BEFORE THE PUBLIC UTILITIES COMMISSION OF THE

STATE OF CALIFORNIA

Application of Southern California Edison Company (U 338-E) for Approval of Its 2018-2020 Triennial Investment Plan for the Electric Program Investment Charge	A1705005	A.17-05-XXX

APPLICATION OF SOUTHERN CALIFORNIA EDISON COMPANY (SCE) (U 338-E) FOR APPROVAL OF ITS 2018-2020 TRIENNIAL INVESTMENT PLAN FOR THE ELECTRIC PROGRAM INVESTMENT CHARGE

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Dated: **May 1, 2017**

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I.

INTRODUCTION

Southern California Edison Company (SCE) respectfully submits this application requesting approval of its 2018-2020 triennial Investment Plan for the Electric Program Investment Charge (EPIC), which is attached hereto. In the California Public Utilities Commission's (Commission) Phase II EPIC Decision (D.)12-05-037, the Commission required that the EPIC program administrators file applications for their triennial investment plans by May 1, 2017.[1] The EPIC program administrators are SCE, Pacific Gas & Electric Company, San Diego Gas & Electric Company and the California Energy Commission (CEC). SCE files this application in compliance with D.12-05-037, as well as the additional compliance provisions adopted by the Commission when approving SCE's 2012-2014 EPIC Investment Plan in D.13-11-025, as well as SCE's 2015-2017 EPIC Investment Plan in D.15-04-020.

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[1] D.12-05-037, p. 31.

II.

BACKGROUND

The California Public Utilities Commission (Commission) established the Electric Program Investment Charge (EPIC) [2] to replace the expiring Public Goods Charge (PGC) and required the investor-owned utilities (IOUs) to continue collection "on all distribution customers in the same manner as the expiring" PGC as of January 1, 2012.[3] On May 24, 2012, the Commission adopted the EPIC Phase II Decision,[4] which established the parameters of the EPIC.[5]

The IOUs are required to collect the EPIC from customers over the years 2013-2020.[6] The EPIC funds applied research and development, technology demonstrations and deployments and market facilitation programs for the benefit of the IOUs' ratepayers.[7] However, the IOUs are only allowed to administer technology demonstrations and deployments. [8] Approximately 80% of the total EPIC funding is administered by the CEC, with the remaining 20% is administered by the IOUs. Additionally, 0.5% of the budget funds Commission oversight of the EPIC.[9] The EPIC's total annual budget is $170 million. [10] However, as noted above, the majority of this funding is allocated to the CEC and SCE administers approximately $14 million annually ($12.76 million for technology demonstration and deployment projects).

The Phase II Decision requires program administers to file coordinated triennial investment plans by May 1, 2014.[11] The second plan covers the period of 2015 through 2017.[12] The Commission requires the administers to, among other things, map "the planned investments to the electricity system

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2 D.11-12-035, at OP 2.
3 *Id.*, at OP 2-3.
4 D.12-05-037.
5 SCE has filed a legal appeal of EPIC, which is pending before the California Appellate Court.
6 *Id.*, at OP 7.
7 D.12-05-037, at OP 1.
8 *Id.*, at OP 7.
9 *Id.,* at OP 5.
10 Id., at OP 7; D.15-04-020, Appendix B Table 5: Approved, Escalated 2015-2017 EPIC Budgets, p. B-7.
11 *Id.*, p. 31.
12 *Id*.

value chain, which includes (i) Grid operations/market design; (ii) Generation; (iii) Transmission; (iv) Distribution; (v) Distribution; and (v) Demand-side management."[13]

At least twice per year, during the development of the respective investment plans and during the execution of those plans, the EPIC administrators are required to consult with stakeholders. These stakeholders include representatives of the legislature, government agencies, utilities, the California Independent System Operator, consumer groups, environmental organizations, agricultural organizations, academics, the business community, the energy efficiency community, the clean energy industry, and other industry associations.[14]

III.

SUMMARY OF SCE'S INVESTMENT PLAN

SCE's Investment Plan for the 2015-2017 program cycle represents a collaborative effort between SCE and the other program administers, incorporates the input of stakeholders and addresses the requirements of D.12-05-037 and D.13-11-025. The Investment Plan proposes to use SCE's share of EPIC funds to further enhance SCE's Advanced Technology organization's 2012-2014 EPIC projects, as well as fund new smart grid efforts.

SCE's Investment Plan consists of eight sections:

1. Background
2. SCE's Technology Vision and Strategy
3. IOU-Administered Program Funding Allocation
4. Stakeholder Input
5. Discussion of Gaps
6. SCE's EPIC Investment Plan
7. Program Administration
8. State Policy Direction

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[13] *Id*., at OP 12.a.
[14] *Id*., at OP 15.

The Background and Executive Summary provide an overview of the EPIC program and the Investment Plan. The section on SCE's Technology Vision and Strategy describes SCE's smart grid strategy and Smart Grid Deployment Plan.[15] The third section explains the allocation of EPIC funding elements and administrators.

The stakeholder input section describes SCE's extensive collaboration with stakeholders. SCE hosted and participated in a webinar and public workshops, and solicited comments from stakeholders on its Investment Plan. This section also summarizes the comments submitted by interested parties.

To help ensure the IOUs were not duplicating deployments and demonstration projects, the IOUs met with the Electric Power Research Institute (EPRI) to conduct an in-depth discussion on utility industry "gaps" in technology demonstrations and deployments. EPRI concluded there are industry gaps in the areas the IOUs have proposed that could be filled through EPIC demonstration and deployment projects.

During the planning of the 2018-2020 Investment Plans, the IOU administrators collectively decided to continue using the jointly developed investment plan framework that was used for the 2012-2014 program cycle and subsequently adopted by the Commission.[16] The framework contains four categories: (1) Renewable and Distributed Energy Resources Integration, (2) Grid Modernization and Optimization, (3) Customer-Focused Products and Services Enablement and Integration, and (4) Cross-Cutting/Foundational Strategies and Technologies. Each of these aforementioned categories addresses initiatives that SCE may pursue as potential projects. Initiatives in each of the four areas ultimately focus on increasing reliability and safety, while decreasing greenhouse gas emissions and costs for customers, supporting low emission vehicles, and spurring the retention and creation of jobs within California.

The Program Administration section explains SCE's approach to program coordination, contracting, intellectual property, project reporting, metrics and remission of funds to the CEC. The

[15] On October 1, 2013, in R.08-12-009, SCE filed its annual Deployment Plan update.
[16] D.13-12-025.

final section details how the Investment Plan complies with the policies of Public Utilities Code sections 740.1 and 8460. SCE includes potential projects that may be developed from this Investment Plan as Appendix A. In compliance with D.13-11-025, SCE also includes a list of approved energy efficiency and demand response portfolios, detailing each project's purpose, funding, deliverables and progress to date, as Appendix B of this filing.[17]

IV.
PROCEDURAL REQUIREMENTS

A. Statutory Authority (Rule 2.1)

This application is made pursuant to D.12-05-037, the Public Utilities Code, the Commission's Rules of Practice and Procedure, and prior decisions, orders, resolutions of the Commission.

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

SCE's full legal name is Southern California Edison Company. SCE is a public utility organized and existing under the laws of the State of California. The location of SCE's principal place of business is 2244 Walnut Grove Avenue, Rosemead, California, 91770. SCE is a wholly-owned subsidiary of Edison International, a public utility holding company incorporated in the State of Delaware.

C. Correspondence (Rule 2.1(b))

Correspondence or communication regarding this application should be addressed to:

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[17] *Id*., p. 66.

D. Proposed Categorization (Rule 2.1(c))

SCE proposes to characterize this proceeding as quasi-legislative, as defined in Rule 1.3(d).

E. Need for Hearing, Issues to Be Considered, and Proposed Schedule (Rule 2.1(c))

The need for hearings and the issues to be considered depend upon the degree to which other parties might contest SCE's application. Assuming other parties contest SCE's application, SCE recommends the Commission hold workshops to seek public comment on SCE's and the other administrators' investment plans. The workshops held during the investment plan development process facilitated stakeholder input and efficiently addressed the four EPIC administrators' investment plans. The same benefits would result from workshops held during the application process. In addition, the Commission has recognized the utility of workshops for the EPIC program by requiring the administrators to continue consulting with stakeholders at least twice per year.

SCE proposes the following schedule:

Application Filed	May 1, 2017
Protests and Responses	June 5, 2017
Reply to Protests and Responses	June 12, 2014
Workshops	July – August, 2017
Opening Briefs	September 13, 2017
Reply Briefs	October 4, 2017
ALJ Proposed Decision	November 6, 2017
Comments on Proposed Decision	November 22, 2017
Reply Comments	November 29, 2017
Commission Decision	December 13, 2017

F. Organization and Qualification to Transact Business (Rule 2.2)

A copy of SCE's Certificate of Restated Articles of Incorporation, effective on March 2006, and presently in effect, certified by the California Secretary of State, was filed with the Commission on March 14, 2006, in connection with A.06-06-020, and is incorporated herein by reference.

A copy of SCE's Certificate of Determination of Preferences of the Series D Preference Stock filed with the California Secretary of State was filed with the Commission on April 1, 2011, in connection with A.11-04-001, and is incorporated herein by reference.

A copy of SCE's Certificate of Determination of Preferences of the Series E Preference Stock filed with the California Secretary of State on January 12, 2012, and a copy of SCE's Certificate of Increase of Authorized Shares of the Series E Preference Stock filed with the Commission on March 5, 2012, in connection with A.12-03-004, and is incorporated herein by reference.

A copy of SCE's Certificate of Determination of Preferences of the Series F Preference Stock filed with the California Secretary of State on May 5, 2012, and as presently in effect, certified by the California Secretary of State, was filed with the Commission on June 29, 2012, in connection with A.12-06-017, and is incorporated herein by reference.

A copy of SCE's Certificate of Determination of Preferences of the Series G Preference Stock filed with the California Secretary of State on January 24, 2013, and presently in effect, certified by the California Secretary of State, was filed with the Commission on January 31, 2013, in connection with Application No. 13-01-016, and is incorporated herein by this reference.

A copy of SCE's Certificate of Determination of Preferences of the Series H Preference Stock filed with the California Secretary of State on February 28, 2014, and presently in effect, certified by the California Secretary of State, was filed with the Commission on March 24, 2014, in connection with Application No. 14-03-013, and is incorporated herein by this reference.

A copy of SCE's Certificate of Determination of Preferences of the Series J Preference Stock, filed with the California Secretary of State on August 19, 2015, and presently in effect, certified by the California Secretary of State, was filed with the Commission on October 2, 2015, in connection with Application No. 15-10-001, and is by reference made a part hereof.

A copy of SCE's Certificate of Determination of Preferences of the Series K Preference Stock, filed with the California Secretary of State on March 2, 2016, and presently in effect, certified by the California Secretary of State, was filed with the Commission on April 1, 2016, in connection with Application No. 16-04-001, and is by reference made a part hereof.

Certain classes and series of SCE's capital stock are listed on a "national securities exchange" as defined in the Securities Exchange Act of 1934 and copies of SCE's latest Annual Report to Shareholders and its latest proxy statement sent to its stockholders has been filed with the Commission with a letter of transmittal dated March 17, 2017, pursuant to General Order Nos. 65-A and 104-A of the Commission.

G. Service List

As directed by D.12-05-037, Ordering Paragraph 11, SCE is serving this application on the services lists for the rulemaking which established EPIC (R.11-10-003) and SCE's pending general rate case (A.16-09-001).

Respectfully submitted,

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WALKER A MATTHEWS, III

/s/Kris G. Vyas

By: Kris G. Vyas
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Dated: May 1, 2017

VERIFICATION

I am a Vice President of Southern California Edison Company and am authorized to make this verification on its behalf. I am informed and believe that the matters stated in the foregoing pleading are true.

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

Executed this **27th Day of April, 2017**, at Pomona, California.

Paul Grigaux
Vice President, Transmission, Substations & Operations

Investment Plan for the Electric Program Investment Charge (EPIC) Program

1. Background and Executive Summary

SCE uses the jointly developed Investor-owned utility (IOU) Electric Program Investment Charge (EPIC) Framework (Joint IOU Framework) to manage its 2018-2020 Triennial Investment Plan. The Joint IOU Framework contains four categories: (1) Renewable and Distributed Energy Resources (DER) Integration, (2) Grid Modernization and Optimization, (3) Customer-Focused Products and Services Enablement and Integration, and (4) Cross-Cutting/Foundational Strategies and Technologies. The categories addresses initiatives that SCE may pursue as potential projects. Initiatives in each of the four categories address grid challenges or opportunities for the benefit of ratepayers. These initiatives map to the Electricity System Value Chain[1] and ultimately support the EPIC's guiding principles of safety, reliability and affordability of electric service, while also supporting the EPIC's complementary principles of decreasing greenhouse gas emissions, supporting use of low emission vehicles and spurring the retention and creation of jobs within California.

SCE's 2018-2020 EPIC Investment Plan contains 24 potential projects with an annual allocated budget of $14 million annually ($12.76 million for technology demonstration and deployment projects). These potential projects are categorized into the four funding categories:

- Renewable & DER Integration: 8 potential projects
- Grid Modernization and Optimization: 8 potential projects
- Customer-Focused Products and Services Enablement: 3 potential projects
- Cross-Cutting/Foundational Strategies and Technologies: 5 potential projects

The Renewable & DERs Integration category supports safe and reliable integration of DERs. Initiatives in this category include, Strategies and Technologies to Increase Renewable Resources on the Grid, Adaptive Protection Strategies and Grid-Scale Storage Strategies and Technologies. The Grid Modernization and Optimization category address the need for the grid to become more flexible and responsive to integrate DERs and respond to the changing energy needs of SCE's customers. Initiatives include Strategies and Technologies for Optimizing Assets, Preparing for Emerging Technologies, and Designing and Demonstrate Grid Planning and Operations of the Future. The third category, Customer-Focused Products and Services Enablement and Integration, recognizes that California's environmental and clean energy policy goals are helping to drive changes in how customers consume and manage electricity. Initiatives include Leveraging the Smart Meter Platform to Drive Customer Service Excellence, Integrating Demand Side Management to Optimize the Grid and Responding to Emerging Grid Integration Issues. The Cross-Cutting/Foundational Strategies and Technologies category addresses challenges that cut across the previous three funding categories. Initiatives in this category include Systems Architecture and Cybersecurity.

The California Public Utilities Commission (Commission) established the EPIC [2] to replace the expiring Public Goods Charge (PGC) and required the IOUs to continue collection "on all distribution customers in the same manner as the expiring" PGC as of January 1, 2012.[3] On May 24, 2012, the Commission adopted the EPIC, Phase II Decision[4], which established the parameters of the EPIC.[5]

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[1] Except generation.
[2] D.11-12-035, at OP 2.
[3] *Id.*, at OP 2-3.
[4] D.12-05-037.
[5] SCE has filed a legal appeal of EPIC, which is pending before the California Appellate Court.

The EPIC Program Administrators are Pacific Gas & Electric Company (PG&E), Southern California Edison Company, San Diego Gas & Electric Company (SDG&E) and the California Energy Commission (CEC). The IOUs are required to collect the EPIC from customers over the years 2013-2020.[6] The EPIC funds applied research and development, technology demonstrations and deployments and market facilitation programs for the benefit of the IOUs' ratepayers.[7] The IOUs administer technology demonstrations and deployments.[8] Approximately 80% of the total EPIC funding is administered by the CEC and the remaining 20% is administered by the IOUs. Additionally, 0.5% of the budget funds Commission oversight of the EPIC.[9] The EPIC's total annual budget is $170 million.[10]

On November, 1, 2012, SCE filed its first triennial, EPIC Investment Plan Application (A.)12-11-004, covering the period of 2012-2014 (EPIC I).[11] SCE's EPIC I investment plan proposed to support SCE's broader technology efforts, including existing smart grid efforts.[12] SCE and the other EPIC Administrators received final approval of the EPIC I Investment Plan Applications from the Commission[13] on November 19, 2013.

The following year, on May 1, 2014, SCE filed its second triennial investment plan application,[14] covering 2015-2017 (EPIC II). SCE's EPIC II investment plan proposed to build on the EPIC I portfolio to fund new technology demonstrations and deployments to improve the grid. On April 15, 2015, SCE and the other EPIC Administrators received the Commission's decision[15] approving the EPIC II Investment Plan Applications.

Per the Commission's requirements for the EPIC, the Administrators are required to file coordinated triennial investment plans May 1, 2017. This third triennial investment plan for 2018-2020 (EPIC III), builds on the EPIC I and EPIC II Portfolios to support California's environmental and clean energy polices, Commission proceedings, such as the DRP and internal grid modernization efforts and corporate goals. This Investment Plan represents a collaborative effort between SCE and the other Administrators, with important input provided from stakeholders that was directly incorporated during the process of developing this Investment Plan.

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.[16] Interested stakeholders may include:

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[6] *Id.*, at OP 7.
[7] D.12-05-037, at OP 1.
[8] *Id*., at OP 7.
[9] *Id.,* at OP 5.
[10] Id., at OP 7; D.15-04-020, Appendix B Table 5: Approved, Escalated 2015-2017 EPIC Budgets, p. B-7.
[11] *Id*., at OP 11.
[12] More information about SCE's smart grid efforts is available in SCE's Application for Approval of its Smart Grid Deployment Plan, Application (A.) 11-07-001 and SCE's Annual Report on the Status of Smart Grid Investments, available at: http://www.cpuc.ca.gov/NR/rdonlyres/2881F099-0028-4152-B19B-E9A6C0FC5CA1/0/SCESmartGridAnnualReport_100113.pdf.
[13] D.13-11-025.
[14] A.14-05-005.
[15] D.15-04-020.
[16] *Id*., at OP 15.

- 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.[17]

In fulfilling this requirement for stakeholder engagements, the EPIC Administrators held a joint scoping webinar, as well as 3 jointly hosted stakeholder workshops. The joint scoping webinar was held on February 24, 2017. The stakeholder workshops were jointly hosted by the Administrators. A Northern California public workshop was held at PG&E's Pacific Energy Center on March 9, 2017. A second Northern California workshop was held at the CEC's facility on March 14, 2017. Finally, a Southern California workshop was held at SCE's AT facility on March 24, 2017. At these jointly hosted engagements (webinar and workshops), SCE encouraged stakeholders to provide input on the investment plan process, as well as provided the opportunity for further feedback through SCE's EPIC webpage[18] and contact email.[19]

As required in Commission Decision (D.)12-05-037, SCE's investment plan maps proposed investments to the electricity system value chain, which includes: (i) Grid operations/market design; (ii) Generation,[20] (iii) Transmission; (iv) Distribution; and (v) Demand-side management. SCE's EPIC III Investment Plan builds on the EPIC I and EPIC II portfolios, proposing new demonstrations and deployments and additional phases of existing projects to improve and enhance grid capabilities. The EPIC Administrators closely coordinated the planning of EPIC III and met on a regular basis to help ensure no duplication existed. The EPIC Administrators jointly met with the Electric Power Research Institute (EPRI)[21] – and hosted an in-depth discussion on gaps that exist in the utility industry that could be filled by technology demonstrations and deployments. EPRI determined that these industry gaps could be addressed by the technology demonstrations and deployments proposed by the EPIC Administrators and that no duplication exists between investment plans.

DERs offer many new opportunities for the grid, but also present many operational challenges and issues, such as voltage stability, frequency control, power quality, harmonics, system protection and control, that needs to be better understood in order to maintain grid safety and reliability. Energy storage systems offer many potential applications for grid management. However, these applications need to be further demonstrated to further understand the potential benefits. Projects in this area will demonstrate technologies that minimize grid disruptions and mitigate power quality issues.

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[17] *Id.*, at OP 15.

[18] SCE's website can be accessed at: www.sce.com/epic

[19] SCE's EPIC public email can be accessed at: SCEEPICProgram@sce.com.

[20] SCE does not have any potential projects in this Investment Plan that map to generation.

[21] EPRI is a respected and long-established national non-profit research institute.

Renewables and DER integration potential projects advance the following capabilities:

- Demonstrating integration of renewable resources and DERs on the transmission and distribution systems, as well as integrating these renewable resources into SCE's own operations;
- Demonstrating and assessing protection strategies and operations to support greater amounts of renewables, especially DERs onto the grid; and
- Demonstrating energy storage for additional grid applications, including safety and cost-effectiveness.

To achieve greater integration of DERs and to optimize dispatch, greater situational awareness and control capabilities for operators are needed. Potential grid modernization and optimization demonstration projects further the following capabilities:

- Demonstrating greater grid intelligence by using advanced computing and leveraging field technologies, such as monitoring and measurement systems;
- Demonstrating emerging technologies and innovative strategies to enhance situational awareness and grid management; and
- Demonstrating advanced automatic monitoring to assess and control the grid to changing conditions to meet customer reliability and power quality requirements.

To achieve California's GHG emission reductions, transportation needs to become electrified and customers need to dynamically manage and consume electricity. Initiatives further support grid integration of customer DERs, including electric vehicles. All potential projects in this category focus on grid impacts and operations, which are separate and apart from existing energy efficiency and demand response efforts. Per the Commission's requirement,[22] a detailed list of current energy efficiency and demand response projects including the purpose, funding, deliverables and progress to date is provided in this filing as Appendix B. Potential Customer Focused Products and Services Engagement projects help to further the following capabilities:

- Furthering Vehicle-to-grid integration (VGI) using new technology solutions, such as an on-board inverter to integrate these resources into SCE's new back office applications, such as the distributed energy management system (DERMS);
- Demonstrating a smart inverter energy management circuit breaker to help provide management and control of non-smart inverters; and
- Demonstrating PEV fast charging stations with integrated energy storage that can be used to control the grid system impact of fast charging, allowing more vehicles to charge, and potentially to respond to grid needs as DERs when not in use to charge a vehicle.

To link and communicate many different distributed and disparate resources, such as smart meters, renewable resources, DERs, energy storage systems, network management systems, micro-grid applications and electric vehicles, systems architecture is needed to integrate these technologies.

As the Grid automates and uses greater amounts of data analytics, as well as measurement and control technologies to integrate greater amounts of DERs, these systems must be kept safe from

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[22] D.13-11-025, at OP 40.

cyber threats. Cybersecurity potential projects will further improve machine-to-machine threat capabilities and increase coordination and knowledge sharing among utilities and government partners. Potential cross-cutting demonstration projects advance the following capabilities:

- Demonstrating advanced analytics for grid management and optimization;
- Ability to standardize and automate cyber threats and analysis among other utilities and partner governmental agencies to increase coordination and knowledge sharing;
- Ability to help to determine if changes made to the grid are legitimate and not made by a malicious cyber actor; and
- Further improving machine-to-machine cyber threat response capabilities.

