Agricultural, Transmission, etc.) may be explored based on the complexity of the underlying rates and size of the customers impacted.

Additionally, several systems may be considered for integration with the tool, such as publically available online resources to develop the previously mentioned machine readable rate schedule table, customer usage inputs, the number of or specific nodes and supporting systems, DER impact shapes (both generating and load) that have been developed for other efforts, including the IDER and DRP proceedings in order to ensure consistency.

This project may also seek to provide customer access to improve understanding of rate options and help customers understand usage and DER adoption impacts, which can be particularly timely given upcoming rate reform changes[8]. It is not only important for the utility to be able to model the impact of DERs at scale, but for customers to be able to do the same for themselves. Current tools often utilize average customer data and not a customer's own usage information. Further confounding customer utilization of existing tools is the fact that they are developed and promoted by the company trying to sell the DER. Creating an interactive tool where customers can gain an independent assessment of the true bill impact of changes to their usage and rate schedule may provide a valuable added customer service. Such a user interface would utilize the same backend calculations used in the en masse bill impact assessment automation process described above if proven successful.

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

Concern, Gap, or Problem to Be Addressed

As the penetration of DERs grows, there is opportunity to expand on rate design practices through added analytics process to better understand bill impact on the customer of potential new dynamic rate options. Current production grade models used for rate design and filing provide limited flexibility to experiment with more dynamic rate designs.

In order for the utilities and regulators to be prepared for the expected substantial growth in DER penetration, there is a need for the capability to effectively model the interaction between DER adoption and rates. This project may help improve that understanding, especially in relation to en masse bill impact assessment automation, enabled rate schedule experimentation, and DER adoption scenario impact modeling.

If proven successful, this project may enable more experimentation to help create valuable new options for our customers in this growing DER market.

Potential Benefits at Full Deployment

This project will seek to develop a dynamic tool that may potentially improve flexibility and speed in the rate design process. The solution may add extra capability to the rate design process, helping to experiment with and potentially even automate the development of new dynamic scenarios for rate considerations. Full deployment would

8

D.15-07-001, *Decision on Residential Rate Reform for PG&E, SCE, and SDG&E and Transition to Time-of-Use Rates* in Rulemaking (R.)12-06-013; CPUC General Rate Case Plan (Phase 2 General Rate Cases and Rate Design Window applications, generally.)

yield a production ready solution that fulfills all rate design requirements, including data outputs for process and calculation transparency.

Reason Proposal Should Be Considered Immediately

The continued integration of DERs has prompted the need for broader reforms to how utilities recover costs. Accelerating the development of this tool provides the ability to explore the fundamentals of more dynamic rate design while DER adoption is still in a relatively early adopter phase. The need for the addition of locational net benefits or other currently non-existent billing determinants are on the rise and development of this tool ahead of this can help the commission and the utilities to be more proactive in the rates they offer the customer base.

Attachment B - EPIC 2 Projects Currently On Hold

Per CPUC Staff request, PG&E has included a list of EPIC 2 Projects approved in D.15-04-020 which are currently On Hold as of the date of this Advice Letter. Please note some of these projects may still become Active in line with PG&E's internal prioritization process.

2.01: Evaluate Storage on the Distribution Grid
2.06: Intelligent Universal Transformer (IUT)
2.08: "Smart" Monitoring and Analysis Tools
2.09: Distributed Series Impedance (DSI)
2.11: New Mobile Technology & Visualization Applications
2.12: New Emergency Management Mobile Applications
2.13: Digital Substation / Substation Automation
2.16: Enhanced Synchrophasor Analytics & Applications
2.17: Geomagnetic Disturbance (GMD) Evaluation
2.18: Optical Instrument Transformers and Sensors for Protection and Control Systems
2.20: Real-time Energy Usage Feedback to Customers
2.24: Appliance Level Bill Disaggregation for Non-residential Customers
2.25: Enhanced Smart Grid Communications
2.30: Leverage EPIC Funds to Participate in Industry-wide RD&D Programs

PG&E Gas and Electric
Advice Filing List
General Order 96-B, Section IV

AT&T
Albion Power Company
Alcantar & Kahl LLP
Anderson & Poole
Atlas ReFuel
BART
Barkovich & Yap, Inc.
Bartle Wells Associates
Braun Blaising McLaughlin & Smith, P.C.
Braun Blaising McLaughlin, P.C.
CENERGY POWER
CPUC
California Cotton Ginners & Growers Assn
California Energy Commission
California Public Utilities Commission
California State Association of Counties
Calpine
Casner, Steve
Center for Biological Diversity
City of Palo Alto
City of San Jose
Clean Power
Clean Power Research
Coast Economic Consulting
Commercial Energy
Cool Earth Solar, Inc.
County of Tehama - Department of Public Works
Crossborder Energy
Crown Road Energy, LLC
Davis Wright Tremaine LLP
Day Carter Murphy
Defense Energy Support Center
Dept of General Services
Division of Ratepayer Advocates
Don Pickett & Associates, Inc.
Douglass & Liddell
Downey & Brand
Ellison Schneider & Harris LLP
Evaluation + Strategy for Social Innovation
G. A. Krause & Assoc.
GenOn Energy Inc.
GenOn Energy, Inc.
Goodin, MacBride, Squeri, Schlotz & Ritchie
Green Charge Networks
Green Power Institute
Hanna & Morton
ICF
International Power Technology
Intestate Gas Services, Inc.
Kelly Group
Ken Bohn Consulting
Leviton Manufacturing Co., Inc.
Linde
Los Angeles County Integrated Waste Management Task Force
Los Angeles Dept of Water & Power
MRW & Associates
Manatt Phelps Phillips
Marin Energy Authority
McKenna Long & Aldridge LLP
McKenzie & Associates
Modesto Irrigation District
Morgan Stanley
NLine Energy, Inc.
NRG Solar
Nexant, Inc.
ORA
Office of Ratepayer Advocates
Office of Ratepayer Advocates, Electricity Planning and Policy B
OnGrid Solar
Pacific Gas and Electric Company
Praxair
Regulatory & Cogeneration Service, Inc.
SCD Energy Solutions
SCE
SDG&E and SoCalGas
SPURR
San Francisco Water Power and Sewer
Seattle City Light
Sempra Energy (Socal Gas)
Sempra Utilities
SoCalGas
Southern California Edison Company
Southern California Gas Company (SoCalGas)
Spark Energy
Sun Light & Power
Sunshine Design
Tecogen, Inc.
TerraVerde Renewable Partners
TerraVerde Renewable Partners, LLC
Tiger Natural Gas, Inc.
TransCanada
Troutman Sanders LLP
Utility Cost Management
Utility Power Solutions
Utility Specialists
Verizon
Water and Energy Consulting
Wellhead Electric Company
Western Manufactured Housing Communities Association (WMA)
YEP Energy
Yelp Energy