Additionally, coordination and collaboration is shown by all the EPIC Administrators proposing a joint cyber security technology demonstration project, Cybersecurity for ICS. This project would be jointly managed and would build on the accomplishments of the California Energy Systems for the 21 Century (CES-21) Program,[23] 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.

To foster coordination, the Administrators will continue to meet to share information on this Investment Plan, as well as the EPIC I and EPIC II portfolios. As projects complete, the Administrators will continue to meet to discuss project learnings. Frequent discussions among the Administrators helps to avoid duplication and identify potential projects and facilitates knowledge sharing.

SCE's investment plan furthers the policies of Public Utilities Code sections 740.1 and 8360. The Investment Plan's initiatives and proposed projects are intended to promote customer benefits and support California's environmental and clean energy policy goals. While not all demonstrations and deployments will succeed, all projects are valuable because of lessons learned. Nevertheless, SCE will prioritize and pursue projects with the greatest probability of success. SCE will terminate or cancel projects that experience significant delays or unanticipated cost overruns. The Investment Plan's initiatives and proposed projects support the loading order, maintain grid reliability and help improve safety. SCE's investment plan describes potential projects that are designed to address all ten of the state's smart grid policies, as described in Public Utilities Code section 8360.

2. SCE Technology Vision and Strategy

California has a number of ambitious clean energy policy goals. A sampling of these key goals and requirements includes:

- California's Greenhouse Gas (GHG) reductions (Senate Bill (SB) 32);[24]

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[23] The CES-21 Program is a joint research and development cyber-security collaborative project between PG&E, SCE, SDG&E and LLNL that examines machine-to-machine cyber automated threats. See Section 6.4.2 Cybersecurity for additional details.

[24] State GHG emissions must be reduced to 40% 1990 levels by 2030.

- California's Renewable Portfolio Standard (RPS);[25]
- California's transportation electrification SB 350[26];
- Commission Distributed Generation Programs, such as the California Solar Initiative (CSI), Renewable Auction Mechanism (RAM) and California Feed-in Tariffs;[27]
- Commission's Energy Storage Procurement Requirement;[28] and
- North American Reliability Corporation (NERC), Critical Infrastructure Protection (CIP) Compliance Requirements;[29]

The electric grid will need to become adaptable and flexible to meet California's clean energy goals and requirements. As described in SCE's DRP Application,[30] DERs present new opportunities and challenges to traditional grid operations. Furthermore, the grid will also need to be resilient from extreme weather events caused by climate change and additional threats from cyber-attacks. New advanced technologies, integrated with innovative strategies, such as cyber security, systems architecture and communications standards will become increasingly important toward maintaining the safety and reliability of the electric grid. Moreover, advancing pre-commercial technologies and demonstrating new strategies is not only imperative toward reliability and safety, but also vital toward enhancing grid capabilities. Enhanced grid capabilities helps to optimize resources, lower costs and incorporate customer technology choices.

SCE's EPIC Investment Plan will continue to be managed by Transmission and Distribution's (T&D) Advanced Technology (AT) Division. AT currently manages the EPIC 1 and EPIC 2 Portfolios, as part of a broader Advanced Technology effort to aware of industry developments. AT helps ensure the planning and coordination of its EPIC Portfolio is cohesive and directly supports:

- California environmental and clean energy policy goals (e.g. SB 32 and SB 350);
- Commission proceedings (e.g., DRP, transportation electrification, etc.); and
- Internal grid modernization and planning efforts.

Advanced Technology's holistic strategy for its EPIC Program helps to integrate new technologies and lessons learned from the projects into existing infrastructure to help support California's environmental and energy policy goals, as well as Commission proceedings. This strategy also helps to ensure program management is efficient and minimizes administrative expenses.

As SCE's EPIC I and EPIC II portfolios continue to mature, there are instances where projects merit additional phases. Examples of potential projects that have proposed additional phases include SA-3, Phase III Field Demonstration and the Integrated Grid Project (IGP), Phase III. SA-3, Phase III Field Demonstration, proposes to build on the accomplishments of the Irvine Smart Grid Demonstration (ISGD), and the SA-3 Phase 3 Lab Demonstration under EPIC II, to field demonstrate a modern

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[25] Utilities' procurement from renewable generation must be 33% by the end of 2020, 40% by the end of 2024 and 50% by the end of 2030.

[26] Requires the Utilities transportation electrification proposals, requires 50% renewable generation by the end of 2030 and a doubling of energy efficiency.

[27] CSI, 3,000M Statewide; RAM, 1,225 MW Statewide and California feed-in tariffs, 750 MW statewide, plus 250 MW statewide for bioenergy.

[28] D.13-10-040, at Appendix A, p. 2; statewide energy storage procurement target: 1,325MW.

[29] Stricter controls for infrastructure protection.

[30] A.15-07-002.

substation automation systems for a transmission substation by adopting scalable technology that enables advanced functionality to meet NERC Critical Infrastructure Protection (CIP) compliance and IT cybersecurity requirements. The IGP's proposed Phase III, will allow SCE to complete the DRP, Demonstration D and incorporate distributed renewable resources from SCE's Preferred Resources Pilot (PRP).

2.1 SCE's Smart Grid Strategy

The EPIC has now replaced SCE's existing research, development and demonstration (RD&D) Program that was funded from the General Rate (GRC). SCE will continue to manage its EPIC Portfolio with the same consistency toward PUC 740.1, as it did with its now defunct RD&D program, dating back to SCE's 1988 GRC. As part of its EPIC Portfolio management, SCE proactively engages with its fellow Administrators and industry broadly. For example, SCE has held a micro-grid tour and discussion with SDG&E and information sharing with Commonwealth Edison of Chicago. Furthermore, SCE routinely provides knowledge and lessons learned for the industry through panel discussions and white papers. Specifically, SCE actively participates in a variety of electric groups such as Institute of Electrical and Electronics Engineers (IEEE) and Edison Electric Institute (EEI). SCE's AT engineering experts also facilitate and lead industry discussions, through engagements, such as Distributech, where SCE has presented on the IGP in 2016 and 2017.

2.2 SCE's Smart Grid Deployment Plan

SCE annually files an update to its Smart Grid Deployment Plan.[31] In this Deployment Plan update, SCE provides an annual deployment baseline with respect to the following areas:

- Customer Empowerment;
- Distribution and Substation Automation;
- Transmission Automation;
- Asset Management; and
- Platform Technologies.

This annual update to the Deployment Plan contains details on implementation of grid capital deployments. The annual update provides details of project activities and milestones that have taken place during the year, including the amount expended. Additionally, the Deployment Plan update provides annual metrics on key grid automation activities.

2.3 SCE's Administration of EPIC Demonstrations & Deployments

SCE will continue to administer its EPIC Portfolio, as part of its broader AT efforts, to help ensure the EPIC stays current of industry developments to avoid duplication. Moreover, SCE will manage the EPIC to support California's environmental and clean energy goals; Commission proceedings; internal grid modernization and planning efforts and aligns with corporate goals. SCE, as it has done with both its EPIC I and EPIC II Investment Plans will continue to administer EPIC funds to advance the grid objectives detailed in Public Utilities Code section 8360.

[31] Commission-approved in D.13-07-024; for additional information, see Footnote 11.

SCE will conduct EPIC demonstrations and deployments at its The Advanced Technology Fenwick Laboratory Facility (Fenwick Labs), Equipment Demonstration Evaluation Facility (E-DEF) and in the field. The Fenwick Labs enables SCE to safely evaluate and test emerging technologies, in a dynamic and fully integrated grid environment. The EDEF is a high-voltage test facility located within an existing SCE substation, which was built to test a variety of new technologies to support renewables integration, grid modernization, infrastructure replacement, and safety enhancements. The EDEF is crucial for conducting many of SCE's EPIC projects, because the E-DEF allows evaluation of pre-commercial, emerging technologies on energized high-voltage equipment and distribution circuits. Having the ability to test using real-world conditions is instrumental toward determining whether the technology and/or strategy is ready for further deployment on the grid. Field deployments allow SCE to further evaluate the results from simulations, as well as Fenwick Lab and E-DEF demonstrations to further assess a technology and/or strategy's potential for operational success.

SCE's administration of EPIC will continue to be consistent with the requirements of the Program[32] and the Commission's approval of EPIC II[33] and EPIC I[34] and the objectives of the Commission's EPIC Phase II Decision.[35] SCE will continue administrating its EPIC Portfolio according to the EPIC's guiding primary and complementary principles. The EPIC primary principles includes:

- greater reliability,
- lower costs, and
- improved safety.

The EPIC Complementary principles includes:

- societal benefits,
- GHG emissions reductions in the electricity sector at the lowest possible cost,
- the loading order,
- low emission vehicles and transportation,
- economic development, and
- efficient use of customer monies to produce ratepayer benefits.

SCE will continue to update the Commission and stakeholders on the status of EPIC projects via an Annual Report, filed February 28[36] and the annual Symposium[37].

3. IOU-Administered Program Funding Allocation

For the 2018-2020 EPIC Program cycle, the Commission's allocation, per its approval of the EPIC II[38] continues to be applicable. SCE will follow the Commission's requirements to update its allocated EPIC budget on January 1, 2018 by the latest Consumer Price Index (CPI). Specifically, the CPI for Urban Wage Earners and Clerical Workers for the third quarter, for the previous three years, which is

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[32] D.15-09-005.
[33] D.15-04-025.
[34] D.13-11-025.
[35] D.12-05-037.
[36] D.12-05-037, at OP16; D.13-11-025, at OPs 22 and 23.
[37] D.15-04-020, at OP 27.
[38] D.15-04-020.

2.065 percent.[39] Furthermore, the Commission in approving EPIC II, requires SCE to identify accumulated interest. Per the requirements of the Commission's EPIC II approval decision, SCE has identified $291,555 thousand in accumulated interest.[40] As instructed by the Commission, SCE intends to return this interest to customers and will reduce its 2018 requested amount by the $291,555 thousand in accumulated interest.

Per the Commission's requirements, SCE's annual and triennial period budgets with grand totals,[41] are shown in the tables[42] below:

TABLE 1: SCE'S EPIC ANNUAL BUDGET (ESCALATED)

Funding Element	**2018**	**2019/2020**
Applied Research	-	-
Technology Demonstration and Deployment	$12.76	$12.76
Market Facilitation	-	-
Program Administration	$1.43	$1.43
Program Oversight	$0.07	$0.07
Less Accumulated Interest	**($0.29)**	**N/A**
Total	**$13.97**	**$14.26**

*Escalated figures shown in millions

TABLE 2: SCE'S EPIC TRIENNIAL (2018-2020) BUDGET (ESCALATED)

Funding Element	**Amount**
Applied Research	-
Technology Demonstration and Deployment	$38.28
Market Facilitation	-
Program Administration	$4.27
Program Oversight	$0.21
Less Accumulated Interest	**($0.29)**
Total	**$42.47**

*Escalated figures shown in millions

The IOU's are only allowed to administer the Technology Demonstration and Deployment category. The Commission's Phase I Decision[43] that continued the expiring PGC and established the EPIC, used the resultant allocation of 50.1% to PG&E, 41.1% to SCE and 8.8% to SDG&E. SCE's allocated budgetary share, less accumulated interest in 2018 is $13.97 million. In 2019 and 2020, SCE's allocated amount will be $14.26 million (see Table 1 above). Over the 2018-2020 triennial

[39] SCE is willing to discuss alternative escalation indices, including indices as may be proposed by the CEC.
[40] D.15-04-020, at OP 15.
[41] *Ibid*, OP 11 at p. 63.
[42] Amounts in tables based on D.15-04-020, Appendix B, Table 5 at p. 7.
[43] D.11-12-035.

period, SCE's allocated amount is $42.47 million (see Table 2) for EPIC administration of technology demonstrations and deployments. SCE's EPIC Portfolio funds new grid demonstrations and deployments, as well as projects that require additional phases. Projects that span additional phases build on the learnings of the initial project to incorporate evaluations of additional capabilities to support California environmental and clean energy policy goals and Commission proceedings. SCE will also use its allocated program administration budget, consistent with the 10% administrative cost cap.[44] Per the Commission's requirements, SCE has replaced its existing RD&D Program and balancing account with the EPIC.[45]

4. Stakeholder Input

The EPIC Administrators are required by the Commission to hold at least two stakeholder engagements, prior to submitting an Investment Plan application.[46] In fulfilling this requirement, the EPIC Administrators held a scoping webinar and three public workshops. The CEC hosted a joint Administrator scoping webinar on February 24th. Additionally, joint Administrator stakeholder workshops were held throughout California, these engagements include:

- PG&E hosted a Northern California public workshop on March 9th;
- CEC hosted a workshop at its facility on March 14th; and
- SCE hosted a Southern California workshop at its Advanced Technology facility on March 24th.

All of the EPIC workshops were attended by a diverse group of stakeholders, including Commission Energy Division and Office of Ratepayer Advocates staff, national labs (i.e. Lawrence Berkeley National Lab and Lawrence Livermore National Lab), universities (i.e. University of California, Riverside, University of California, Los Angeles, California Polytechnic State University, San Luis Obispo,) and consumer groups (i.e., Office of Ratepayer Advocates, Greenbank Associates), environmental groups (i.e., Institute for Environmental Entrepreneurship), energy efficiency community (Home Energy Analytics), clean energy industry (Solar City, California Clean Energy Fund) and other stakeholders (i.e. Port of Long Beach).

The February scoping webinar solicited input from stakeholders on the IOUs' proposed EPIC framework, including the categories of focus and associated initiatives. The subsequent public workshops in March built on this framework and provided further context and details on the Investment Plans by providing an overview of potential projects and highlighted a few of these projects from the categories of the IOU's Joint Framework for Technology Demonstrations and Deployments. Stakeholders had the opportunity[47] to ask questions and directly provide input on the aforementioned Plans. [48] Additionally, stakeholders had the opportunity to further engage with the EPIC Administrators through their respective websites[49] and email contacts.[50]

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[44] As adopted by the Commission in D.12-05-037, at OP 5.

[45] Id., at Conclusion of Law 15.

[46] D.12-05-037, at OP 15.

[47] Deadline to submit comments, March 31, 2017.

[48] Exhaustive lists of stakeholder questions from the webinar and workshops are posted on SCE's EPIC website.

[49] SCE's EPIC website can be accessed at: www.sce.com/epic.

[50] SCE's EPIC public email can be accessed at: SCEEPICProgram@sce.com.

Stakeholder feedback from these workshops was particularly useful toward putting together SCE's Investment Plan. During the CEC hosted workshop, Greenbank Associates provided comments that identified a possible industry gap between the recent transportation electrification proposals and the proposed 2018-2020 (EPIC III) investment plans, inquiring whether the EPIC Administrators had interest in electric vehicle charging, coupled with energy storage.

SCE greatly appreciates the stakeholder feedback from the clean energy community on the initiative, Responding to Emerging Grid Integration Issues within the Customer Focused Products and Services Enablement funding category (see section 6.3.3 for additional details). To address Greenbank Associates' aforementioned concern, SCE has directly incorporated their stakeholder feedback and created a potential project entitled:

- Distributed PEV Charging Resources

This potential project will demonstrate PEV fast charging stations with integrated energy storage that can be used to control the grid system impact of fast charging, allowing more vehicles to charge, and also responding to grid needs as DERs when not in use to charge a vehicle.

5. Discussion of Gaps

Both the Public Utilities Code Section 740.1(d), and the Commission's EPIC Phase II Decision, D.12-05-037,[51] require the Administrators to not unnecessarily duplicate work. In addition to closely coordinating investment plans to help ensure compliance with this requirement, all of the Administrators also engaged EPRI experts.[52] On January 30th the EPIC Administrators and EPRI discussed the EPIC III investment plans, current industry gaps in technology demonstrations and deployments and identified any potential duplication of efforts.

The IOUs presented the Joint IOU Framework categories, previously used for the EPIC I and the EPIC II investment plans and subsequently adopted by the Commission. Additionally, the CEC provided an overview of their proposed strategic initiatives for technology demonstrations and deployments. EPRI provided presentations on industry gaps, according to the IOU's categorization of funding areas. The IOUs then discussed proposed initiatives within each of these aforementioned four program categories. Similar to past investment plans, some of the initiatives build on SCE's first triennial Investment Plan, while other initiatives are new and address emerging grid challenges. For the first category, Renewables and Distributed Energy Resources Integration, SCE discussed potential capabilities to advance including:

- Demonstrating integration of renewable resources and DERs on the transmission and distributions systems, as well as integrating these renewable resources into SCE's own operations;
- Demonstrating and assessing protection strategies and operations to support greater amounts of renewables, especially DERs onto the grid; and

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[51] Conclusion of Law 1.

[52] EPRI's expertise covered the four areas of the Joint IOU's framework. Specific attendance included: Tom Key and Haresh Kamath (Renewables & Distributed Energy Resources), Mark McGranaghan (Grid Modernization & Optimization), Mark McGranaghan (Customer Focused Products & Services), Matt Wakefied (Cross-cutting, Foundational Strategies and Technologies, cyber-security).

- Demonstrating energy storage for additional grid applications, including safety and cost-effectiveness.

For the Grid Modernization and Optimization Program Category, using the initiatives as a guide, SCE discussed the following potential capabilities:

- Demonstrating greater grid intelligence by using advanced computing and leveraging field technologies, such as monitoring and measurement systems;
- Demonstrating emerging technologies and innovative strategies to enhance situational awareness and grid management; and
- Demonstrating advanced automatic monitoring to assess and control the grid to changing conditions to meet customer reliability and power quality requirements.

Similarly for the Customer Focused Products and Services Enablement Program category, SCE discussed the potential capabilities to advance including:

- Furthering Vehicle-to-grid integration using new technology solutions, such as an on-board inverter to integrate these resources into SCE's new back office applications, such as the distributed energy management system (DERMS);
- Demonstrating a smart inverter energy management circuit breaker to help provide management and control of non-smart inverters; and
- Demonstrating PEV fast charging stations with integrated energy storage that can be used to control the grid system impact of fast charging; allowing more vehicles to charge, and also to respond to grid needs as DERs when not in use to charge a vehicle.

The last category, Cross-cutting/Foundational Strategies and Technologies, using the initiatives as a guide, SCE discussed the following potential capabilities:

- Demonstrating advanced analytics for grid management and optimization;
- Ability to standardize and automate cyber threats and analysis among other utilities and partner governmental agencies to increase coordination and knowledge sharing;
- Ability to help to determine if changes made to the grid are legitimate and not made by a malicious cyber actor; and
- Further improving machine-to-machine cyber threat response capabilities.

EPRI concluded from the Administrator's presentations and list of potential projects that there are industry gaps in technology demonstrations and deployments that could be filled by the Administrator's EPIC III Investment Plans. As technology matures and/or new energy policy goals are created, it is imperative the EPIC administrators continue to regularly meet to discuss industry developments, coordinate and discuss Program challenges, leverage lessons learned from completed projects and identify possible collaborative opportunities. A prime example of identifying collaborative opportunities is in the area of Cybersecurity. The EPIC Administrators jointly propose a potential project, Cybersecurity for Industrial Control Systems (ICS). This joint collaboration proposes to leverage and build on the multiple learnings and deliverables from the IOUs jointly administrated CES-21 Program,[53] to further machine-to-machine threat response by demonstrating adaptive controls and dynamic zoning for ICS and enhancing the visual interfaces for the simulation engine.

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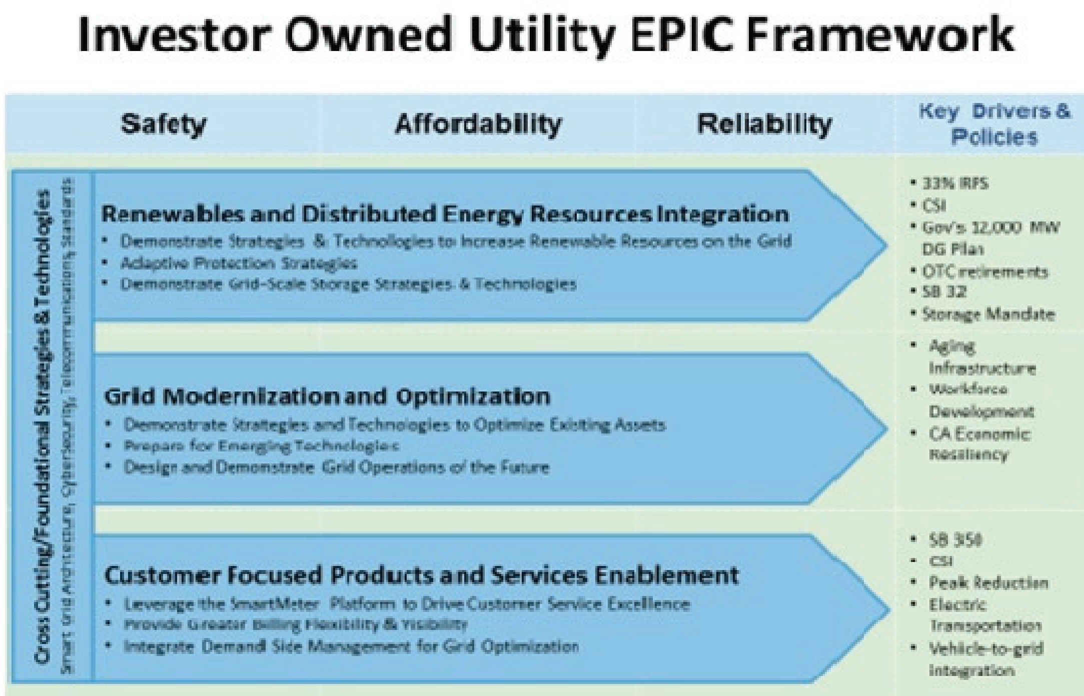
[53] D.14-03-029.

6. SCE's EPIC Investment Plan

SCE's EPIC III investment plan continues to leverage the Joint IOU Framework used for the EPIC I and the EPIC II investment plans. During the first triennial planning period, the IOU's collaborated to develop a common methodology for assessing Technology Demonstrations and Deployments. The Joint IOU Framework presents a broad spectrum of capability gaps, which was approved by the Commission[54] and shown below:

FIGURE 2 - JOINT IOU FRAMEWORK



While the Joint IOU Framework was developed during the first EPIC triennial planning period, SCE has updated the framework to reflect current grid challenges and additional key policy drivers since SCE's EPIC I and EPIC II Investment Plans were approved by the Commission.[55]

The proposed potential projects presented in this Investment Plan (see Appendix A), demonstrate viable technology solutions, as well as new and innovative strategies needed to enable grid capabilities to address operational challenges and advance California's energy goals and requirements. Similar to previous investment plans, a few potential projects need to span multiple EPIC funding cycles, due to regulatory mandates and/or the results of the project merit additional phase(s).[56] This continues to hold true for the Cross Cutting/Foundation Strategies and Technologies category, which needs to continually evolve as technology emerges and matures, enabling the grid to have greater capabilities and interoperability. All of these potential projects presented in this

[54] D.13-11-028, OP 8

[55] D.13-11-025, at OP 8 and D.15-04-020, at OP 1.

[56] D.15-04-020, at OP 21, allows Administrators to leverage prior investments via proposing an additional phase.

Investment Plan follow the Commission's guiding principles for the EPIC to produce customer benefits of greater reliability, lower costs and/or increased safety. In addition to primary customer benefits, projects may also result in complementary benefits of societal benefits, GHG emissions reductions, supporting the loading order, low-emission vehicles/transportation, economic development and/or efficient use of customer monies.[57]

The EPIC Administrators have maintained close coordination through the first two investment plans and regularly engage in information sharing sessions on completed projects, as well as planning sessions to identify gaps and areas of collaboration, such as the jointly proposed Cybersecurity for ICS. Furthermore, the Administrators met with EPRI to further identify industry gaps and determine if any duplication exists between Administrator's investment plans. The discussion with EPRI was imperative toward confirming the validity of the gaps that this EPIC investment plan could fill and determined there was no potential duplication. Furthermore, the Administers hosted joint webinar and public forums, soliciting stakeholder feedback. SCE gained insightful feedback during the investment planning process that was directly incorporated as a potential project.

As the EPIC Program continues to mature and Administrators complete projects and (potentially) jointly administer a collaborative project, it will become even more critical for the EPIC Administrators to continue regularly meeting to coordinate on the Cybersecurity for ICS and the Program in general. Coordination among the EPIC Administrators provides a platform to leverage learnings from projects, identify funding opportunities and areas of collaboration, such as the proposed joint project and avoid duplication.

6.1 Renewable & Distributed Energy Resource Integration

In order to achieve California's GHG reduction goals, as well as the Commission's RPS requirements, energy storage mandate and objectives for the DRP's demonstration projects, increasing amounts of renewables and DERs will need to be safely and reliably integrated onto the grid. Renewable resources encompass a wide range of technologies that are RPS eligible, from geothermal and biomass, which provide baseline power to wind and solar resources, which are intermittent. DERs also span a wide range of technologies, which includes rooftop solar photovoltaics (PV), distributed energy storage, and fuel cells.

Energy storage systems offer many potential applications for grid management. However, these applications need to be further demonstrated to unlock the potential benefits, as well as the safety and reliability issues with integrating increasing amounts of these resources on the grid.

Renewable resources, energy storage systems and DERs operate much differently, than traditional power plants, which in the past provided baseline power. Wind and solar renewable resources depend on weather conditions to effectively operate. These resources offer many new opportunities for the grid, but also present operational challenges and issues, (e.g., voltage stability, frequency control, power quality, harmonics, system protection and control) that needs to be better understood in order to maintain safety, reliability and affordability of electricity service to customers.

The primary goal of this funding category is to demonstrate and deploy advanced technologies and new strategies to safely and reliably integrate renewable resources and DERs. This integration of

[57] D.12-05-037, at OP 2.

renewable and DERs helps support California's environmental and clean energy goals, the Commission's DRP requirements and SCE's corporate strategic goals.

Priority Initiatives

SCE has extensive experience safely integrating renewable resources and DERs on the electric grid. For example, SCE has been involved in renewable resources since the nation's first wind project was installed in the early 1980's. SCE has a long history demonstrating and deploying energy storage technology. SCE deployed a 10 MW battery storage system at its Chino substation in the 1990s and recently finished the American Recovery and Reinvestment Act (ARRA) funded, Tehachapi Wind Energy Storage Project (TSP) and the ISGD (see section 6.1.3: Demonstrating Grid-Scale Storage Technologies and Strategies for additional details). SCE continues to operate the TSP as it evaluates additional grid applications for energy storage systems.

Using real time power hardware in the loop tests, advanced algorithms, SCE's AT engineers can model the power system and its behaviors under a multitude of operational scenarios, involving high penetrations of renewables and DERs. This capability helps SCE to understand the impacts of these resources in various combinations and quantities on both the transmission and distribution systems. These potential impacts include system performance, protection and controls and restoration schemes. It is critical for SCE to perform lab demonstrations in a simulated environment, before physically deploying renewables and DERs on the grid. These laboratory and field demonstrations help ensure safety and grid reliability. Furthermore, the results and lessons learned provide strategies for mitigating operational and safety challenges before widely deploying these resources on the grid.

Another key component for integrating DERs on the grid is the establishment of technical standards. SCE continues to be active in rewriting the IEEE 1547 standard for interconnecting distributed generation and the associated UL 1741 standard. Once these standards are rewritten, it will help further safely integrate these resources by making them more adaptable to the modernizing grid and spread wide-scale adoption. However, much work and testing still needs to take place before these revised standards can be finalized.

SCE has extensively tested and continues to evaluate smart inverters. In addition to directly testing and evaluating these devices, SCE is an active participant in the California Rule 21 Smart Inverter Working Group. In this Working Group, SCE has provided meaningful recommendations for Voltage Ride Through, which better allows SCE to manage DERs on the grid. SCE's recommendation was based on field measurements. Deployment of voltage sensors, coupled with analysis enabled this recommendation. Furthermore, SCE has widely published in IEEE on smart inverter functions and potential benefits. SCE has widely shared results and lessons learned with the Commission, utilities, EPRI, IEEE, universities and vendors.

SCE continues to serve as an industry thought leader in the Renewable and DER Integration area and advances industry knowledge by authoring technical papers. A sample of recent papers include:

- "Modernizing the California Grid," Sherick, Yinger, March/April 2017 issue of the IEEE PES Power & Energy Magazine.
- "Final Technical report – Irvine Smart Grid Demonstration – A Regional Smart Grid Demonstration Project," Yinger, Irwin, Final Report submitted to the US Department of Energy (DOE) on December 29, 2015.

- “Voltage Ride-Through (VRT) Recommendations for Distributed Electronic-Coupled Generation” Bravo, Sun, Bialek for the 2015 IEEE Power Engineering Systems General Meeting Conference” in Denver, Colorado and “2015 IEEE Green Technologies Conference in New Orleans, Louisiana in 2015.
- “Benefits Analysis of Smart Grid Demonstration Projects,” Karali, Zhang, Ren, Shaffer, Clampitt, Yu, Yinger, Marnay, for the 2016 China International Conference on Electricity Distribution, Xi’an China in August 2016.
- “Distributed Energy Resources Challenges for Utilities,” Bravo, Sun, Bialek for the 2015 IEEE Power Engineering Systems General Meeting Conference” in Denver, Colorado and “2015 IEEE Green Technologies Conference in New Orleans, Louisiana 2015.

Additionally, SCE has also advanced knowledge in this space by presenting on these technical papers at industry discussions such as Distributech, IEEE Industry Applications Society Los Angeles Metro Section, EPRI, and DOE’s Grid Modernization Workshop.

The IOUs collaboratively worked to develop the Renewable and Distributed Energy Resources Integration priority initiatives when creating the Joint IOU Framework. In developing this investment plan, the IOU worked in tandem to help ensure these initiatives are high priorities and do not duplicate efforts. These initiatives are high priorities based on:

- SCE’s extensive experience testing, managing and integrating renewables and DERs, and in particular energy storage systems;
- Support of California’s environmental and clean energy policy goals;
- Commission proceedings, such as the Distribution Resources Plan; and
- EPRI subject matter experts review of these initiatives and have deemed them as high priorities for filling existing industry gaps.

The Renewable and Distributed Energy Resources Integration priority initiatives includes the following:

- Demonstrate strategies and technologies to increase renewable resources on the grid
- Adaptive protection strategies
- Demonstrate grid-scale storage strategies and technologies

The initiative’s proposed potential projects, will map to the following elements of the electric system value chain: Grid Operations/Market Design, Transmission and Distribution.

6.1.1 Demonstrate Strategies and Technologies to Increase Renewable Resources on the Grid

Problem or Opportunity to be addressed

California’s environmental and clean energy policy goals, as well as the Commission’s requirements in the DRP proceeding, require SCE to safely and reliably integrate increasing amounts of renewables and DERs onto the grid. Moreover, SCE is committed to integrating these renewable resources into its own operations, in order to provide clean energy for customers. For example, SCE has set a corporate goal of allocating at least 5% of its annual vehicle purchase on electric drive vehicles. Heavy-duty electric drive vehicles are an emerging technology and charging infrastructure presents challenges to distribution operations that can result from high demand for PV distributed generation and concentrated PEV charging.

While Renewables and DERs present environmental benefits and new opportunities for customer choice and grid applications, they also pose technical challenges to grid operations. At the bulk power level, high penetrations of renewable generation can potentially cause voltage stability issues, due to the resource's intermittency and lack of VAR control coordination. At the distribution level, many inverter-based DERs will trip off during a system disturbance under the current requirements, which may even worsen the condition, if a large number of DERs trip off in a short period. Additionally, DERs can mask the actual customer demand and there currently is limited visibility of DERs to operators, who either need additional time to verify the information or do not perform load transfer with the concerns of overloading and tripping the circuit breakers on the adjacent circuits. If the circuit overloads it will increase the system restoration time and negatively impact system reliability. Additionally, integration of diverse systems and technologies that can transmit data, needs to be evaluated to determine how to best optimize control structure for energy management and grid services, such as demand response programs.

<u>How the initiative will advance the strategy and overcome barriers</u>

This initiative's focus is to facilitate safe and reliable integration of increasing amounts of renewable resources and DERs on the transmission and distribution levels. Furthermore, this initiative also supports safe and reliable integration of these renewable resources into SCE's own operations, in order to provide clean energy for customers. SCE also proposes to demonstrate an advanced SCE service center, housing electrified utility crew trucks, together with employee workplace charging, connected to a local service area. The aim of this potential project is to evaluate high penetration of distributed solar generation with a range of plug-in electric vehicles, fleet trucks (charge during p.m.) and employee vehicles (charge in a.m.). These vehicle systems, when not driving, can potentially be used as grid assets and respond directly to support system voltage and stabilize demand.

Integration of greater amounts of high penetrations of renewables and DERs onto the electric grid presents challenges to grid operations. To address these operational challenges, SCE proposes to evaluate system voltage and VAR control under high renewables penetrations to determine impacts. Additionally, SCE proposes to expand capabilities to provide distribution state estimation for resource control and additional visibility for utility operators into secondary systems to examine mitigation solutions. Consistent with SCE's approach for past grid demonstration efforts, these new system restoration strategies will first be modeled, using power system modeling and simulation techniques. Once the concepts are proven in a simulated environment, the process can then transition to the field.

Potential project demonstrations will support evaluation of technologies and strategies to minimize disruptions to the grid, increase generation resource flexibility and to manage the variability of renewable resources and DERs to maximize opportunities for grid applications and mitigate operation challenges.

The following are commonly discussed impacts and barriers to the widespread adoption of renewable and distributed energy resources:

a. Frequency control,
b. Voltage regulation,
c. Reverse power flows,
d. Operational flexibility,
e. Reliability capacity and planning, and
f. Capacity margin.

SCE's Potential Demonstration Projects

- Service and Distribution Centers of the Future
- Distribution State Estimation under High DER Penetration
- Power System Voltage and VAR Control under High Renewables Penetration
- Predictive Distribution Reliability
- Tools & Technologies for Managing Secondary Systems

The following table lists the potential demonstration projects and the drivers/barriers they are intended to address.

SCE Project	**Barriers Addressed**
Power System Voltage and VAR Control under High Renewables Penetration	a, b, c, d, e, f
Service and Distribution Centers of the Future	a, b, c, d, e,
Predictive Distribution Reliability	a, b, c, d, e,
Tools & Technologies for Managing Secondary Systems	a, b, c, d, e,

6.1.2 Adaptive Protection Strategies

Problem or Opportunity to be Addressed

Traditionally, utility operations were vertically integrated and electric power flowed from centrally planned generation sources over transmission lines and then distributed to customer load centers via distribution grids. As SCE adds more renewable resources and greater amounts of DERs, to support California's energy and environmental policy goals, integrating these energy resources at the transmission and distribution levels create new operational challenges for system protection strategies. These existing system protection strategies were based on traditional utility operations and consequently may require modifications with integrating increasing amounts of DERs or possibly even new approaches to protection.

Solar and wind renewable resources whether at the transmission or distribution levels are dependent on weather conditions for output. Rapidly changing weather conditions (e.g., sudden cloud cover over solar) can substantially reduce the output of these resources, which increases the complexity of scheduling and delivering energy, as well as maintaining grid reliability. DERs have the potential to provide bi-directional power flows, which at high penetration levels can cause distribution grid operation challenges (e.g., harmonics, power quality, etc.). Due to the dynamics of these renewable resources it could invalidate existing distribution level protection schemes, requiring new approaches. Deployment of customer owned micro-grids and virtual power plants also present challenges to grid reliability. These customer owned and operated systems can frequently connect and disconnect to-and-from the grid, or ramp up and down their aggregated generation or demand. The dynamic nature of these micro-grid systems can greatly affect the characteristics of distribution systems, which is beyond current protection and operations practices. To provide control/protection, a high degree of granular monitoring, accurate event detection and situational awareness is needed.

How the initiative will advance the strategy and overcome barriers

This initiative's objective is focused on demonstrating and assessing protection strategies and operations to support greater amounts of renewables, especially DERs onto the grid. At high penetration levels, DERs can provide new opportunities for grid operations, such as potentially becoming active participants in supporting system stability. However, these resources also present operational challenges, such as harmonics and power quality. Other emerging technologies, such as customer micro-grids, surpass existing protection schemes and operations. In order to facilitate the integration DERs at greater amounts and potentially emerging technologies, such as micro-grids onto the distribution grid, it requires demonstrating and assessing current practices, as well as new approaches for protection and control.

Individual and aggregate DER dynamics need to be evaluated, in order to determine how these resources could potentially contribute toward supporting local grid reliability. Greater DER deployment, especially renewables at high penetration levels on the distribution system, requires SCE to analyze models with power computer systems, such as using real time power hardware in the loop tests and field demonstrations to make sure there is adequate protection and control of these resources to maintain grid reliability. Moreover, it is important to test these protection strategies and schemes with existing utility assets to help ensure compatibility, in order for safe, reliable and affordable deployment.

The following are commonly discussed impacts and barriers to DER integration and impacts on protection and controls:

a. Electric system safety and reliability,
b. Regulatory and legislative requirements,
c. System limitations,
d. Operating capabilities,
e. Industry standards, and
f. Business case and operating information.

SCE's Potential Demonstration Projects

- Control & Protection for Micogrids & Virtual Power Plants
- Distributed Energy Resources Dynamics Integration Demonstration
- Distributed Energy Resource Protection and Control of Distribution Networks

SCE Project	Barriers Addressed
Control & Protection for Micogrids & Virtual Power Plants	a, b, c, d, f
Distributed Energy Resources Dynamics Integration Demonstration	a, b, c, d, f

Distributed Energy Resources Protection and Control of Distributed Networks	a, b, c, d, f

6.1.3 Demonstrate Grid-Scale Storage Strategies and Technologies

Problem or Opportunity to be Addressed

The Commission's Energy Storage mandate requires SCE to procure and deploy 580 MW of storage capacity on SCE's system. [28] More recently, in response to the Commission's Resolution[58], issued to address electrical reliability risks due to the moratorium on injections into the Aliso Canyon Natural Gas Storage Facility, SCE conducted an Aliso Canyon Energy Storage (ACES) solicitation and awarded Tesla contracts to supply 20 MW of energy storage capacity near the Mira Loma Substation, as well as submitting a utility owned storage application on March 30, 2017.[59] Given the mandate and recent history, SCE will be adding greater amounts of energy storage onto the grid in the near future. Furthermore, energy storage has many potential grid applications and could be possible solutions for integrating renewable resources (wind and solar) at the transmission level, and DERs on the distribution system. Furthermore, energy storage has the potential to provide ancillary services to CAISO, or can be used to improve local reliability of the distribution system by helping to integrate DERs, while mitigating potential grid impacts from these new DERs. SCE is in the process of assessing many of these potential applications, including challenges to reliability, cost-effectiveness and safety. SCE's approach[60] involving a road map process, which includes initial desktop work, battery chemistry testing, systems evaluations, field demonstrations and pilot projects, will continue to be essential to maintaining the safety and reliability of the grid as SCE deploys greater amounts of energy storage.

SCE has experience outside of the EPIC Program evaluating energy storage technologies in the field. Recent examples include the two DOE funded programs, the Tehachapi Wind Energy Storage Project (TSP) and the ISGD. The TSP evaluated energy storage technology for mitigating the transmission level impacts of renewable resources (solar and wind), while providing services to the CAISO market. While, TSP has concluded as a DOE funded project, SCE continues to operate the resource to further understand cost-effectiveness of CAISO services.[61] The ISGD program evaluated customer sited and utility sited energy storage devices to understand distribution grid impacts. The details of these projects were discussed in SCE's EPIC I Investment Plan and noted in SCE's EPIC II Investment Plan.

As more energy storage systems are integrated onto the grid, there is a gap as to whether energy storage benefits (e.g., managing line loading to prevent line overload or duct bank temperature violations, optimizing local voltage, and supporting the integration of renewable resources) can be applied to adjacent circuits and increase operational flexibility by dynamically transferring load.

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[58] E-4791.

[59] A.17-03-XXX.

[60] Set forth in the white paper entitled "Moving Energy Storage from Concept to Reality: Southern California Edison's Approach to Evaluating Energy Storage," published in 2010.

[61] Commission approval via Resolution E-4809.

How the initiative will advance the strategy and overcome barriers

While SCE continues to integrate greater amounts of energy storage on the grid and assesses additional grid applications, EPIC funding is critical to addressing adoption barriers, including safety, cost-effectiveness[62] and identifying deployment opportunities. These demonstrations assess the value, technical performance, and costs of energy storage systems that facilitate local reliability or greater integration of DERs onto the grid. As energy storage system technology matures and new technologies and new battery chemistries emerge, these systems as well as innovative control strategies will need to be evaluated through IOU demonstrations. Data and lessons learned from these demonstrations will also be used to improve industry standards, validate models and facilitate further grid integration.

Laboratory or field simulations may be performed to determine optimum location and siting for reliability or to assess how the energy storage system would perform under various system contingencies (e.g., rapid changes in renewable resource generation levels, loss of a major conventional generation source, or loss of a transmission line). Additionally, control systems and software may be evaluated to provide reliability support to the CAISO or provide local distribution reliability.

The following are commonly discussed drivers for and barriers to the widespread adoption of energy storage system technologies with the potential for enhancing grid management:[63]

a. Electric grid operational needs
b. Regulatory and legislative requirements,
c. Evolving markets
d. Further cost-effective evaluation methods
e. Cost transparency and price signals
f. Developing interconnection process

SCE's Potential Demonstration Project

- Storage-Based Distribution DC Link

The following table lists the potential demonstration project and the drivers/barriers they are intended to address.

SCE Project	Barriers Addressed
Storage-Based Distribution DC Link	a, d, e

6.2 Grid Modernization & Optimization

The grid need to become more flexible and responsive to variable conditions of DERs and the changing energy needs of SCE's customers. To fully integrate these emerging resources and

[62] As raised in the Commission's Energy Storage Framework Staff Proposal in R.10-12-007.
[63] Drivers and barriers were based in part on the Commission Energy Storage Framework Staff Proposal in R.10-12-007.

optimize dispatch, greater situational awareness and control capabilities for operators are needed. The application of computer-based management and control systems (i.e., energy management systems, distribution management systems, etc.), coupled with information from field technologies (i.e., remote terminal units, protective relays, remote distribution switches, etc.), and communications networks (i.e., fiber optic and microwave links, etc.) provides an opportunity to achieve greater grid intelligence on how to integrate increasing amounts of DERs. Enhancements to remote monitoring, protection, control and automation capabilities improve distribution system management.

SCE has vast experience advancing distribution system management and control systems and is an industry leader in both substation and distribution system automation technologies. SCE has helped advance the IEC 61850 substation automation standard, which provides enhanced situational awareness and decision-making capabilities, while being NERC, CIP compliant. Currently, SCE has equipped over 488 of its 900 substations with automation technology -- 284 of its substations have microprocessor-based relays that operate over local area networks, and 104 of substations have remote terminal units and programmable logic controllers. While SCE believes it is an industry leader with its current automation strategies, further demonstration evaluations still need to be performed, in order to fully integrate both distribution and substation automation into one comprehensive and coordinated system for automation.

Real-time monitoring devices, smart meters, sensors and advanced distribution management provide information that can be leveraged to enable more efficient maintenance and increase field crew safety. These monitoring devices can be leveraged to better understand incipient asset failure, potential impacts to the grid from natural hazards and climate change induced extreme weather phenomena, as well as reducing the risk of crews from customer hazards.

The Grid Modernization and Optimization funding category's goal is to further advance grid capabilities to meet emerging DER and the changing energy needs of SCE's customers. New grid technologies that leverage monitoring and control devices, as well as information from field devices enables grid capabilities to further integrate and optimize DERs.

Priority Initiatives

Within the Grid Modernization and Optimization funding category, the administrators have jointly developed the following priority initiatives:

- Demonstrate strategies and technologies for optimizing assets;
- Preparing for emerging technologies; and
- Design and demonstrate grid planning and operations of the future.

These initiatives have been reviewed and confirmed with EPRI subject matter experts as having a high priority. The investments considered in this section will map to the following elements of the electricity system value chain: Grid Operations/Market Design, Transmission, and Distribution.

6.2.1 Demonstrate Strategies and Technologies for Optimizing Assets

Problem or Opportunity to be Addressed

This initiative's objective is to enable greater grid intelligence by using advanced computing and leveraging field technologies, such as monitoring and measurement systems. Data is available from a range of these technologies including, sensors, smart meters, supervisory control and data acquisition (SCADA). By using more precise grid information it enables further grid capabilities. For example, SCE proposes to demonstrate a modern substation automation system that meets the high availability needed for critical substations. The demonstration will evaluate advanced communications and measurement functionality, while meeting NERC CIP compliance and IT cybersecurity requirements.

Field data and advanced computing can fill data gaps within SCE's geographical/asset information systems. Individual circuit primary impedance information at the distribution level is currently not fully available and secondary impedance information is not available at all. Lack of accuracy associated with primary distribution line impedances limits SCE's ability to conduct effective and accurate load flow/ state estimation studies to support foundational distribution management functions.

Information from many different field technologies can also be leveraged in concert, aggregating multiple data sources into a single application to improve the accuracy of customer outage and field restoration data. This application would provide alerts on incipient asset failures and potential customer energy theft to further optimize operations. These alerts would improve capital efficiency and support condition-based maintenance and asset replacement.

Additionally, SCE currently uses Reliability Analyzer and Outage Explorer applications, which enables users to perform analysis of historical outages and field restorations. However, these existing tools have key limitations that are largely related to data quality and data access issues. Additional grid awareness can be enabled by reducing the time lags, lack of granularity and consistency in the collection and categorization of outage data.

How the initiative will advance the strategy and overcome barriers

This initiative advances technology solutions to optimize existing assets and overcomes barriers by enhancing grid capabilities. One potential demonstration, SA-3 proposes to build on the accomplishments of the following three past projects:

- SA-3 Phase II MacArthur Pilot (part of the Irvine Smart Grid Demonstration),
- SA-3 Phase 3 Lab Demonstration (EPIC 1), and
- System Intelligence and situational awareness (EPIC 2).

SA-3 is a modern substation design that is flexible and can integrate DERs by providing enhanced situational awareness and decision support capabilities. SCE proposes to field demonstrate a modern substation using SA-3, with enhanced communications and measurement and control capabilities. Additionally, SA-3 meets NERC, CIP compliance and internal IT requirements. If the field demonstrations are successful, SA-3 will become the new transmission substation standard.

In order to optimize dispatch of DERs on the distribution grid, it is critical that SCE establish primary and secondary line impedance information for distribution circuits by examining field data. The availability of complete primary line impedance information can result in accurate load flow / distribution state estimation results and greater real time management of the distribution grid.

This initiative also evaluates different methods to optimize field data to improve T&D and customer maintenance. Pattern recognition technologies will be evaluated that are capable of using information from field technologies to provide internal alarms on asset failure and potentially customer theft. An additional demonstration proposes to improve and optimize existing reliability dashboard tools. The objectives are to integrate additional internal data sets, (e.g., power up/down events and associated time stamps; minimum, maximum and average voltage, latitude, longitude of affected structures); as well as evaluate and possibly integrate outage algorithms with the reliability dashboard. This increased and enhanced data integration will increase speed of outage metrics or forecasts. This information would ultimately be displayed in an automated and easy to access platform.

This initiative aligns with NERC CIP, the Commission's safety efforts, and supports internal corporate grid modernization efforts.

The following are commonly discussed drivers for and barriers to the widespread adoption of technologies with the potential for enhancing the utilization of existing utility assets:

a. Electric system safety and reliability,
b. Regulatory and legislative requirements,
c. System limitations,
d. Operating capabilities,
e. Industry standards, and
f. Business case and operating information.

<u>SCE's Potential Demonstration Projects</u>

- Reliability Dashboard Tools
- Advanced Data Analytics Technologies
- Substation Automation-3, Field Demonstrations
- Distribution Primary & Secondary Line Impedance

The following table lists the potential demonstration projects and the drivers/barriers they are intended to address.

SCE Project	Barriers Addressed
Reliability Dashboard Tools	a, c, d, f
Advanced Data Analytics Technologies	a, c, d, f
Substation Automation-3, Field Demonstrations	a, b, c, d, e, f
Distribution Primary & Secondary Line Impedance	a, b, c, d, f

6.2.2 Prepare for Emerging Technologies

<u>Problem or Opportunity to be Addressed</u>

To fully integrate and optimize a range of DERs, such as solar PV, energy storage systems, and electric vehicles, the distribution systems requires greater flexibility and responsiveness. This initiative's objective is to demonstrate emerging technologies and innovative grid strategies to enhance grid management capabilities.

To provide greater responsiveness to DERs, system operators need greater situation awareness to manage the grid and provide distribution system operator functions. SCE plans to build on the learnings of the Next Generation Distribution Automation II project from its EPIC II portfolio. The Next Generation Distribution Automation project integrates advanced control algorithms, modern wireless communication systems, and the latest advancements in distribution sensors and equipment in order to manage the overall system performance. This potential demonstration proposes to integrate new Field Area Network wireless radio to automation devices and continue to improve grid control functionalities.

As increasing amounts of DERs are integrated onto the distribution grid and displace traditional generation resources, the distribution system needs greater management capabilities, such as distribution optimal power flow. Today, optimal power flow is applied to the transmission grid to optimize large central inertia driven generation resources. However in the future, the grid will use greater amounts of DERs, which are often small, dispersed and non-inertia driven resources.

<u>How the initiative will advance the strategy and overcome barriers</u>

The grid needs to become more responsive and have the ability to integrate a range of emerging DERs. Integration of DERs can be challenging, because the load is variable and cannot be scheduled. To fully integrate and optimize the dispatch of DERs, grid operators need greater situational awareness, management and controls. Technologies, such as state-of-the-art sensing devices, intelligent controllers, protection devices, behind-the-meter devices, and wireless communications when integrated together as a complete system can enhance grid capabilities to integrate and optimize DERs and maintain grid reliability.

This initiative aligns with the Commission's DRP proceeding, complements internal grid modernization efforts and supports SCE's future capital deferral framework. The following are commonly discussed drivers for and barriers to the widespread adoption of emerging utility system technologies:

a. Electric system safety and reliability,
b. Regulatory and legislative requirements,
c. System limitations,
d. Operating capabilities,
e. Industry standards, and
f. Business case and operating information.

SCE's Potential Demonstration Projects

- Next Generation Distribution Automation, Phase III
- Distribution Optimal Power Flow

The following table lists the potential demonstration projects and the drivers/barriers they are intended to address.

SCE Project	Barriers Addressed
Next Generation Distribution Automation, Phase III	a, b, c, d, e, f
Distribution Optimal Power Flow	a, b, c, d

6.2.3 Design and Demonstrate Grid Planning and Operations of the Future

Problem or Opportunity to be Addressed

This initiative's objective is to automatically monitor, assess and control the grid to adapt to changing conditions to meet customer reliability and power quality requirements. Changing conditions from DERs are further compounded by climate change, which causes weather variability. Climate change could potentially affect the availability of renewable resources, such hydro and wind and cause extreme weather events and natural hazards.

Extreme weather events and natural hazards can cause significant disruptions to the grid. Utilities are critical infrastructure and after these weather events need effective restoration strategies to help the public with further recovery. These restoration strategies can be improved and enhanced by understanding the impacts of these weather events on the grid. Current practice is done in piecemeal approaches with different groups responsible for a particular asset or operation developing their own damage models and mitigation criteria. Therefore holistic restoration tools are needed to help inform operational groups of the threat's size and how to best approach restoration.

Growth in DERs, such as distributed solar and energy storage installations, as well as electric vehicle adoption, requires increasing the flexibility of distribution system designs and configurations. Improving and enhancing distribution system designs and configurations has the potential to improve integrating and siting of DERs, while deferring infrastructure upgrades.

Customer DERs increase the complexity of the working environment for field crews working on circuits. Safety hazards, such as an unexpected back-feed could occur when a faulty inverter switch causes power from a customer's PV, battery storage and/or electric vehicle to flow onto the de-energized circuit. Technology solutions such as using a mobile application that enables crews to check meters or key assets in the field with their I-phones or Tough Book computers prior to performing work could provide potential solutions.

How the initiative will advance the strategy and overcome barriers

Increasing the flexibility of distribution circuit designs and configurations helps integrate increasing amounts of DERs, as well as helps the grid respond to climate change induced weather variability.

SCE proposes a new and innovative approach for integrating emerging and mature tools to comprehensively assess natural hazards that can impact the grid. This demonstration will use a centralized data architecture that integrates various types of SCE assets from non-electric, generation, grid infrastructure and threat modeling to identify vulnerabilities across the different types of infrastructure. Additionally, the centralized data architecture would assess the different types of damage, loss, restoration, and mitigation models to help strategic decision making before, after and during a significant natural hazard.

Advanced technology solutions have the potential to reduce field crews from customer hazards. Field technologies such as field sensors, smart meters, etc. are also capable of providing data sources to potentially provide real/near real time status of faulty equipment. These applications would automate decision-making to improve efficiency of crew operations and safety.

This initiative aligns with the Commission's Fire Safety Rulemaking,[64] including the Fire Threat Map proceeding and general safety efforts, as well as supports internal grid planning. The following are commonly discussed drivers for and barriers to the widespread adoption of future grid operations and planning technologies:

a. Electric system safety and reliability,
b. Regulatory and legislative requirements,
c. System limitations,
d. Operating capabilities,
e. Industry standards, and
f. Business case and operating information.

<u>SCE's Potential Demonstration Projects</u>

- Advanced Technology for Field Safety
- Advanced Comprehensive Hazards Tool
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The following table lists the potential demonstration projects and the drivers/barriers they are intended to address.

SCE Project	Barriers Addressed
Advanced Technology for Field Safety	a, b, c, d, f
Advanced Comprehensive Hazards Tool	a, b, c, d, f

6.3 Customer-Focused Products & Services Enablement and Integration

California's environmental and clean energy goals are driving changes in how customers consume and manage electricity. To achieve California's GHG emission reductions, transportation needs to become electrified and customers need to dynamically manage and consume electricity. In the

[64] Rulemaking (R.)15-05-006.

future, customers may even become more active participants in providing local reliability, through existing programs such as demand response.

SCE has extensive history evaluating, demonstrating and facilitating the safe, reliable and efficient connection of transportation onto the grid. Electric vehicles are still an emerging area and disparate vehicle technology systems need a unified management system. Additional demonstrations using VGI are needed, in order to achieve more meaningful participation from customers. Moreover, industrial customers such as the Los Angeles Airport and the Port of Long Beach are just beginning to electrify operations. These customers will need further equipment tests, especially in the heavy-duty vehicle segment. Moreover, additional demonstrations will be needed to help manage local reliability of the distribution grid as these industries electrify.

Smart meters help enable customers to actively participate in energy management. These smart meters enable the utility to measure energy usage with greater granularity. The information that smart meters provide enables customers to more effective and efficiently manage and consume energy. This customer energy usage information can be used by customers to manage their energy costs more closely or by third parties to design products that more closely matches customer needs. This information, also allows customers or third-parties (with customer's consent) the opportunity for additional benefits by allowing participation in demand response programs. As customers adopt electric vehicles and need to charge at home, managing their overall electricity consumption through smart meters, becomes more important.

Priority Initiatives

Recognizing California's transportation electrification and GHG goals, the priority initiatives of this category supports technology solutions and strategies to further grid integration of customer DERs and electric vehicles. The IOUs worked to collaboratively create the following priority initiatives to enable and integrate customer-focused products and services:

- Leverage the Smart Meter Platform to Drive Customer Service Excellence;
- Integrate Demand Side Management to Optimize the Grid; and
- Respond to Emerge Grid Integration Issues.

These initiatives are considered high potential, because they were reviewed and confirmed with EPRI subject matter experts to be high priorities that could help to fill existing industry gaps. The investments contemplated in this section will map to the following elements of the electricity value chain: Grid Operations/Market Design, Transmission, Distribution and Demand Side Management.

6.3.1 Leverage the Smart Meter Platform to Drive Customer Service Excellence

Problem or Opportunity to be Addressed

This initiative's primary focus is to support customers in becoming more active participant in managing and consuming electricity, in order to provide greater customers choice. Additionally, this initiative focuses on empowering customers to become clean energy participants in helping California meet its environmental goals to reduce GHG emissions and improve local air quality. As customers adopt electric vehicles, dynamic management of energy consumption, becomes increasingly important to minimize costs from high prices and maximize additional opportunities for benefits, such as participating in demand response programs. SCE will continue to demonstrate new technologies, as well as innovative and interoperable strategies to help enable customers to become more active clean energy participants. Furthermore, SCE will also support standards to help ensure safety and promote wide-scale adoption.

A potential project opportunity will expand on the Beyond the Meter Device Communications project launched in the EPIC I plan. The initial EPIC I project demonstrated Rule 21-defined interfaces with customer-owned distributed generation, including PV, energy storage and EV charging. Phase II seeks to leverage lessons learned from the initial lab demonstration's results. Phase II proposes a field deployment evaluation of integrating and managing small commercial customer-owned DER systems with SCE's Distributed Energy Management System (DERMS), in order to assess real world conditions.

<u>How the initiative will advance the strategy and overcome barriers</u>

This initiative helps to remove barriers to support customers' active participation in energy management. Additionally this initiative supports California meet environmental and clean energy goals, by helping safely integrate electric vehicles. As customers adopt electric vehicles and transportation in general electrifies, SCE needs to be able to monitor and manage these new electric loads in order to reduce negative impacts to the grid, such as preventing transformer overloading, or provide benefits, such as extra load during times of over-generation. However, since vehicles are designed for transportation, managing their variable electricity consumption can be difficult, especially in scenarios where charging durations are limited. While there is little leeway for delaying, curtailing or reducing charging, (i.e., high powered DC fast charging), DERs and in particular energy storage systems could offer potential solutions to these grid challenges.

The following are drivers for and barriers to leveraging the smart meter platform to drive customer service excellence:

a. Linkages between smart meters and field technologies to integrate DERs
b. Regulatory and legislative requirements,
c. System limitations,
d. Operating capabilities, and
e. Business case and operating information.

<u>SCE's Potential Demonstration Project</u>

- Beyond The Meter, Phase II

The following table lists a potential demonstration project and the drivers/barriers they are intended to address.

SCE Project	Barriers Addressed
Beyond The Meter, Phase II	a, c, d, e

6.3.2 Integrate Demand Side Management to Optimize the Grid

Problem or Opportunity to be Addressed

This initiative's objective is to help support customers actively managing and consuming energy consumption through demand side management. As transportation electrifies it provides customers with potential demand side management opportunities. Electric vehicles and electric vehicle charging stations, may have potential to possibly integrate demand-side management, in particular demand response to further optimize the grid.

One potential project opportunity in this initiative proposes to build on lessons learned from past VGI pilots. In these past VGI pilots, the focus was on demand response used in coordination with AC Level 2 Charging (V1G). Many automakers are now also evaluating using the vehicle battery to discharge to the grid (V2) or provide related distribution services (e.g., frequency response), and this project seeks to help further support these services. In order to support the goal of achieving V2G, there are a number of issues that need to be resolved. SCE intends to work with automakers and EVSE manufacturers to better understand interconnection issues. These interconnection issues include permitting discharge from inverters that conform to Society of Automotive Engineers (SAE) J3072: Interconnection Requirements for Onboard, Utility-Interactive Inverter Systems, rather than standards for allowing/disallowing discharge at multiple locations. EVs connect to the grid at multiple locations,[65] and a better understanding is needed on how existing grid codes (e.g., Rule 21) apply to EVs. SCE will also work to integrate these resources into back office applications (i.e., DERMS), in order to both support new types of interconnection and use these resources for grid support purposes, such as voltage and frequency management or the integration of other renewable resources. Evaluation will include:

- Related standards will be conducted, including SCE's The Institute of IEEE 2030.5 communications interfaces,
- EVSEs, which must provide many of the safety functions as existing solar grid-tied inverters (e.g., anti-islanding, voltage and frequency support, etc.), and
- The power line communications necessary between the EVSE and the EV (e.g., SAE 2847/3).

How the initiative will advance the strategy and overcome barriers

This initiative removes barriers toward customers more actively managing and consuming energy by directly supporting V2G and helps to further integrate DERs onto the grid. As customers adopt electric vehicles in greater amounts, it will become increasingly important to properly incentivize and coordinate the use of charging and discharging to reduce negative impacts to the distribution grid to prevent transformer overloading by staggering vehicle charging. Furthermore, this initiative looks to evaluate additional grid applications for electric vehicles, given these resources battery storage and flexibility potential.

[65] UL Standard 1741.

This initiative supports the Commission and SCE's transportation electrification efforts.[66] Furthermore, this initiative supports the Commission's requirements for VGI, aligns with the Rule 21 Smart Inverter Working Group, as well as SCE's corporate Grid Modernization efforts.

The following are drivers for and barriers to integrating demand-side management to optimize the grid:

a. Linkages between DERs to optimize grid operations,
b. Regulatory and legislative requirements,
c. System limitations,
d. Operating capabilities,
e. Business case and operating information.

SCE's Potential Demonstration Project

- Vehicle-to-Grid Integration Using On-Board Inverter

The following table lists a potential demonstration project and the drivers/barriers they are intended to address.

SCE Project	Barriers Addressed
Vehicle-to-grid Integration Using On-Board Inverter	a, b, c, d, e

6.3.3 Respond to Emerging Grid Integration Issues

Problem or Opportunity to be Addressed

As electric vehicle growth continues to accelerate, charging of these vehicles is changing customer energy needs. Automakers of electric vehicles are continually increasing the size of batteries and allowing for higher charging capacity. Fast charging, especially at high penetrations can be challenging for utility planning and grid management, because the energy consumption cannot be planned or scheduled. This initiative aims to demonstrate possible solutions for these challenges that fast charging for electric vehicles present to utility planning and grid management.

One potential solution is to integrate energy storage with PEV fast charging stations that can be used to control the system impact of fast charging. This allows more vehicles to charge, and also enables the station to respond to grid needs as DERs when not in use to charge vehicles. Combining fast charging systems with energy storage meets the needs of SCE's customers, while also potentially supporting grid reliability. Fast charging systems, integrated with energy storage and proper communication and controls, could potentially be used by a distribution system operator to manage the grid. Energy storage systems, coupled with modern electronics, inverters, communications, and controls, these systems could integrate with SCE's Energy Management System and SCADA to reduce peak demand and manage voltage. A potential solution for providing these needed communication and controls for load management is a smart inverter energy management circuit

[66] A.17-01-021.

breaker. Additionally, energy storage may be used for ancillary services to charge or discharge instantly to provide frequency regulation, voltage control, and reserve energy that can be used by the grid to help integrate renewable resources. Energy storage could also be used to provide distribution grid support, which would supply power and energy capacity to defer or eliminate the need to upgrade aging or inadequate gird infrastructure.

How the initiative will advance the strategy and overcome barriers

This initiative helps remove communication and presents new technology solutions to help empower customers to become more active participants in their energy management and consumption. Moreover, this initiative helps address the changing needs of electric vehicle customers and the grid challenges of electric vehicle fast charging systems. This initiative demonstrates potential grid solutions to enable these fast-charging systems to become grid assets used by distribution system operators for local grid reliability. Furthermore, this initiative supports California's environmental and clean energy policy goals, as well as complements the Commission's transportation electrification efforts, including SCE's recently filed transportation electrification portfolio.

This initiative supports the Commission's transportation electrification efforts and complements SCE's proposed transportation electrification portfolio. Additionally, the initiative also supports internal grid modernization efforts.

The following are drivers for and barriers to responding to emerging grid integration issues:

a. Linkages between DERs to optimize grid operations,
b. Regulatory and legislative requirements,
c. System limitations,
d. Operating capabilities, and
e. Business case and operating information.

SCE's Potential Demonstration Projects

- Distributed PEV Charging Resources

The following table lists potential demonstration projects and the drivers/barriers they are intended to address.

SCE Project	Barriers Addressed
Distributed PEV Charging Resources	a, b, c, d, e

6.4 Cross Cutting/Foundational Strategies and Technologies

To achieve each of the elements of SCE's smart grid vision and the goals previously discussed in the investment plan's initiatives (Sections 6.1-6.3), an innovative systems architecture will be needed. This systems architecture will need to accommodate many disparate resources, including smart meters, renewable resources, DERs, energy storage systems, network management systems, micro-grid applications and electric vehicles. In addition to linking and communicating these devices, the system architecture will need to be flexible and agile to accommodate:

- increased data analytics;
- expanded data management needs;
- meet unanticipated energy consumption from intermittent resources; and
- enable new and emerging grid technologies.

This approach for coordinating, connecting and communicating these distributed resources on the grid, helps manage functional quality and scalability for system performance.

As the grid increases automation, data analytics and computing allow greater integration of DERs, however these systems must be kept safe from cyber threats. Safety and security of the grid depends on robust cybersecurity and the frequency and sophistication of cyber-attacks are continually increasing. Utilities need to further protect industrial control systems (ICS) to keep the grid secure and the public safe.

SCE has experience successfully demonstrating cybersecurity projects, both outside of the EPIC, such as the CES-21 Program and in past EPIC Investment Plans, such as the Cyber-Intrusion Auto-Response and Policy Management System (CAPMS).[67] The objective of CAPMS was to demonstrate the ability of SCE's common cyber security services to support cyber-intrusion auto-response and policy management for distribution and critical infrastructure protection. Specifically, this system demonstrated the effectiveness of cyber security software and system configurations to automatically detect a cyber-attack and take automated action to protect the electric system through the enforcement of advanced cybersecurity devices. Currently, SCE is participating in a jointly administrated cybersecurity project, outside of the EPIC, called the CES-21 Program. While the CES-21 Program has not yet completed, many learnings from this research collaboration have already been achieved. These achievements in the CES-21 program are can be leveraged to demonstrate further improvements toward machine-to-machine automated threat response for ICS.

Priority Initiatives

California's IOUs worked collaboratively to develop the following initiatives that comprise the Cross Cutting / Foundational Strategies and Technologies program category, see below:

- Systems Architecture; and
- Cybersecurity.

These elements were reviewed and confirmed with EPRI's subject matter experts and this section's potential investments will map to the following elements of the electricity value chain: Grid Operations/Market Design, Transmission and Distribution.

6.4.1 Systems Architecture

Problem or Opportunity to be Addressed

The grid needs to become more flexible and adaptable to changing conditions. SCE's ISGD provided many learnings on how to respond to these changing grid conditions using DERs, including

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[67] CAPMS was a part of SCE's second EPIC Investment Plan, (A.14-05-005).

distributed PV and energy storage. This initiative looks to build on this project and aims to provide further grid coordination. As new resources are added to the grid, such as renewables, DERs, energy storage systems, and electric vehicles, it becomes increasing important to coordinate these resources by leveraging advances in telecommunications, monitoring and performance measurement, and data analytics. As the grid becomes more distributed and increases the complexity of the distribution system's operating environment, linking and being able to communicate with these disparate systems is crucial, in order to safely and reliably integrate these resources.

<u>How the initiative will advance the strategy and overcome barriers</u>

This initiative directly supports the Commission's DRP, Demonstration D and SCE's PRP. In order to coordinate and communicate many different disparate resources, grid operators need a distributed control architecture to maintain grid reliability. SCE recognizes the mix of electric resources is very impactful to the Communities it serves. One potential project is to demonstrate a Smart City. This project would build on the learnings of ISGD and the IGP. This potential demonstration would leverage ongoing distributed control architecture and improved planning processes that includes increased understanding of customer technology adoption and increased integration with City planning and DER permitting processes. The goal is to provide more efficient buildout of infrastructure, streamline joint processes, such as permitting and interconnections for Solar PV and energy storage systems. The demonstrations would also enable locally sponsored de-carbonization initiatives, such as a potential net-zero emissions for the 2024 Summer Olympics, *if* Los Angeles is selected by the International Olympic Commission as the Game's host.

The following are drivers for and barriers to using existing and new systems architecture to integrate DERs, better leverage existing assets and implement strategies to benefit the safe, reliable and affordable operation of SCE's electricity system:

a. Grid reliability due to high penetrations of DERs
b. Regulatory and legislative requirements/recommendations,
c. Advanced systems architecture to integrate DERs
d. Advanced communications designs
e. Smart inverter specifications and standards, and
f. Emerging energy technologies impact on the distribution network.

<u>SCE's Potential Demonstration Projects</u>

- Smart City
- Integrated Grid Project, Phase III

The following table lists the potential demonstration projects and the drivers/barriers they are intended to address.

SCE Project	Barriers Addressed
Smart City	a, b, c, d, f
Integrated Grid Project, Phase III	a, b, c, d, e, f

6.4.2 Cybersecurity

Problem or Opportunity to be Addressed

Safety is a top priority for the IOUs, CEC and the Commission. As the grid advances and uses increased computing to automate, keeping it secure from cyber threats is of vital importance. The energy sector is a target because of the assets they control and the value they represent, therefore the range and sophistication of Cyber-attacks continues to increase. During this past year there were prominent cyberattacks against electric industry ICS owners and operators, including attacks against the Ukrainian power grid and a virus/malware attack at the Gundremingen nuclear facility in Germany. These attacks are significant because they targeted the electric industry's ICS owners and operators and represent the diversification of cyberattacks. Given these recent cyberattacks, as well as the increased frequency and sophistication of these threats, it is critical to continue improving machine-to-machine threat capabilities for ICS systems and increase coordination and knowledge sharing between utilities and government partners.

How the initiative will advance the strategy and overcome barriers

As the frequency and sophistication of cyber-attacks increase, it is critical for us to be proactive to quickly identify, respond and mitigate threats to Industrial Control Systems. This initiative overcomes current manual communications barriers by automating information sharing and coordination of cyber threats and responses among utilities and government partners. Furthermore, the initiative helps enable SCE to better understand the risks to reliability from cyber threats.

One potential demonstration is Cybersecurity for ICS, which would be a joint project by all the EPIC Administrators and would build on the successes of the CES-21 Program. The CES-21 Program is a joint research collaborative project between PG&E, SCE, SDG&E and Lawrence Livermore National Lab (LLNL), improving machine-to-machine automated threat response. This project would further improve machine-to-machine automated threat response by demonstrating adaptive controls and dynamic zoning for ICS and enhancing visual interfaces of the simulation engine. The project would leverage the CES-21 Program's machine-level threat intelligence, physical test bed environment, as well as the simulation engine to expand the IOUs cyber threat response capabilities in order to take the concept of machine-language threat intelligence and advances it to enable dynamic response in the face of an attack. 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. The demonstration of adaptive control and dynamic zoning in a physical lab environment can also be complemented by early modeling using the simulation environment. This will be particularly helpful in understanding grid impact of deployed cyber security controls at scale. The project would be able to demonstrate enhanced functionality of the simulation engine, making it more accessible, usable, and valuable to end users by having a visual interface, with the ability to tweak model characteristics in real time to evaluate complex scenarios, which would otherwise require significant time and modeling language fluency to develop. Additionally, this project would leverage the CES-21 Program's simulation engine used to evaluate complex scenarios, which require significant time and modeling language fluency to develop. The project would demonstrate enhanced functionality of the simulation engine, making it more accessible, usable, and valuable to end users by having a visual interface, with the ability to tweak model characteristics in real time.

This initiative supports SCE's existing cybersecurity efforts, builds on the learnings of the CES-21 Program and complements the Commission's recently opened physical security rulemaking. The following are drivers for and barriers to cybersecurity to benefit the safe, reliable and affordable operation of SCE's electricity system:

a. Electric system safety, security and reliability,
b. Regulatory and legislative requirements/recommendations,
c. System limitations,
d. Operating capabilities,
e. Knowledge sharing between utilities and government partners,
f. Industry standards, and
g. Business case and operating information.

<u>SCE's Potential Demonstration Projects</u>

- Distributed Cyber Threat Collaboration
- Energy System Posturing
- Cybersecurity for Industrial Control Systems

The following table lists the potential demonstration projects and the drivers/barriers they are intended to address.

SCE Project	Barriers Addressed
Distributed Cyber Threat Collaboration	a, b, c, e, f
Energy System Posturing	a, b, c, d, e, f
Cybersecurity for Industrial Control Systems	a, b, c, d, e, f, g

7. Program Administration

The EPIC Administrators regularly meet on a bi-weekly basis via meetings and conference calls to help ensure the investment plans are well coordinated and avoid duplication. The IOUs have agreed to continue using the Joint IOU Framework (Section 6) for program administration, as it has for the previous EPIC I and EPIC II investment plans. The investment planning process was transparent and to maximize stakeholder involvement, the EPIC Administrators held a joint webinar, as well as three joint stakeholder workshops. SCE has directly incorporated feedback from these stakeholder engagements into its investment plan.

The EPIC Administrators will continue to meet and engage to coordinate, leverage funding, identify areas of collaboration and avoid duplication of efforts. Additionally, the EPIC Administrators joint sponsor an annual symposium that provides the Commission, Legislature and stakeholders a public forum to learn about key results from highlighted EPIC projects from the EPIC I and EPIC II investment plans.

7.1 Program Coordination

As mentioned above, SCE will continue to regularly meet with the other Administrators. These meetings provide an opportunity to learn about completed projects, discuss programmatic issues, avoid duplication and identify potential areas of collaboration.

As the EPIC Program matures, the Administrators have increasingly coordinated and collaborated not only on the EPIC investment planning process and implementation of plans, but also potential projects. These coordination and collaboration efforts are shown by all of the Administrators engaging EPRI on industry gaps in technology demonstrations and deployments and possible areas of duplication. Additionally, this coordination and collaboration is further evidenced by the Administrators proposing a joint cyber security technology demonstration project, Cybersecurity for ICS. This project would be jointly managed by all four Administrators and would build on the accomplishments of the CES-21 Program, 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 (see preceding section, 6.4.2 Cybersecurity for more details).

7.2 Contracting

SCE proposes to continue to use pay-for-performance contracts for this Investment Plan to fund its technology demonstration and deployment projects. SCE has long standing, established policies for pay-for-performance procurement policies and procedures. SCE plans to comply with the Commission's requirements for competitive bidding,[68] but in limited instances, SCE will continue to use non-competitive awards, such as when:

- Material or services is needed and only one reliable source is available and no other supplier will satisfy utility requirements;
- Specialized knowledge, skill, experience or expertise is needed and only one supplier is determined to have this needed skill set;
- Bidding is cost prohibitive in comparison to the cost of materials or services needed;
- An opportunity exists to develop and use Diverse Business Enterprise suppliers;
- The procurement provides special discounts, rates, or terms and conditions (i.e., cost share) that are not available under normal competitive conditions; or
- Equipment, materials, or services are obtained for trial testing, evaluation or experimental work.

SCE will continue to reflect these limited instances of non-competitive awards in SCE's Annual Report, per the Commission's requirements. [69]

7.3 Program Flexibility

In approving the EPIC Administrator's EPIC II Applications, the Commission directives for funding research institutes and proposing new projects has limited the EPIC Administrator's program flexibility. These limitations have hampered Administrator abilities to effectively and efficiently manage the EPIC Portfolio.

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[68] D.12-05-037, at Findings of Fact (FoF) 18.

[69] D.13-11-025, at OP 18.

The Commission's EPIC II Approval decision allows funding of research institutes, but only allows demonstration and deployment activities. The Commission's strict definition of permissible activities has greatly limited SCE's ability to participate and fund in research collaborative opportunities. EPRI pools resources with utilities across the US to advance technological developments for the grid. However, due to the Commission's strict requirements, the Utilities are barred from all of EPRI's Programs and only able to work with EPRI, *if* a program can be specially customized for the Utility EPIC Administrators. Limiting participation to customized programs, severely limits industry collaborative opportunities

In its EPIC II approval the Commission also clarified that Administrators do not have the authority to initiate new projects from previously approved Investment Plans.[70] The Commission subsequently established a Tier 3 advice letter process for EPIC Administrators to propose new projects (The Commission established separate rules for the CEC, requiring a signed formal business letter).[71]

Per the Commission's requirements, the Utility Administrators are required to file a Tier 3 advice letter to gain approval of new projects. In establishing this process, the Commission would provide expedited review in order to allow portfolio flexibility and quickly react to cost-share opportunities. On February, 7, 2017, PG&E submitted a Tier 3 advice letter[72] requesting approval of New EPIC Projects between Triennial EPIC Applications. Prior to filing this advice letter, PG&E checked to make sure that there was no duplication among the EPIC Administrators. Despite broad support from stakeholders, a party protested the advice letter. The extended period to respond to protests and incorporate protest responses into a draft resolution diminishes the possibility of an expedited review and approval.

SCE supports the opportunity for all stakeholders to provide input on proposed new projects, however to maximize the Program's administration, the EPIC portfolio needs to be flexible and responsive to emerging technologies and policies. The Administrators need program flexibility to:

- Make sure the limited EPIC funding available is being used for demonstrations and deployments that use the latest technology solutions and strategies;
- Use opportunities as they arise to utilize technologies and/or strategies to further support California environmental and energy policy goals, as well as Commission proceedings; and
- Address the fact that federal cost-share opportunities often have a short timeline to submit proposals.

The Tier 3 advice letter process is an inadequate mechanism for providing EPIC Administrator's needed program flexibility. While the current process does not completely eliminate opportunities to leverage funding from outside sources, it greatly diminishes the ability to respond to these opportunities.

SCE recommends revisiting the issues of research institute funding and the process for new projects. The Commission's directives and guidance in D.15-02-040 on these issues was well intentioned, but has caused the program to become out of alignment with its guiding principle to provide ratepayer benefits. Due to current EPIC Program restrictions, SCE is not proposing any demonstrations with EPRI. Severely limiting EPRI's involvement in the Utilities EPIC Portfolio's, is detrimental to

[70] D.15-04-020, p. 45 and at FoF 11 p. 60.
[71] D.15-09-005, at OP 1 and 3.
[72] PG&E Advice 5015-E.

advancing grid technology solutions and undermines the Program's guiding principle to provide ratepayer benefits.

The current process for proposing new projects has proven to be too lengthy to be adequately responsive to meeting the needs of the EPIC Administrators. The Tier 3 advice letter process needs to be modified, in order to provide needed program flexibility to maximize ratepayer benefits. SCE recommends a Tier 2 advice letter process for approving new projects. The Tier 2 advice letter process will provide transparency of these new projects for interested stakeholders, while providing Commission staff the discretion to expedite review and approval.

7.4 Project Reporting and Information Dissemination

SCE submits an Annual Report documenting its EPIC activities from the previous calendar year for both the EPIC I and EPIC II Investment Plans, per the Commission's EPIC reporting requirements,[73] on February 28.

As SCE's EPIC Portfolio matures and projects conclude, SCE prepares a project closeout report and submits these closeout reports as part of its EPIC Annual Report. The report complies with the Commission's reporting requirements and includes, a description of the issue or problem the project addresses, the approach and analysis, key findings and recommendations for subsequent actions. Furthermore, the IOUs regularly meet to discuss these completed projects to leverage lessons learned, broaden understanding and avoid duplication.

As SCE demonstrates advanced technology and new, innovative grid strategies to improve grid operations, SCE will continue to publish papers, share project results and make presentations to a variety of regulatory, academic, industry and standards organizations, including: DOE, EPRI, IEEE, National Institute of Standards and Technology (NIST), Lawrence Berkeley National Lab (LBNL) and LLNL, among others. This industry dissemination of information is important to increase both technology and standards adoption.

7.5 Metrics

SCE will continue to use the metrics established in D.13-11-025, which were adopted by the Commission as a supplement to each Investment Plan.[74] These metric areas will help to evaluate the progress and overall success of SCE's Investment Plan and includes:

- Potential energy and cost savings;
- Job Creation;
- Economic Benefits;
- Environmental Benefits;
- Safety, Power Quality and Reliability;
- Other Metrics (to be developed based on specific projects through ongoing administrator coordination and development of competitive solicitations);
- Identification of barriers or issues resolved that prevented widespread deployment of technology or strategy;
- Effectiveness of information dissemination;

[73] D.13-11-025, at OPs 14, 22-23, Attachments 5-6.
[74] D.13-11-025, at OP 26, Attachment 4.

- Adoption of EPIC technology, strategy, and research data/results by others; and
- Reduced ratepayer projects through external funding or contributions for EPIC-funded research on technologies or strategies.

SCE will continue to comply with the Commission's directives[75] to determine applicable metrics on a project-by-project basis to be measured and/or evaluated and to establish a measurement plan to evaluate the effectiveness of the planned area of investment. Moreover, SCE will continue to identify any additional applicable metrics to further improve evaluation of its EPIC Portfolio.

7.6 Allocation of Programmatic Funding to the CEC

The Commission's decision[76] approving the EPIC II Investment Plans, established requirements for the IOUs to remit the CEC's allocated administrative budget. Consistent with this Commission decision, SCE remits administrative payments in advance of the quarter on the first business day of that quarter.[77]

For the CEC's allocated programmatic budget, once funding is approved at a CEC business meeting and is legally encumbered consistent with Commission requirements,[78] SCE receives a business letter from the CEC requesting remittance of funding and SCE remits payment. [79]

8. State Policy Direction for IOU-Administered RD&D & Smart Grid Programs

SCE's investment plan is required by the Commission to further the provisions and objectives of Public Utilities Code Sections 740.1 and 8360. The Joint-IOU Framework continues to apply to the statutory principles in these respective Code Sections. Furthermore, SCE's programmatic administration of its proposed EPIC III Portfolio intends to continue to fully comply with these Code Sections.

8.1 Public Utilities Code Section 740.1

The evaluation of research, development and demonstration projects proposed by electrical and gas corporations, Public Utilities Code (PUC) Section 740.1 requires the Commission to consider the following set of guidelines.

- First Guideline: projects should offer a reasonable probability of providing benefits to ratepayers. After Commission approval, SCE will select projects from its Investment Plan that it determines will provide the best probability of providing customer benefits by following EPIC's guiding principles for lowering costs, improving safety and/or increasing reliability, as well as other societal benefits. While not all demonstrations will be successful in achieving intended direct customer benefits, all demonstrations are useful to the utility industry, because even unsuccessful projects provide valuable lessons learned.

[75] D.13-11-025, p. 67.
[76] D.15-04-020.
[77] D.15-04-020, p. 40.
[78] D.13-11-025, OP 46.
[79] D.12-05-037, at OP 7.

- Second Guideline: Expenditures on projects with a low probability for success should be minimized. SCE intends to select projects from its Investment Plan that it deems has the greatest probability of providing direct customer benefits. If a project experiences excessive delays, cost overruns, technology changes or if the probability of success is insufficiently low, SCE will terminate the project, as it has done in past investment plans.[80] SCE will attempt to avoid such projects, however the point of a pre-commercial technology demonstration phase is to prove the cost effectiveness of the technologies' and the viability of its capabilities.

- Third Guideline: Projects remain consistent with the corporation's resource plan. SCE's Investment Plan is consistent and aligns with the broader company's objectives of clean energy, electrification, grid/grid edge, customer choice, departing load and operational excellence, but also directly supports SCE in other proceedings, including the DRP, PRP, transportation electrification and safety. These grid advances through demonstrations also supports the loading order and helps California achieve its clean energy goals and requirements.

- Fourth Guideline: Avoid unnecessarily duplicating research being done by another entity. The EPIC Administrators regularly meet to discuss projects to help safeguard against unnecessarily duplicating work. To further safeguard against duplication, all of the EPIC Administrators held a discussion of industry gaps to help ensure the proposed work wasn't duplicating efforts of the Administrators and that the work could potentially fill existing industry gaps (see Section 5, Discussion of Gaps).

- Fifth Guideline: Each project should support at least one of the following objectives:
    - Environmental Improvement;
    - Public and Employee safety;
    - Conservation by efficient resource use or by reducing of shifting system load
    - Development of new resources and processes, particularly renewables resources and processes that further supply technologies; and
    - Improvement of operating efficiency and reliability or otherwise reducing operating costs.

  The Commission's EPIC guiding principles of greater reliability, less cost and improved safety, coupled with its complementary principles of societal benefits, greenhouse gas emissions mitigation and adaption in the electricity sector at the lowest possible cost, the loading order, low-emissions vehicles/transportation, economic development, and efficient use of ratepayer monies, directly addresses these PUC objectives. In support, the Joint IOU Framework embeds these code objectives and Commission principles in each of its Funding Categories, so that each supporting initiative and proposed project directly addresses reliability, affordability and/or safety, as well as complementary principles such as societal and environmental improvements. Safety and environmental improvements are of paramount importance and are embedded in each of the four funding areas.

  While conservation is primarily covered through existing EE and DR programs, the Joint IOU Framework's category of Customer Products/Services Enablement addresses system and

[80] SCE terminated the Super Conducting Transformer project, because of excessive delays with the vendor providing the technology to be demonstrated.

operations integration of technologies and innovative grid strategies, which distinguishes it from existing EE and DR programs. There is limited funding for Demonstrations and SCE has no intention of duplicating internal efforts. Appendix B, confirms there is no overlap between programs.

The IOUs Renewables & Distributed Energy Resources Integration funding category, addresses new resource processes, primarily renewables and DERs by demonstrating pre-commercial technologies and novel strategies to facilitate the safe and reliable integration of renewables and DERs on the grid.

The IOUs Grid Modernization & Optimization funding category, addresses improvements to operating efficiency and reliability, or other reduce costs by demonstrating technologies and new strategies that will lead to deployment of assets that improve grid capabilities and reliability.

8.2 Public Utilities Code Section 8360

The Joint IOU Framework's four categories of funding (see Section 6), incorporates Public Utilities Code Section 8360's ten objectives to modernize the state's electric grid with infrastructure that enables customer choice, while providing safe, reliable, efficient and secure electric service for customers.

The Renewable and Distributed Energy Resources Integration funding category (Section 6.1) addresses integration challenges of greater renewable and DERs penetration on the grid, while safely, reliability and affordably integrating these resources on the electric grid. This category directly supports the following paragraphs in Public Utilities Code Section 8360:

(c) Deployment and integration of cost-effective distributed resources and generation;
(g) Deployment and integration of cost-effective advanced electricity storage; and
(j) Identification and lowering of unreasonable or unnecessary barriers to adoption of smart grid technologies, practices and services.

The Grid Modernization and Optimization funding category (Section 6.2) focuses on the continual need to reliably, safely replace aging infrastructure with new and more effective technologies and strategies in a cost-effective manner. This area directly supports the following objectives of PUC, Section 8360:

(a) Increased use of cost-effective digital information and control technology to improve reliability, security and efficiency of the electric grid;
(b) 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; and
(j) Identification and lowering of unreasonable or unnecessary barriers to adoption of smart grid technologies, practices and services.

The Customer Products & Services Enablement funding category (Section 6.3) recognizes the need to provide customers with choices, as products such as plug-in electric vehicles increase and transportation in general continues to electrify operations. This category addresses grid impacts and operations, separate from existing EE and DR programs[22] and supports the following paragraphs of PUC, Section 8360:

(d) Development and incorporation of cost-effective demand response, demand-side resources and energy efficient resources;
(e) Deployment of cost-effective smart technologies, including real time, automated, interactive technologies that optimize the physical operation of appliances and consumer devices for metering, communications concerning grid operations and status and distribution automation;
(f) Integration of cost-effective smart appliances and consumer devices;
(g) Deployment and integration of cost-effective advanced electricity storage and peak-shaving technologies, including plug-in electric and hybrid vehicles, and thermal-storage air-conditioning;
(h) Provide consumers with timely information and control options;
(i) Develop standards for communication and interoperability of appliances and equipment connected to the electric grid, including the infrastructure serving the grid; and
(j) Identification and lowering of unreasonable or unnecessary barriers to adoption of smart grid technologies, practices and services.

The final section, the Cross-Cutting Strategies & Foundational Technologies funding category (Section 6.4) focuses on enabling foundational capabilities that cut across the three previous categories. Cross-cutting and Foundational Technologies initiatives, such as advancing new systems architecture, interoperability, and cyber security all directly supports PUC, section 8360's objectives.

Appendix A

Potential Projects

PROJECT NAME: CYBERSECURITY FOR INDUSTRIAL CONTROL SYSTEMS

EPIC DESCRIPTION	PROJECT EXPLANATION
Technology or strategy to be demonstrated	This project will build on the learnings and accomplishments of the California Energy Systems for the 21st Century (CES-21) Program. The CES-21 Program is a joint research collaborative project between Pacific Gas and Electric (PG&E), Southern California Edison (SCE), San Diego Gas and Electric (SDG&E) and Lawrence Livermore National Laboratory (LLNL), building the foundations of machine-to-machine automated threat response (MMATR). This EPIC project proposes to evaluate potential demonstrations that build on that foundation, such as potentially including adaptive controls and dynamic zoning for industrial control systems and enhanced visual interfaces of the simulation engine developed in the CES-21 Program. As transactive controls and other grid modernization connectivity upgrades occur, 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 supervisory control and data acquisition (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, DER management system “safe” zones, etc.) could be manipulated in order to contain or thwart a cyberattack. The project will comprehensively test these protective capabilities in a laboratory environment to ensure they act as anticipated. The simulation engine developed in CES-21 has provided the IOUs insight into wide-scale grid effects of certain cyberattacks and remediation. However, each simulation requires significant development and coding to run, leading to long development cycles. This project may streamline that process through 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. A cybersecurity scenario catalog covering incidents of particular interest to the IOUs will be developed. This may include translation software to convert grid models in common formats (e.g. CYME) into the simulation engine’s format (ParGrid), allowing utilities to upload existing, detailed models of grid configurations that have already been developed under other modelling packages, maximizing the benefit obtained from these advanced simulation approaches. Grid and network component models not currently in existence will be developed so that the capability addresses grid modernization initiatives at the IOUs. These simulation engine enhancements will provide enhanced situational awareness and decision support to grid operators.
Concern, problem or gap to be addressed	The frequency and sophistication of cyber-attacks is increasing and as the grid advances and uses increased computing to automate, keeping it secure from cyber threats is of vital importance. In order to safeguard against these cyber-threats it is crucial to leverage the learnings that have resulted from the Joint IOUs’ CES-21 Program and further machine-to-machine threat response capabilities.
Pre-commercial technology or strategy aspect	The project will use various technologies, at various stages of pre-commercial maturity.

<table>
<tr><th>EPIC DESCRIPTION</th><th>PROJECT EXPLANATION</th></tr>
<tr><td>How the project avoids duplication from other initiatives</td><td>SCE, PG&E, SDG&E and the CEC are not aware of any utilities or other entities conducting this work. As a Commission requirement of the CES-21 Program, the Joint IOUs and LLNL have conducted benchmarking in the past and the CES-21 Program leads the industry.</td></tr>
<tr><td>Prioritization: High priority project</td><td>This project is high priority, because it improves safety, builds on the learnings of the CES-21 Program, and complements the Commission’s recently opened physical security rulemaking. As the frequency and sophistication of cyber threats increases, it is critically important the CEC work with the joint utilities and Department of Energy national labs to collaboratively safeguard against these threats to keep the grid and public safe.</td></tr>
<tr><td>EPIC primary or secondary principles met</td><td>This project provides clear ratepayer benefits and supports the EPIC’s guiding principles of greater reliability and increased safety through:
Demonstrating an increased ability to respond to serious attacks by taking machine speed actions could reduce the impact of a serious cyberattack
Improved ability for cyber professionals to run attack scenarios and potential responses, to deliver quantified information on the relative importance of different vulnerabilities.
At full deployment, these solutions would act as a tool for cyber security professionals to prepare against ICS network attackers, and aid in protecting against serious impacts on customer outages and safety.

The project also supports the EPIC’s complementary principles of societal benefits and is an efficient use of ratepayer monies by demonstrating the effectiveness of improving system protections against cyberattacks. Furthermore, this project could potentially leverage additional federal funding. Additional potential federal cost-share is being investigated.</td></tr>
</table>

PROJECT NAME: ADVANCED DATA ANALYTICS TECHNOLOGIES

EPIC DESCRIPTION	PROJECT EXPLANATION
Technology or strategy to be demonstrated	This project will demonstrate the possibility of using advanced data analytics technologies for Transmission and Distribution (T&D) and customer maintenance. This project will evaluate pattern recognition technologies that are capable of using new and/or existing data sources such as from sensors, smart meters, supervisory control and data acquisition (SCADA), for predicting or providing alarms on the incipient failure of distribution system assets. These assets would include connectors, transformers, cables, and smart meters. For example, data patterns from sources around a cable splice/connection could alert of impending failure. Another example would be a dramatic decrease in a customer's electric consumption, which could potentially point to energy theft or an impending meter failure/malfunction.
Concern, problem or gap to be addressed	This analytics technology would provide system awareness and alerts on incipient asset failures for SCE's T&D system planning and engineering groups. Condition based maintenance techniques could be applied as data analysis to flag impending asset failures. Additionally, this analytics technology can potentially flag large consumption changes, indicating potential energy theft or meter malfunctions, which can alert SCE's smart meter services organization.
Pre-commercial technology or strategy aspect	The technologies in this space are still in the development stage. While significant improvements are claimed to have been made, SCE has not yet come across a software or technology solution that is deemed completely proven. However, the advances are adequate enough to warrant further investigation and demonstration, given the benefits of the results of such a technology.
How the project avoids duplication from other initiatives	Within SCE, there are no other groups that are working on a similar project. SCE has also benchmarked other investor-owned utilities (IOUs) across the state, and there does not appear to be any similar work being performed.
Prioritization: High priority project	This project is considered high priority, because of its potential to enhance system reliability. Additionally, the project could potentially improve planning and maintenance efforts by prioritizing asset replacements based on incipient failure indicators, instead of time based maintenance and by identifying the occurrence of energy theft and meter billing malfunctions. These enhancements could potentially provide system reliability benefits and improve customer satisfaction through reduction in Customer Minutes of Interruption (CMI) and System Average Interruption Duration Index (SAIDI)/ System Average Interruption Frequency Index (SAIFI) metrics.
EPIC primary or secondary principles met	This project has ratepayer benefits and supports the EPIC's primary principles of promoting greater reliability and lower costs by making operations more efficient and effective. These improved efficiencies have the potential to improve reductions in CMI, as well as safety metrics that include SAIDI and SAIFI. This project also supports the EPIC's complementary principles for efficient use of ratepayer funds.

PROJECT NAME: ADVANCED TECHNOLOGY FOR FIELD SAFETY

EPIC DESCRIPTION	PROJECT EXPLANATION
Technology or strategy to be demonstrated	This project will demonstrate the possibility of using new advanced technologies to reduce T&D field crew to customer hazards. The project will evaluate technologies that are capable of using data sources such as field sensors, smart meters, etc. to provide real/near real-time status of faulty equipment. For example, an unexpected back-feed from a distributed generation site (e.g. customer's Vehicle to grid (V2G), energy storage system, Photovoltaics (PV) system) could pose a significant safety hazard to the field crew working on the associated distribution circuit.
Concern, problem or gap to be addressed	There is an inherent danger of an unexpected back-feed from a customer premise for field crew working on circuits. Safety hazards could occur when a faulty inverter switch causes power from a customer's PV, battery storage and/or vehicle to grid strategy to flow onto the de-energized circuit. This project will demonstrate and evaluate technology solutions, such as a mobile application that enables crews to check meters or key assets in the field with their I-phones or Tough Book computers prior to performing work. The crew could also use the mobile application to do a load-side check that customers are back online before departure. Moreover, a broken neutral conductor from distributed generation could potentially cause a dramatic voltage imbalance and a fire hazard for the customer.
Pre-commercial technology or strategy aspect	The technologies in this space are still in the developmental stage. While significant improvements are claimed to have been made, SCE has not yet come across a software or technology solution that is deemed completely proven. However, the advances are adequate enough to warrant further investigation and demonstration, given the benefits of the results of such a technology.
How the project avoids duplication from other initiatives	Within SCE, there are no other groups that are working on a similar project. SCE has also benchmarked other investor-owned utilities (IOUs) across the state, and there does not appear to be any similar work being performed.
Prioritization: High priority project	This project is considered high priority, because it could possibly improve the safety of crews in the field, for SCE's T&D groups, such as Grid Operations, Field Engineering and Safety. Moreover, the project could potentially improve the safety of customer's distributed generation by detecting high voltages.
EPIC primary or secondary principles met	This project provides clear electricity ratepayer benefits and supports the EPIC's guiding principles of safety and reliability. The project could potentially provide improvements to SCE's T&D crew safety and customer safety by enabling crews to use an Application to check customer sites for any unexpected back-feeds and/or detect unexpected high voltage. These safety improvements also supports the EPIC's complementary principle of efficient use of ratepayer monies.

PROJECT NAME: STORAGE-BASED DISTRIBUTION DC LINK

EPIC DESCRIPTION	PROJECT EXPLANATION
Technology or strategy to be demonstrated	This project will demonstrate a new and innovative architecture for a distribution-connected energy storage systems and examine its benefits. Typically, energy storage systems are connected to a single electrical point. This demonstration, proposes an architecture that will allow the energy storage system to connect to two unique distribution circuits, through the use of two power conversion systems, tied to a single storage medium. This approach will allow the storage system to support both circuits, individually or simultaneously, and will also provide a means of dynamically exchanging power between the two circuits (DC link). Moreover, this approach will capture most of the traditional benefits associated with having energy storage on both circuits, and provide added flexibility by allowing operators to dynamically transfer load from one circuit to the other, supplementing the existing feeder parallel/tie switches. To support these benefits, the system will be installed in close proximity of an existing parallel/tie switch, or at a location close to the connection of two circuits, and the storage medium will be sized taking in consideration both circuit needs.
Concern, problem or gap to be addressed	This project addresses the typical issues energy storage is traditionally considered for, such as managing line loading to prevent line overload or duct bank temperature violations, optimizing local voltage, and supporting the integration of renewable resources. The opportunity the demonstration addresses is to examine whether it is feasible to provide these benefits to two adjacent circuits, and to enhance the operational flexibility currently provided by the feeder parallel/tie switches by allowing the dynamic transfer of load from one circuit to another circuit. A regular parallel/tie switch only allows a fixed amount of load to continuously transfer, whereas a dynamic DC link allows the power transfer to be set to any value, up to the maximum rating of the Power Conversion System, and allows this power transfer to dynamically adjust based on the loading of the two circuits.
Pre-commercial technology or strategy aspect	The individual technologies considered for this project can be considered commercial. However, this is a new and innovative approach with technologies that have not been used in the proposed topology and appropriate electrical design and control algorithms are needed.
How the project avoids duplication from other initiatives	Within SCE, there are no other groups that are working on a similar project. SCE has also benchmarked other investor-owned utilities (IOUs) across the state, and there does not appear to be any similar approach being evaluated.
Prioritization: High priority project	This project provides critical data to enhance understanding of whether energy storage systems are viable for reliability, such as managing line loading to prevent line overload or duct bank temperature violations, optimizing local voltage and allows the capture of potential additional value streams.
EPIC primary or secondary principles met	This project provides ratepayer benefits and supports the EPIC's primary principles of promoting greater reliability and lower cost, and improving integration of renewables and DERs, by extending the traditional benefits provided by a single energy storage system to two adjacent distribution circuits. This will effectively improve the utilization and value of the storage asset, while enhancing operational flexibility and reliability.

PROJECT NAME: INTEGRATED GRID PROJECT PHASE 3

EPIC DESCRIPTION	PROJECT EXPLANATION
Technology or strategy to be demonstrated	This project proposes the Integrated Grid Project's Phase III. Phase III aligns and supports SCE's filed Distribution Resource Plan (DRP) Demonstration D. Furthermore, the Preferred Resource Pilot (PRP) is also procuring energy that is scheduled to be implemented in 2020 within the distribution system area known as Johanna Junior and allows for further demonstration of increased levels of higher penetration of distributed energy resources. Phase III will demonstrate technology that will increase overall awareness of impacts of high penetration of renewable energy.
Concern, problem or gap to be addressed	The IGP, Phase III would allow SCE to complete the DRP Demo D objectives and enable the PRP deployed resources to be incorporated. Maintaining this testbed would also assist in reducing risk of deploying emerging technologies by continuing evaluation of the distributed control architecture demonstration work from Phase I and Phase II.
Pre-commercial technology or strategy aspect	The technologies and business rules in this space are still in the development stage.
How the project avoids duplication from other initiatives	SCE continues to evaluate external activities to ensure there is little to no duplication. SCE is not aware of any projects that provide the demonstration learnings of the IGP.
Prioritization: High priority project	This project is strategic and high priority, because it supports and helps SCE complete DRP, Demonstration D.
EPIC primary or secondary principles met	The project will provide clear electricity ratepayer and societal benefits and supports the EPIC's guiding principles to provide greater reliability and lower costs by demonstrating coordination and automation to optimize interconnected DER devices, while increasing the resiliency and flexibility of the distribution grid. The project also supports the EPIC's complementary principle of the loading order by incorporating resources from the PRP.

PROJECT NAME: SMART CITY DEMONSTRATION

<table>
<tr><th>EPIC DESCRIPTION</th><th>PROJECT EXPLANATION</th></tr>
<tr><td>Technology or strategy to be demonstrated</td><td>The Smart City project will leverage ongoing distributed control architecture and improved planning processes that include increased understanding of customer technology adoption and increased integration with City planning and distributed energy resource permitting processes.

Technologies to demonstrate would include the following areas:
Access and exchange of infrastructure and interconnection data amongst the utility, City, and Resource Providers; and
Ability of application developers to access an integration platform that enables standard communication protocols and a common information model to enable distributed applications.
The Smart City demonstration seeks to integrate disparate data and seeks to meet the following objectives:
Increase coordination between electric system and urban planning;
Coordinate infrastructure construction activities within a City;
Streamline the interconnection process through automated systems between SCE and the City;
Partner with cities to engage more customers in renewable resources (e.g. Community Solar PV, Community Storage) and creating more opportunities for electric transportation;
Work with cities to customize their resource portfolio to meet a Climate Action Plan goal;
Leverage assets (e.g. Telecommunications, Right of Ways);
Coordinate communication on energy programs (e.g. Energy Efficiency, Demand Response, Charge Ready, Green Rate); and
Assist large customers (i.e. the City as an energy customer) in more efficiently utilizing their energy resources and improving resiliency for critical operations center (e.g. emergency command centers).</td></tr>
<tr><td>Concern, problem or gap to be addressed</td><td>The electric utility infrastructure and the portfolio mix of electric resources are very impactful to the communities that SCE serves. Engaging with a City, recognizes the importance of the role they play in electricity and should provide more efficient buildout of the infrastructure, streamline joint processes (e.g. interconnection of Solar PV/Storage), and enable locally sponsored de-carbonization initiatives.</td></tr>
<tr><td>Pre-commercial technology or strategy aspect</td><td>The technologies and business rules in this space are still in the development stage.</td></tr>
<tr><td>How the project avoids duplication from other initiatives</td><td>SCE routinely engages with its communities in its service territory and this would be a directed demonstration with a specific City to identify overall benefits.</td></tr>
<tr><td>Prioritization: High priority project</td><td>This project is strategic and high priority; as SCE implements its Grid Modernization plan, there appear to be significant opportunities for SCE to coordinate and integrate with communities within SCE's service territory.</td></tr>
</table>

EPIC DESCRIPTION	PROJECT EXPLANATION
EPIC primary or secondary principles met	This project provides clear electricity ratepayer benefits and supports the EPIC's primary principle of lower costs through coordination and automation, by promoting increased penetration of DERs. The project also supports EPIC's complementary principles of greenhouse gas emissions mitigation and adaptation in the electricity sector at the lowest possible cost, has societal benefits and is an efficient use of ratepayer monies.

PROJECT NAME: NEXT GENERATION DISTRIBUTION AUTOMATION III

EPIC DESCRIPTION	PROJECT EXPLANATION
Technology or strategy to be demonstrated	This project will evaluate and demonstrate the latest advancements in technologies to improve reliability, personnel and public safety, and operational efficiencies, such as high impedance fault detection and real-time equipment health diagnostics. The project will build on lessons learned from the Next Generation Distribution Automation II project and proposes to expand the technology to automation devices and continue to improve control functionalities. The project's objective is to demonstrate future advanced capabilities to manage the grid with higher distributed energy resources (DER) penetration to support requirements to enable the Distribution System Operator (DSOs) role. The project will integrate he latest breakthroughs in distribution equipment and sensing technology to demonstrate a complete system design. This project will demonstrate technologies that are applicable for both overhead and underground distribution circuits.
Concern, problem or gap to be addressed	This project could support SCE to better meet equipment commitments that extend beyond the Distribution Resource Plan (DRP) and readiness to support DSOs in the future through projects including the Integrated Grid Project (IGP).
Pre-commercial technology or strategy aspect	The technologies in this space are still in the development stage. While significant improvements are claimed to have been made, SCE often comes across a software or technology solution that is not completely proven. However, the advances are adequate enough to warrant further investigation and demonstration, given the benefits of the results of such a technology.
How the project avoids duplication from other initiatives	Within SCE, there are no other groups that are working on a similar project. SCE has also benchmarked other investor-owned utilities (IOUs) across the state, and there does not appear to be any similar work being performed.
Prioritization: High priority project	This project is considered high priority. This project aligns with SCE to support high DER penetration and readiness to support DSOs. The project also aligns with SCE's white paper titled "The Emerging Clean Energy Economy: Customer Driven, Modernized. Reliable", which considers expanding system capabilities as DSOs that plan and manage a modernized plug-and-play grid. Enabling and encouraging DERs will facilitate greater customer choice, expand energy products and services, while also helping achieve clean energy policies.
EPIC primary or secondary principles met	This project provides clear electricity ratepayer benefits and supports all of the EPIC's primary principles of promoting greater reliability, lower costs and increased safety. The project's focus on improved efficiency of the Infrastructure Replacement Program, also supports the EPIC's complementary principles of efficient use of ratepayer monies. The project could potentially lower costs of infrastructure replacement by reducing costs of replacing equipment on normal time versus overtime and reduced outage durations. Furthermore, this project improves safety by reducing equipment failures and any potential injuries caused by these failures. Safety is also improved through efficient automation, which provides functions for DER integration and could lead to SAIDI-MAIDI benefits from greater situational awareness for grid operators.

PROJECT NAME: SA-3 PHASE III FIELD DEMONSTRATIONS

EPIC DESCRIPTION	PROJECT EXPLANATION
Technology or strategy to be demonstrated	The Substation Automation 3 (SA-3) Phase III Field Demonstrations would build on the accomplishments of the SA-3 Phase II MacArthur Pilot part of the Irvine Smart Grid Demonstration, the SA-3 Phase 3 Lab Demonstration under EPIC 1, and the System Intelligence and situational awareness under EPIC 2 The project's objective is to successfully demonstrate a modern substation automation system that meets the high availability needed for SCE's critical Bulk Power (>220 kV) substations by adopting scalable technology that enables advanced functionality which meets NERC Critical Infrastructure Protection (CIP) compliance and IT cybersecurity requirements. The project will demonstrate the following technologies at SCE's Viejo 220/66/12 kV "A-System" Substation: • Peer-to-Peer communications for protection schemes (GOOSE Messaging). This technology is being used to help reduce the amount of wiring necessary in the substation and provide additional monitoring capabilities. • High Availability network design for devices providing critical communications functions. For this project, Parallel Redundancy Protocol (PRP) will be demonstrated. PRP is a technology that has been adopted as part of the International Electrotechnical Commission's (IEC) 61850 Standard, which provides guaranteed zero packet loss in case of a single failure. • One of the PRP Networks will demonstrate a new network technology called Software Defined Networking (SDN). SDN networks provide greater flexibility in the network design with a streamlined centralized configuration and management tools, while adding additional security measures. • New substation annunciator system. The goal of the new system is to have a lower cost annunciator and significantly reduce engineering and wiring, while utilizing IEC 61850 communications and data driven configuration. • Utilize IEEE 1588 PTP to provide time synchronization over the network eliminating the need for the coaxial networks needed with IRIG-B time synchronization. PTP provides sub-microsecond accuracy vs the millisecond accuracy available in IRIG-B. Also PTP can take advantage of the network redundancy to maintain proper time synchronization. • This Project will introduce IP Based communications to the Transmission Substation while demonstrating NERC CIP Compliance. The demonstration will use a server grade computing system utilizing machine virtualization to host substation applications, such as the Human Machine Interface and provide the necessary cyber security controls utilizing virtualized version of network security appliances such as firewalls. The computing system known as the Common Substation Platform will host additional applications working in conjunction with a centralized server to provide the following features: Configuration Management Application: This application provides a mechanism for maintaining substation and IED configuration files and shall provide a controlled process to ensure the consistency of these files. • Firmware Version Management Application: Provides a mechanism of tracking the evolution of a device firmware over time. It provides a central database to track current and past releases. • Password Management Application: Application allows SA-3 to manage, store and organize device passwords. It will provide the mechanisms to automatically change the device passwords after pre-defined events. • Fault/Event File Management Application: Automatically collect disturbance data from all the substation devices capable of producing them, and to make the data available to authorized users as soon as possible. • High speed communications from the Substation to SCE's data historian. The Substation Automation 3 (SA-3) phase III system is expected to become the new transmission substation standard after successful Field demonstration. Relevant portions of the demonstration will also be added to the Distribution Substation Automation Standards.

EPIC DESCRIPTION	PROJECT EXPLANATION
	The project will expand on the ideas of the overall SA-3 project and IEC 61850 and demonstrate the following advanced applications: • Demonstrate Field Installation of Process Bus Technology • Laboratory Demonstration of Virtualized Protection Relays • Utilizing SCE's substation engineering tool (IEC 61850 System Configurator) to automatically generate Substation Elementaries, Logic Diagrams, and other drawings that are currently manually drawn, and consume a large portion of a substation project. • SA-3 with the Common Substation Platform provides a platform for additional data analytics, and additional applications. The Project will explore utilizing relay generated data to perform Just in time maintenance of substation breakers.
Concern, problem or gap to be addressed	This project addresses the problems facing SCE's Substation Automation Systems including, cost and maintenance of existing operator substation control interface known as Human Machine Interface, cost of the existing Annunciator system, replacement of obsoleted protection relays, and meeting NERC CIP Compliance with a modern Substation Automation System. The problems facing the existing transmission substation has enormous impacts on project implementation's timeline, cost, and resources. The existing substation automation system uses vendor's proprietary software, which prevents using better modern relays and equipment from other vendors. The overall goal of this project is to provide measurable engineering, operations, and maintenance benefits through improved cybersecurity and reliability for transmission substations. The demonstration addresses interoperability and allows the system to work with IEDs from multiple vendors. Additionally, the project prevents vendor lock-in due to proprietary software and hardware and assures that SCE will have the flexibility to implement the best solution available.
Pre-commercial technology or strategy aspect	This project will utilize various technologies at various stages of maturity. All of the technologies being demonstrated are commercially available. However, this demonstration proposes a new and innovative approach to utilize these technologies to achieve added system reliability and/or reduce cost.
How the project avoids duplication from other initiatives	Within SCE, there are no other groups that are working on a similar project. SCE has also benchmarked other investor-owned utilities (IOUs) across the state, and there does not appear to be any similar work being performed. This demonstration is for SCE's critical Bulk Power (>220 kV) substations while GRC testimony was focused on distribution substation (115 kV and below).
Prioritization: High priority project	This project is considered high priority. The project has a high focus on NERC CIP and cost reduction. The project is introducing applications that meet compliance requirements using technology solutions, and technology that can provide cost reduction by eliminating wiring, This project aligns with SCE goals for Grid Modernization to support high DER penetration and readiness to support Distribution System Operators (DSOs). SCE wrote a white paper to consider expanding system capabilities as DSOs that plan and manage a modernized plug-and-play grid. Enabling and encouraging distributed energy resources will facilitate greater customer choice, expand energy products and services, while also helping achieve clean energy policies.
EPIC primary or secondary principles met	This project provides clear electricity ratepayer benefits and supports the EPIC's primary principles of promoting greater reliability and lower costs. The project could lead to lower costs by using new technologies to reduce wiring, installation cost, and automating manual processes where possible. Greater reliability may be achieved, by adding additional monitoring capabilities and by data analytics that have the potential to help improve maintenance programs.

PROJECT NAME: DISTRIBUTED CYBER THREAT ANALYSIS COLLABORATION

EPIC DESCRIPTION	PROJECT EXPLANATION
Technology or strategy to be demonstrated	This project will demonstrate the ability to standardize and automate utility cybersecurity threat analysis through a Distributed Cyber Threat Analysis Collaboration (DCTAC) framework. This DCTAC will conduct local utility, collaboration with utility peers and sharing with national analysis centers to support expedient cyber threat feed analysis. This framework will demonstrate the capability to effectively consume internal and external sourcing threat feeds, process them for legitimacy, and identify utility risk impact, potential response measures through collaboration with utility peers and national analysis centers to validate and verify threats as well as significantly shorten the time needed to respond to a cyber compromise of the electric grid.
Concern, problem or gap to be addressed	The duration of cyber-attacks varies in time and significant attacks usually involve multiple victims. Current cyber practice is for individual Security Operations Centers (SOCs) to gather data and perform the analyses with almost no external collaboration due to the fact that to contribute in any meaningful manner the analysts must be on-site to have access to investigatory data. Moreover, there is a lack of common practice to support utility-to-utility analysis, which negatively contributes to the attack duration and impact.
Pre-commercial technology or strategy aspect	The project will leverage the new STIX v2 standard data structure as originated by the Department of Homeland Security (DHS) and being advanced by the Organization for the Advancement of Structured Information Standards (OASIS) along with its associated commercial development tools to automate the exchange of investigatory data and improve the response to cyber events. The results of this demonstration will not only benefit SCE and other project participants, it will support the progress and/or refinement of standards through coordination with OASIS, a nonprofit consortium that drives the development, convergence and adoption of open standards for the global information society.
How the project avoids duplication from other initiatives	SCE is coordinating with the DHS, Department of Energy, other Utilities and OASIS to ensure that this project does not duplicate other known initiatives.
Prioritization: High priority project	The largest risk of a successful cyberattack to the grid involves malware that infiltrates the industrial control systems and maliciously operates for a length of time, causing damage to software and hardware. This project will demonstrate how to effectively protect our modernized electric system against these types of cyberattacks by standardizing and automating the cyber threat feeds by facilitating collaboration across the electric system, SOCs and government agencies.
EPIC primary or secondary principles met	This project provides clear ratepayer benefits and supports the EPIC's guiding principles of greater reliability and increased safety. The project also supports the EPIC's complementary principles of societal benefits and is an efficient use of ratepayer monies by demonstrating the effectiveness of shortening the response time to address cyberattacks.

PROJECT NAME: ENERGY SYSTEM CYBERSECURITY POSTURING (ESCP)

EPIC DESCRIPTION	PROJECT EXPLANATION
Technology or strategy to be demonstrated	This project proposal will demonstrate the Energy System Cybersecurity Posturing (ESCP) toolset. To protect the SCE Grid from cyber-attacks, it is imperative to know how it is configured. The first step in effective protection is understanding everything about the electric grid system from a cyber perspective. This demonstration will automate the ability to probe the Utility's supervisory control and data acquisition system (SCADA), using an automated probing capability which will enable the system to report back on how it is configured. This will help SCE to better respond to cyber threats. By creating a toolset to automate this ability, it will reduce manpower monitoring for updates on the grid. In addition, this technology will help to determine if changes made to the grid system are legitimate and not made by a malicious actor. The ESCP project will engineer toolset capability in two phases, The first phase will demonstrate the capability to execute an automated system posture where cybersecurity and regulatory related system attributes will be collected and analyzed via a toolset. The second phase of the project will be to demonstrate enhanced network communications situational awareness through a Software Defined Networking (SDN) interface with the capability to support cross cutting operations and cybersecurity analysis. The SDN will demonstrate the capability to enhance security and ensure delivery of information critically needed. SDN focuses on how the network carries the information that enables operators to determine the state of the grid and to control the energy. For example, Industrial Control System traffic needs to have a different priority than a portal video stream. The SDN will enable the network to know what route to take, how to prioritize traffic and what to block. This will make the network smarter, faster, more efficient, more reliable and safer. The network is able to achieve these improvements, because it has the ability to see what information is passing through the network and makes a cyber based decision on how that information is routed. To get the information SCE needs and to send controls information back to the grid, SCE needs to be using these newer, more modern networks. We propose to demonstrate methods and software to use this capability to help us secure networks, so SCE is able to understand the risks and benefits of new technology. The product will demonstrate that it can automatically scan a large network, identify and detect (from prior scan) what has changed. This technology is not available today on Grid systems.
Concern, problem or gap to be addressed	Currently in the energy sector there is a common challenge to acquire real time system posturing for risk to reliability from cyber threat potentials. The gap has been in understanding environmental posture from a cybersecurity perspective, due to lack of appropriate data elements to support: 1. Risk level awareness to determine level of impact. 2. Based on impacted system components, response resourcing can be established. 3. Identification of unauthorized/unauthenticated function attempts. 4. Attack training scenarios based on risk intelligence analytics.
Pre-commercial technology or strategy aspect	There are IT based technologies available but they have not matured to account for the reliability requirements of OT environments. The cyber-attack history against critical infrastructure is driving the demand for such ESCP cross cutting technologies. SCE has conducted independent analysis of IT technologies, and discussed the issues with industry peers to confirm the industry need.

EPIC DESCRIPTION	PROJECT EXPLANATION
How the project avoids duplication from other initiatives	Within SCE, there are no other groups that are working on a similar project. SCE has also benchmarked other investor-owned utilities (IOUs) across the state, and there does not appear to be any similar work being performed.
Prioritization: High priority project	The largest risk of a successful cyberattack to the grid involves malware that infiltrates the ICS and operates for a length of time, spreading like a cancer. This project will demonstrate how to effectively protect our modernized electric system against these types of cyberattacks by facilitating collaboration across electric system SOCs and government agencies.
EPIC primary or secondary principles met	This project provides clear electricity ratepayer benefits and supports the EPIC's primary principles of promoting greater reliability and lower costs by using cross-cutting foundational strategies and advanced technology to help establish a utility/industry practice for self-awareness of posture, in order to support minimal impacts on consumer energy from cyber-attacks.

PROJECT NAME: DISTRIBUTION OPTIMAL POWER FLOW

EPIC DESCRIPTION	PROJECT EXPLANATION
Technology or strategy to be demonstrated	This demonstration will evaluate various distribution optimal power flow (OPF) engines. Applying OPF to the distribution grid is a very new concept and the traditional OPF algorithms that are applied to transmission grids / bulk electric system today are designed around 3 phase balanced networks that optimize large central inertia driven generation plants. In the future, more generation will come from distributed resources that are often small, dispersed, and non-inertia driven. These resources are close to load centers and located on a 3 phase unbalanced distribution grid where the majority of this generation will be single phase, which poses a huge challenge when needing to integrate and optimize for reliability and economics. There is also the opportunity to leverage the full capabilities of smart inverters, which allow multi-objective control of single resources, which is not possible with traditional inertia driven generation resources. With the challenges and opportunities outlined above, there is a need to evaluate and establish new techniques / algorithms to be able to meet future Grid Management functionality.
Concern, problem or gap to be addressed	Distribution optimization is a foundational technology with the Grid Management System roadmap (Grid Modernization) in being able to enable distributed energy resources (DER) reliability services, aggregating resources to provide services to wholesale markets, as well as supporting SCE's future capital deferral framework.
Pre-commercial technology or strategy aspect	The technologies in this space are still in the development stage. SCE has not yet come across a software or technology solution that is deemed completely proven. There has been technical papers written by academia and work by vendors to develop further solutions. This warrants further investigation and demonstration, given the benefits of the results in enabling SCEs vision of the grid of the future.
How the project avoids duplication from other initiatives	Within SCE, there are no other groups that are working on a similar project. SCE has also benchmarked other investor-owned utilities (IOUs) across the state, and there does not appear to be any similar work being performed.
Prioritization: High priority project	This project is considered high priority. SCE needs to have this functionality deployed in production in the 2019 / 2020 timeframe to be able to support initial capital deferral projects and initial reliability services.
EPIC primary or secondary principles met	This project provides clear electricity ratepayer benefits and supports the EPIC's primary principles of promoting greater reliability and lower costs by examining the possibility of establishing real time optimization of the Distribution Grid that will enable least cost operation of the Distribution Grid. The project will also enable the ability to be able to dispatch DER to provide reliability services to the utility, which reduces the need for future traditional grid investments.

PROJECT NAME: DISTRIBUTION PRIMARY & SECONDARY LINE IMPEDANCE

EPIC DESCRIPTION	PROJECT EXPLANATION
Technology or strategy to be demonstrated	This project will examine the possibility of establishing primary and secondary line impedance information for distribution circuits, by examining the voltage and power signatures at the meter and transformer level, by leveraging a basic connectivity model of the circuits and utilizing SCADA data. The availability of complete primary line impedance information can result in accurate load flow / distribution state estimation results and greater real time management of the distribution grid and greater utilization of capacity within the existing installed infrastructure before new assets deemed to be required. Today secondary impedance information does not exist within our source asset/geographical information systems. To be able to fulfil future requirements associated with distributed energy resources (DER) management/optimization and dispatch of DER resources to meet both reliability and market needs, impedance models for secondary distribution networks will be required. Therefore technologies are needed that are capable of studying the voltage and power signature at the smart meter, along with SCADA data and a basic connectivity model to derive an impedance model automatically. For system planning and engineering groups, this technology would provide more accurate impedance models and combined with the load data from smart meters can provide significantly better inputs into the power flow analysis and Integrated Capacity Analysis (ICA) required by the Commission's Distributed Resources Plan.
Concern, problem or gap to be addressed	Currently there are data gaps within SCE's geographical/asset information systems. Individual circuit primary impedance information at the distribution level is currently not fully available at SCE and secondary impedance information is not available at all. Through this technology we will examine the possibility of deriving impedances data for primary distribution networks and establish secondary impedances of distribution circuits. Lack of accuracy associated with primary distribution line impedances will limit the ability to conduct effective and accurate load flow/ state estimation studies to support foundational Grid Modernization – Grid Management functions which is foundational in SCE being able to become a Distribution System Operator.
Pre-commercial technology or strategy aspect	The technologies in this space are still in the development stage. While significant improvements are claimed to have been made, SCE has not yet come across a software or technology solution that is deemed completely proven. However, the advances are adequate enough to warrant further investigation and demonstration, given the benefits of the results of such a technology.
How the project avoids duplication from other initiatives	Within SCE, there are no other groups that are working on a similar project. SCE has also benchmarked other investor-owned utilities (IOUs) across the state, and there does not appear to be any similar work being performed.
Prioritization: High priority project	This project is considered high priority. Accurate impedance information will allow SCE to benefit significantly by conducting effective load flow studies and running real time distribution grid applications e.g. FSLIR, OPF, State Estimation etc.
EPIC primary or secondary principles met	This project provides clear electricity ratepayer benefits and supports the EPIC's primary principles of promoting greater reliability and lower costs by examining the possibility of establishing accurate impedance information for distribution circuits, which can result in effective management and optimal utilization of the Distribution power system.

PROJECT NAME: ADVANCED COMPREHENSIVE HAZARDS TOOL

EPIC DESCRIPTION	PROJECT EXPLANATION
Technology or strategy to be demonstrated	This project will demonstrate a new and innovative approach to integrate emerging and mature hazard assessment tools. This demonstration will use a centralized data architecture that integrates various types of SCE asset data from non-electric, generation, and grid infrastructure. The project aims to identify vulnerabilities across different types of infrastructure to understand the overall risk to the grid. The project will demonstrate hazard scenarios and the impacts of those scenarios to the SCE system. Additionally, the project will help to determine what mitigation and recovery approaches can be taken to ensure the least impact and cost. The goal is to optimize and demonstrate tools to merge assessment and mitigation data for enhanced decision-making before, during, and after a significant event.
Concern, problem or gap to be addressed	Natural hazards throughout SCE's territory threaten the grid's reliability, safety, and affordability. Extreme weather events, wildfires, and earthquakes pose significant risks to our critical infrastructure and assets. Centralization and effective interpretation and use of decision-making tools and information is critical to prevent or mitigate loss and damage and initiate recovery efforts. Today, "piecemeal" solutions are tailored to individual applications and threats. As such, disparate processes, methods, and models may exist, which may be in conflict and may affect mitigation and recovery plans in larger incidents and disasters. Centralization and optimization of hazard response capabilities is required to enhance effective responses during these natural hazard events.
Pre-commercial technology or strategy aspect	Technologies in this space are still in the development stage. There are some limited vulnerability analytics tools (CARPA.org); however these current tools only take into consideration the vulnerability and do not provide adequate integration capabilities on restoration, recovery, or mitigation scenarios. Rather than develop new technologies there may be opportunities to configure and customize a suite of commercial tools and determine if pre-commercial tools can be leveraged to develop this comprehensive hazards tool.
How the project avoids duplication from other initiatives	Within SCE, there are no other groups that are working on a similar project. There are efforts to create individual damage and restoration models for specific types of threats. This effort attempts to aggregate and integrate these individual efforts and will also incorporate additional threats (not currently covered by existing efforts), such as earthquakes.
Prioritization: High priority project	This project is considered high priority. Phase information will allow SCE to benefit significantly by conducting threat and impact analysis of natural disaster events, such as earthquakes for improved safety. The project will demonstrate hazard mitigation capabilities to determine the potential for losses and how to provide efficient mitigation to improve the resiliency of the grid. This project is aligned with the fire threat map proceeding and will use the fire threat maps, as they become adopted by the Commission. Furthermore, the project would provide valuable reliability and safety information for system planning and engineering groups to help assess current infrastructure to identify and mitigate system vulnerabilities. Additionally, this information would be helpful for operational groups by providing the basis for optimal restoration strategies, likelihood of damage and loss and restoration and mitigation strategies.
EPIC primary or secondary principles met	This project provides clear electricity ratepayer benefits and supports all of the EPIC's primary principles of promoting greater reliability, lower costs and improved safety by providing SCE a tool that can inform the optimal design and mitigation strategies to make the grid resilient to natural hazards and disasters. Improved grid resiliency could lead to fewer equipment replacements from these natural hazards and/or disasters.

PROJECT NAME: BEYOND THE METER PHASE 2

EPIC DESCRIPTION	PROJECT EXPLANATION
Technology or strategy to be demonstrated	The Beyond the Meter Device Communications (BTM) Phase 2 project proposes to build on the lessons learned in the project's initial phase, which demonstrated Rule 21-defined interfaces with customer-owned distributed generation, including photovoltaic (PV), energy storage, and Electric Vehicle (EV) charging. Phase 2 will continue to evaluate the integration and management of small commercial customer-owned distributed energy resources (DER) systems with SCE's Distributed Energy Resource Management Systems (DERMS), with an emphasis on EV charging use cases, but will deploy this technology (or similar technology) in SCE territory, possibly at SCE sites, in order to understand how the technologies evaluated in Phase 1 can be deployed in real world conditions under pilot program and tariff conditions.
Concern, problem or gap to be addressed	As Plug-in Electric Vehicles (PEV) penetration increases, along with battery sizes and charging capacity, SCE will need to be able to monitor and manage these new loads in order to reduce negative impacts, such as preventing transformer overloading, or provide benefits, such as extra load during times of over generation. However, due to the fact that EVs are meant to provide transportation, managing charging can be difficult, especially in scenarios where charging durations are limited. Distributed generation and/or storage could offer potential solutions to these challenges. An evaluation of the required Rule 21 interfaces and functionalities in the lab and field are necessary to ensure integration is beneficial to the site host, the driver, and the distribution utility. This project aligns with ongoing Grid Modernization and Transportation Electrification activities and Rule 21 Smart Inverter proceedings.
Pre-commercial technology or strategy aspect	Existing energy management systems that manage building loads such as HVAC and light are common. However, systems that monitor and manage EV charging, PV and/or storage are just now being developed.
How the project avoids duplication from other initiatives	Within SCE, there are no other groups that are working on a similar project.
Prioritization: High priority project	The project also supports State clean energy policies, such as SB 350 and SB 32, which drives transportation electrification. Moreover, the project evaluates the increasing numbers of higher powered EV battery sizes and charging capacities proposed by automakers. Additionally, in most non-residential scenarios, 5 or more Electric Vehicle Supply Equipment (EVSEs) are deployed and used simultaneously. In some of these scenarios, EV telematics or communications with an EVSE or aggregator may be possible. While there is little leeway for delaying, curtailing or reducing charging, such as in higher powered charging scenarios, the use of distributed generation and storage may be desirable both to reduce bills and to support the grid. Methods to accomplish this, as well as the use of required Rule 21 interfaces need to be explored and understood.
EPIC primary or secondary principles met	This project provides clear electricity ratepayer benefits and supports the EPIC's primary principles of promoting greater reliability and lower costs by evaluating the barriers and benefits of establishing DER programs. New DER interconnections will also support power system planning and design, as it allows for full utilization of capacity within the existing and planned installed infrastructure before new assets deemed to be required. The project also supports EPIC complementary principles for societal benefits, greenhouse gas emissions mitigation and adaption in the electricity sector at the

EPIC DESCRIPTION	PROJECT EXPLANATION
	lowest possible cost, low-emission vehicles/transportation and is an efficient use of ratepayer monies.

PROJECT NAME: RELIABILITY DASHBOARD TOOLS

EPIC DESCRIPTION	PROJECT EXPLANATION
Technology or strategy to be demonstrated	This project will evaluate the demonstration of different methods to optimize existing reliability dashboard tools (Reliability Analyzer and Outage Explorer). The project has the following objectives: 1) Evaluating the addition of internal data sets; 2) Exploring the addition of internal or external algorithms or signatures; 3) Automating data feeds; and 4) Improving access to SCE users, such as through a web or portal link. Integration of additional data sets is expected to increase overall value and quality of reliability dashboard tools. Examples of internal data sets, which merit investigation include: • Power up/down events and associated time stamps; • Minimum, maximum, and average meter voltage; • Latitude, longitude of affected structures; • SCE electrical connectivity model information; and • Equipment failure data in SAP. Evaluation and possible integration of outage algorithms with the reliability dashboard is expected to increase accuracy and speed of outage metrics or forecasts. Existing algorithms or signatures which merit investigation include: • The System Average Interruption Duration Index (SAIDI)/ System Average Interruption Frequency Index (SAIFI) algorithm, which automate and increase accuracy of outage duration estimates; and • The Voltage Signature algorithm, which improves transformer-to-meter connectivity estimates. In addition, there may be other algorithms, such as equipment failure algorithms (internal or external to SCE), which would merit investigation. Algorithms would require modifications to ensure operational use cases are satisfied. Evaluation of other data sets may be useful for the improvement of outage or restoration forecasts. Examples of other data meriting investigation include: restoration throughput rates for various equipment types; vegetation management data such as tree counts; environmental data such as soil moisture/wetness at various depths, topography type; etc.; and weather data from the National Digital Forecast Database. Finally, the project aims to demonstrate dashboard tools in an automated and easy to access platform. Tools are expected to be refined via focus group or user test sessions involving key users.
Concern, problem or gap to be addressed	Retrieval, compilation, and analysis of customer outage and field restoration data has remained a long standing challenge for SCE and other utilities. SCE now uses reliability dashboard tools, including Reliability Analyzer and Outage Explorer, which enable users to perform analysis of historical outages and field restorations. However, these existing tools have key limitations that are largely related to data quality and data access issues. SCE has the ability to analyze reliability data, but there are time lags and a lack of granularity and consistency in the collection and categorization of outage data. The ability to analyze outages is also limited to a few analysts, which do not directly influence improvements in reliability. Increasing the quality, accuracy, speed, ease of use, and accessibility of reliability analytic tools will lead to improve reliability, as measured by the SAIDI, SAIFI, and Momentary Average Interruption Frequency Index (MAIFI) metrics.

EPIC DESCRIPTION	PROJECT EXPLANATION
Pre-commercial technology or strategy aspect	The project seeks to optimize SCE's current reliability dashboard tools, Reliability Analyzer and Outage Explorer reliability analysis applications. • Reliability Analyzer uses SCE outage data from ODRM and other sources to display outage causes, outliers, trends, and improvement opportunities. • Outage Explorer is an SAP Lumira tool which provides restoration performance information for all unplanned outages. Currently, input data is retrieved from SCE databases including OMS, Telogis, and other GIS sources. This demonstration furthers optimization of these reliability dashboard tools by: 1) Evaluating the addition of internal data sets; 2) Exploring the addition of internal or external algorithms or signatures; 3) Automating data feeds; and 4) Improving access to SCE users, such as through a web or portal link.
How the project avoids duplication from other initiatives	Within SCE, there are no other groups that are working on a similar project. The tool contains SCE customer outage and performance data, which is specific to SCE territory and its operational users.
Prioritization: High priority project	This project is considered high priority due to the value it provides to management, operational users, and anticipated benefits in reliability metrics, such as SAIDI and SAIFI. Operational groups within Transmission and Distribution, such as Reliability / Asset management, Grid Operations, Distribution Construction & Management (Field Engineering), and Safety would benefit from optimizing these reliability dashboard tools.
EPIC primary or secondary principles met	This project has ratepayer benefits and supports the EPIC's primary principles of promoting greater reliability and lower costs by providing SCE with a tool that can inform the optimal design and mitigation strategies to make the gird more reliable. This improved reliability has the potential to improve reductions in CMI, as well as safety metrics that include SAIDI and SAIFI. This project also supports EPIC's complementary principles for efficient use of ratepayer funds. This project provides clear electricity ratepayer benefits and supports EPIC's primary principles of promoting greater reliability and lower costs by providing SCE with a tool that can inform the optimal design and mitigation strategies to make the gird more reliable. The primary benefits include: • Reduction in SAIDI/SAIFI metrics. • Improved customer satisfaction through reduction in CMI • Improved decision-making for future outage restoration efforts

PROJECT NAME: VEHICLE-TO-GRID INTEGRATION USING ON-BOARD INVERTER

EPIC DESCRIPTION	PROJECT EXPLANATION
Technology or strategy to be demonstrated	This project seeks to build on the lessons learned from past vehicle grid integration (VGI) pilots where demand response for electric vehicle charging (V1G) was used. This demonstration will further evaluate discharging power to the grid from the vehicle batter (V2G) which is a probable near term application being pursued by many automakers. However, for V2G to become a possibility, there are still many unresolved issues that need to be explored. This project intends to work with automakers and electric vehicle supply equipment (EVSE) manufacturers on a demonstration of V2G, in order to: • Understand new interconnection issues such as: permitting discharge from inverters that conform to Society of Automotive Engineers (SAE) J3072: Interconnection Requirements for Onboard, Utility-Interactive Inverter Systems rather than UL 1741; allowing/disallowing discharge at multiple locations (EVs connect to the grid at multiple locations), and understanding how existing grid codes (e.g., Rule 21) apply to EVs. • Support the integration of these resources into SCE's new back office applications such as the distributed energy resources management system (DERMS) and Grid Interconnection Planning Tool (GIPT) in order to both support new types of interconnection and utilize these resources for grid support purposes such as voltage and frequency management or the integration of other renewable resources. • Evaluate related technologies and standards, including SCE's The Institute of Electrical and Electronics Engineers (IEEE) 2030.5 communications interfaces, the electric vehicle supply equipment which must provide many of the safety functions as existing solar grid-tied inverters (e.g., anti-islanding, voltage and frequency support, etc.), and the power line communications necessary between the EVSE and the EV (e.g., SAE 2847/3). The proposed project will be executed in two phases. Phase 1 (Jan 2018 – Mar 2019) will be a lab demonstration conducted at the Advanced Technology's Garage of the Future Lab, in Westminster, California. In it, the team will procure applicable technologies via Request for Proposals (RFP), including EVs from project partner automakers, L2 EVSEs, and network platforms such as EPRI's Open Vehicle Grid Integration Platform or automaker telematics. Phase 2 (Apr 2019 – Dec 2019) will consist of a field demonstration of V2G use cases and technologies at select customer sites. The use cases will be derived from SAE J2836/3 and Rule 21. VGI and V2G related industry documents will also be used to guide development of lab and field demonstrations. Industry documents include: SAE J2836/3, SAE J2837/3, SAE J3072, the California Smart Inverter Profile (CSIP) of IEEE 2030.5, ISO 15118 and IEEE 1547.
Concern, problem or gap to be addressed	As PEV penetration increases, it will become increasingly important to properly incentivize and coordinate use of PEV charging and discharging to reduce negative impacts to the grid, including preventing transformer overloading by staggering vehicle charging. Moreover, grid integration of flexible and potentially underutilized PEV battery storage can complement California's 2025 greenhouse gas emissions goal. In its Strategic Plan, the California Independent System Operator (CAISO) describes how EVs might serve as a "fast-acting grid-balancing resource" on a grid that has transformed from a centralized "one-way" system to a "two-way decentralized network." (CAISO, 2014-2016 Strategic Plan, September 2013). According to U.S. Department of Energy/Electric Power Research Institute's Electricity Storage Handbook, potential applications of PEVs as storage include customer facing services: power quality, power reliability, retail energy time-shift, demand charge mitigation; distribution infrastructure services: distribution upgrade deferral and voltage support; and wholesale market services, including frequency regulation. A demonstration to evaluate these potential uses for the grid is needed.
Pre-commercial technology or strategy aspect	As mentioned above, many of the processes, technologies and standards for V2G are still in development. SCE needs to begin evaluating V2G technology to ensure it can fully integrate these resource opportunities in the next 2-5 years, while also supporting SCE's Grid Modernization strategies.

EPIC DESCRIPTION	PROJECT EXPLANATION
How the project avoids duplication from other initiatives	Within SCE, there are no other groups that are working on a similar project. SCE has actively engaged EPRI, CPUC, and other IOUs to ensure duplication of effort has been avoided.
Prioritization: High priority project	This project is high priority because it supports both automakers and the Commission's transportation electrification efforts, specifically SCE's transportation electrification proposal and the Commission's ruling (R.13-11-007) requiring VGI. Moreover, this project aligns with Rule 21 Smart Inverter proceedings and ongoing Grid Modernization activities by assessing the technical and financial feasibility of V2G integration. Furthermore, SCE needs to evaluate regulatory barriers to use EVs as a grid resource and alignment of the objectives of the various actors: vehicle owner, charging station operator, facility, involved in the provision of power to or from the resource.
EPIC primary or secondary principles met	This project provides clear electricity ratepayer benefits and supports the EPIC's primary principles of promoting greater reliability and lower costs by evaluating the barriers and benefits of establishing V2G programs. New DER interconnections will also support power system planning and design, as it allows for full utilization of capacity within the existing and planned installed infrastructure before new assets deemed to be required. The project also supports EPIC complementary principles for societal benefits, greenhouse gas emissions mitigation and adaption in the electricity sector at the lowest possible cost, low-emission vehicles/transportation and is an efficient use of ratepayer monies.

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Transmission & Distribution Business Unit

PROJECT NAME: DISTRIBUTED PLUG-IN ELECTRIC VEHICLE CHARGING RESOURCES

EPIC DESCRIPTION	PROJECT EXPLANATION
Technology or strategy to be demonstrated	This project demonstrates Plug-in electric vehicle (PEV) fast charging stations with integrated energy storage that can be used to control the grid system impact of fast charging, allowing more vehicles to charge, and also to respond to grid needs as distributed energy resources (DERs) when not in use to charge a vehicle. Fast charging units currently demand 25 to 125 kW, and the load cannot be planned or scheduled. This demand is expected to climb to 350 kW or more as advertised by vehicle and charging system suppliers. This intermittent and unpredictable high demand present challenges to utility planning. Combining fast charging systems with energy storage can result in higher load factor, while still providing satisfactory service to customers. The size of such storage systems, along with power components, will determine their effectiveness in a particular duty cycle, by the demands on the system from customers in the real world. The demands on such energy storage systems may be met by the capabilities of used batteries. These measures increase the likelihood of higher numbers of such stations being operational. Integrated energy storage provides reliability in the case of grid events – transient or otherwise – and improves charging service in the evolving modern system of increased renewable and distributed generation. This project will demonstrate the reliability improvement of such systems subject to grid events. The project will demonstrate that energy storage integrated in charging systems can provide functions that support grid reliability. Typically, fast electric vehicle charging systems are not considered assets, which can be considered for Demand Response service. When such a system with integrated energy storage is installed and connected with proper communications and controls, it becomes a potential grid asset used by a distribution system operator to manage the grid. With modern electronics and inverters, communications, and controls, these systems could integrate with facility Energy Management System and SCE's SCADA to reduce peak demand and manage voltage. Energy storage may be used for ancillary services to charge or discharge instantly to provide frequency regulation, voltage control, and reserve energy that can be used by the grid to help integrate renewable power. It could also be used to provide distribution grid support, which would supply power and energy capacity to defer or eliminate the need to upgrade aging or inadequate gird infrastructure.
Concern, problem or gap to be addressed	State policy initiatives, such as SB 350 and SB 32 are driving transportation electrification, and one of the challenges is establishing enough charging infrastructure. Fast charging systems are seen as a helpful measure to increase penetration in the market, as those that might not have charging at home and those who travel long distances could be accommodated. Automakers have proposed increasing numbers of higher powered chargers, which could strain local electric systems. In addition, distribution system needs along with state policies are driving increased need for distributed generation and energy storage. At the same time, the industry is faced with the prospect of large quantities of used batteries from PEVs. This project demonstrates technology and techniques that can address these issues.
Pre-commercial technology or strategy aspect	The technology demonstrated in this project has been proposed by some suppliers, and some aspects have been demonstrated in a lab or isolated cases, but not at scale on large systems. One automaker has proposed an architecture that could be similar to what is demonstrated here.
How the project avoids duplication from other initiatives	Within SCE, there are no other groups that are working on a similar project. SCE has also benchmarked other investor-owned utilities (IOUs) across the state, and there does not appear to be work being performed to the extent described here.

EPIC DESCRIPTION	PROJECT EXPLANATION
Prioritization: High priority project	This project is considered a high priority. The project demonstrates high penetration of renewable generation and PEV charging demand through integration of DERs. Moreover, the project supports increasing numbers of higher powered chargers proposed by many automakers. The project also supports State clean energy policies, such as SB 350 and SB 32, which drives transportation electrification and has significant potential for load growth, system efficiency improvement, and carbon emission reduction.
EPIC primary or secondary principles met	This project supports the EPIC primary principles of greater reliability and lower costs and supports EPIC's complementary principles of low-emission vehicles/transportation and corresponding greenhouse gas mitigation and societal benefits. The project also provides clear ratepayer benefits through transportation electrification and supporting integration of renewable generation. Grid reliability could be enhanced through mitigated system impact and grid voltage support. Costs could be lowered by raising charger load factor and managing peak demand. System costs could be lowered by using a dual function asset on the same space and connection.

PROJECT NAME: SERVICE AND DISTRIBUTION CENTERS OF THE FUTURE

EPIC DESCRIPTION	PROJECT EXPLANATION
Technology or strategy to be demonstrated	This project will demonstrate an advanced SCE service center, housing electrified utility crew trucks, together with employee workplace charging, connected to a local service area with high penetration of distributed solar generation and plug-in electric vehicles. The electrification of transportation at the service center will be conducted in a way that not only does not adversely impact the local system, but interacts with the system using vehicle-grid integration (VGI) technology to ensure reliable and stable service at both the service center and local area. This project will deploy electrified utility trucks and utility and workplace electric vehicle supply equipment (EVSE) with advanced VGI communications and controls to receive and respond to both Demand Response (direct) and SCE grid (dynamic) signals to both ensure reliable charging and to support the local grid's stability. The vehicle systems, when not driving, can be used as grid assets and respond directly to support system voltage and stabilize demand. The two-front approach presented leverages the operating characteristics of both fleet trucks (charge during p.m.) and employee vehicles (charge in a.m.). Modern electric and hybrid electric vehicles and associated systems over a full range of sizes and applications needed for service center operations would be acquired and baseline tested in the lab for performance and power quality prior to being deployed for demonstration. Equipment would range from state of the art original equipment manufacturer available electric vehicles and plug-in electric vehicles, which range from light, medium, and heavy-duty utility specific trucks. Portable, battery based energy systems such as idle mitigation and electrified work equipment that charge from the grid would also be evaluated. Employee and guest electric vehicles would be accommodated with VGI capable charging infrastructure. Charging infrastructure, which may include Level 1, Level 2 and Direct Current Fast Charge EVSE, with integrated communication and control features in accordance with Society of Automotive Engineers, Institute of Electrical and Electronics Engineers, and other modern protocols would be acquired, lab evaluated, and then deployed for demonstration. Metering and data recording systems would be integrated and synchronized with building and facility EMS and SCE grid SCADA systems. This equipment will be able to respond to direct or dynamic requests based on grid and facility needs (i.e., voltage, reactive power, real power). This project demonstrates techniques and use cases documented in the VGI Roadmap published by the California Independent System Operator in February 2014 and evaluates the effectiveness of those techniques. The Roadmap identifies V1G and V2G use cases, and this project will evaluate both for effectiveness. V1G systems are controllable loads, whereas V2G systems can act as generators. The key goals of this project are to evaluate the ability to fully electrify an SCE service center with fleet vehicles and equipment and also employee charging, to effectively integrate this facility into the local distribution system with manageable impact, and to actively respond to and support the local grid system with distributed generators and loads. The results can be used to study such integration with other service centers.
Concern, problem or gap to be addressed	SCE is committed to electrify its fleet by allocating at least 5% of its annual vehicle purchase on electric drive vehicles. It is a challenge to satisfy all fleet requirements with electric drives, particularly in heavy-duty and specialized classes. This project will address the challenges of installing charging infrastructure to fully electrify, as well as the localized challenges that can result from high demand for PV distributed generation and concentrated PEV charging. Fully integrated and capable V1G and V2G systems have not been demonstrated. Moreover, the project supports SCE's grid reliability and modernization plan and lessons learned from the project may be applicable to SCE's fleet customers.

EPIC DESCRIPTION	PROJECT EXPLANATION
Pre-commercial technology or strategy aspect	Many of the technologies in this space are still in the development stage. SCE has not yet come across a solution that has been proven in all the cases described as a system working together on an actual distribution system. However, components have, and the advances are adequate enough to warrant further investigation and demonstration.
How the project avoids duplication from other initiatives	Within SCE, there are no other groups that are working on a similar fully integrated demonstration. SCE has also benchmarked other investor-owned utilities across the state, and there does not appear to be any similar work being performed.
Prioritization: High priority project	This project is considered high priority. SCE has challenges acquiring technology that meet fleet needs to satisfy fleet electrification goals, and large investments will soon be required to install charging infrastructure. Customer demand for distributed solar generation is high and may reach limits in some areas. Moreover, the project supports the state's In addition, aggressive clean energy policies for greenhouse gas reduction and transportation electrification.
EPIC primary or secondary principles met	This project supports the EPIC primary principles of greater reliability and lower costs and supports the EPIC's complementary principles of low-emission vehicles/transportation and corresponding greenhouse gas mitigation and societal benefits. The project also provides clear ratepayer benefits through transportation electrification and supporting integration of renewable generation. This project demonstrates equipment and techniques that can integrate those energy systems in large numbers, while continuing to provide reliable electric power, while doing so at lowest cost by utilizing data and controls, so that components are not just loads or generators, but interactive components.

PROJECT NAME: CONTROL AND PROTECTION FOR MICROGRIDS AND VIRTUAL POWER PLANTS

EPIC DESCRIPTION	PROJECT EXPLANATION
Technology or strategy to be demonstrated	This project will examine control and protection schemes for safe and reliable operation of distribution systems with customer owned nested microgrids (MGs) and virtual power plants (VPPs). Furthermore, this project will facilitate grid operations under high penetration of renewable resources and highly variable topology. Distribution level synchrophasor measurement units (D-PMU) technology offers high resolution, fast speed and precise monitoring and control systems that can enable deployment of advanced protection and operation schemes for microgrids. Example applications are angle and voltage instability detection and prevention; synchronized load transfer and system reconfiguration; and fault detection in systems with high penetration of power electronic apparatus. D-PMU will be included and evaluated as part of the solution platforms. This demonstration will be conducted in two phases. The first phase will be a lab demonstration using real time hardware in the loop testing approach (HIL). This testing approach will ensure detailed verification and examination of the schemes on simulated microgrids of various topologies and ownership structure. The second phase of the demonstration will include testing parts of SCE's distribution systems that include customer owned and/or SCE owned distributed energy resources (DERs) that will be used to implement nested microgrids. Distribution PMU applications can be accurately modeled and tested in RTDS, using hardware in the loop evaluation approaches to incorporate physical devices interacting with representative distribution system models. Testing scenarios will include sudden changes in generation and loads and dynamically varying topology of the system.
Concern, problem or gap to be addressed	Due to the rapidly increasing number of DERs being deployed on distribution systems, deployment of customer owned microgrids and virtual power plants, there are increasing challenges to grid reliability. Such customer owned and operated systems can frequently connect / disconnect to/from the grid or ramp up / down their aggregated generation or demand. The collective effects can drastically change the dynamic nature and characteristics of distribution systems; requiring high degree of granular monitoring, accurate event detection and situational awareness to facilitate very fast control/protection of the system integrity. The conventional protection and operation practices cannot meet the requirements of the microgrids. Microgrids will change the dynamics of the systems and will expose customers to events and phenomena,that if not properly monitored and controlled can significantly affect the quality and integrity of the grid.
Pre-commercial technology or strategy aspect	Use of technologies such as synchrophasor measurement units (PMU) and their associated applications for distribution systems offer unmatchable capabilities and greater flexibility in control and operation of highly dynamic distribution systems. The platform will be used to implement and demonstrate advanced protection and controls for microgrids that are highly dynamic with topology and characteristics changing frequently.
How the project avoids duplication from other initiatives	Within SCE, there are no other groups that are working on a similar project. SCE has also benchmarked other investor-owned utilities (IOUs) across the state, and there does not appear to be any similar work being performed that considers PMU applications for protection and controls of microgrids.

EPIC DESCRIPTION	PROJECT EXPLANATION
Prioritization: High priority project	This project is considered high priority, customer owned microgrids have received great attention in recent years and deployment is increasing. Many developers and technology providers are now offering DERs designed as microgrids. SCE engineers need to be proactive and use control and protection schemes that can best work and coordinate with the existing systems.
EPIC primary or secondary principles met	This project provides clear electricity ratepayer benefits and supports the EPIC's primary principles of promoting greater reliability and lower costs by evaluating the requirements and technologies of microgrids and systems with virtual power plants and aggregators. New protection and control schemes along with advanced monitoring will support increased DER penetration and maintains the reliability of the grid. The project will also provide the knowledge and skills required by utility engineers to supporting grid modernization.

PROJECT NAME: DISTRIBUTED ENERGY RESOURCES DYNAMICS INTEGRATION DEMONSTRATION

EPIC DESCRIPTION	PROJECT EXPLANATION
Technology or strategy to be demonstrated	This project aims to better understand the dynamics of distributed energy resources (DERs) and looks to engage utility partners, inverter manufacturers, and software vendors. This project will first review inverter manufacture data, understand individual inverters, and will demonstrate and validate the dynamics of DERs using real time power hardware in the loop (PHIL) tests. The project will then expand to circuit and substation level to evaluate aggregated DERs and capture the dynamics of multiple DERs in the system. Field data will be monitored and collected to benchmark and validate against the aggregated DER dynamics found in the lab. This lab demonstration will enable better understanding of the impact of high penetration of DERs on the distribution systems and the bulk system. Moreover, this effort can further help determine the optimum DER integration capacity, due to bulk system constraints, as well as inform the related technical requirement discussions and standard revisions currently ongoing in the industry.
Concern, problem or gap to be addressed	The increasing levels of DER penetration on the distribution system may negatively impact the performance of not only distribution systems, but also transmission systems (and subtransmission systems). Most of these impacts are envisioned to be protection related, and requires greater evaluation to understand the dynamic responses of individual DERs, as well as aggregated DERs. In addition, with the recent industry trend, DERs may become more active participants in supporting system stability. Understanding DERs that reflect the individual and aggregated dynamic behaviors are essential for sound system stability and grid protection.
Pre-commercial technology or strategy aspect	The technologies explored in this project are still in the development stage. SCE has not yet come across a software or technology solution that addresses this concern.
How the project avoids duplication from other initiatives	Generic DER models have been developed for dynamic studies, however, these generic models need to be further enhanced and demonstrated to capture the behaviors that are required from Rule 21 and Institute of Electrical and Electronics Engineers (IEEE) 1547 revision. In addition, there seems no effort as of yet to demonstrate and validate DERs, especially on an aggregated basis.
Prioritization: High priority project	This project is considered high priority. As DER penetration continues to grow at a fast pace, the envisioned impact may occur in the near future and better understanding of the potential impacts, as well as the determination of DER integration capacity are critical to ensure safe and reliable bulk system operation.
EPIC primary or secondary principles met	As this project will enable more safe DER interconnections and minimize the adverse aggregated impacts to bulk power system, this project provides clear electricity ratepayer benefits and supports EPIC's primary principles of promoting greater reliability and lower costs. In addition, this project also supports EPIC's secondary principles including GHG emission mitigation and adaptation in the electricity sector at the lowest possible cost.

PROJECT NAME: DISTRIBUTED ENEGERY RESOURCES PROTECTION AND CONTROL OF DISTRIBUTION NETWORKS

EPIC DESCRIPTION	PROJECT EXPLANATION
Technology or strategy to be demonstrated	This project will examine and evaluate the impact of high penetrations of Distributed Energy Resources (DER) on SCE's existing protection and controls practices for the distribution system. This includes the interaction between the control systems of various types of DERs during system events, as well as the interaction between the DER control systems with existing distribution system control practices. The demonstration will include a parametric analysis that will consider the following main items: • Different circuits within SCE's system (rural or urban and meshed versus radial); • Different penetration levels of DER; • Different types of DER (PV, synchronous machine, BESS, etc.); and • Different types of system load (industrial, residential, and commercial). The results of this project will provide insight into the performance and the reliability of the protection system and identify possible improvements in the protection system schemes to maintain dependability and reliability of the protection scheme under high penetration of DERs. The results of this project also will support SCE to identify the limitations and to improve its existing practices/systems.
Concern, problem or gap to be addressed	Historically, distribution systems assumed unidirectional power flow and existed purely to serve load. The incorporation of DER challenges these traditional design/operational philosophies and requires system operators and designers to re-examine their distribution systems protection practice. Highly dynamic distribution systems requires revision of the current distribution system protection practices, in order to maintain the reliability and dependability of the protection system.
Pre-commercial technology or strategy aspect	This is focused on investigation of interactions of DER control system and existing system protection practice under different circuit configuration/DER penetration/load and DER characteristics. The study and demonstration will be focused on electromagnetic and transient domain, which is different from what ICA is examining (steady-state and long-term dynamics).
How the project avoids duplication from other initiatives	Within SCE, there are no other groups that are working on a similar project. SCE has also benchmarked other investor-owned utilities (IOUs) across the state, and there does not appear to be any similar work being performed that considers mitigation solutions.
Prioritization: High priority project	This project is considered high priority. Due to the growing use of sophisticated technologies by residential and commercial customers, and high penetration of DERs, there is an urgent need to review the protection system behavior and identify possible improvements.
EPIC primary or secondary principles met	This project provides clear electricity ratepayer benefits and supports EPIC's primary principles of promoting greater reliability and lower costs by evaluating and revising the distribution system protection practice to enhance the reliability and dependability of the distribution protection system under high penetration of DER. The demonstration will enable faster interconnections and increase in penetration level of PV systems without comprising the reliability of the protection system for the hosting feeder.

PROJECT NAME: PREDICTIVE DISTRIBUTION RELIABILITY

EPIC DESCRIPTION	PROJECT EXPLANATION
Technology or strategy to be demonstrated	This project will help to quantitatively evaluate the reliability impacts of DERs which can guide proper mitigation measures to ensure a continuously safe and reliable power supply to customers. This project will identify the limitations of current predictive reliability analysis methodology and identify possible enhancement so that distribution reliability with the presence of DERs can be properly analyzed. Predictive distribution reliability will demonstrate future reliability trends, explore and prioritize reliability improvement options, and to minimize potential risks. Current methodologies are based on unidirectional power flow assumption, which may not be the case with DER integration. This project will examine technologies that are capable of simulating system reliability behaviors under bidirectional power flow scenarios which include the numbers of customers being impacted by both momentary and sustained outages, the restoration mechanism under DER penetration with and without microgrid, and the duration of customers experiencing outages in order to properly calculate the expected distribution reliability indices such as System Average Interruption Frequency Index (SAIFI) and System Average Interruption Duration Index (SAIDI), and potentially new metrics for DER scenarios. During this project, various factors will be taken into consideration. These include but are not limited to the variability of DER output and the impact of DERs to distribution automation.
Concern, problem or gap to be addressed	One of the potential benefits that DERs might be able to provide is to enhance distribution grid reliability by supporting local customers when main grid experiences outages (e.g. microgrid). However, many inverter-based DERs will trip off during system disturbance under the current requirements, which may even worsen the condition, if a large number of DERs trip off in a short period of time. In addition, DERs can mask the actual customer demand and there currently is limited visibility of DERs to operators, who either need additional time to verify the information or do not perform load transfer with the concerns of overloading and tripping the circuit breakers on the adjacent circuits. This will increase the system restoration time and negatively impact system reliability. The variable DER output will further add uncertainty to the system reliability. Current studies mainly focus on safe and economical DER interconnections. Less focus has been put on understanding the impacts of DERs to distribution reliability. This predictive distribution reliability demonstration can help create cost-effective reliability project plans by simulating system reliability performance under various scenarios. SCE has been performing this analysis to prioritize reliability improvement projects (e.g., aging infrastructure replacement). However, current predictive reliability analysis methodologies adopted in most commercial power system analysis tools depend on upstream protective device identification, assuming one-way power flow. As reverse power flow will occur in various locations on the grid with more and more DERs interconnected, a new predictive distribution reliability will be needed to properly maintain system reliability.
Pre-commercial technology or strategy aspect	The technologies in this space are still in the development stage. SCE has not yet come across a software or technology solution that addresses this concern.
How the project avoids duplication from other initiatives	Within SCE, there are no other groups that are working on a similar project. SCE has also benchmarked other investor-owned utilities (IOUs) across the state, and there does not appear to be any similar work being performed.
Prioritization: High priority project	This project is considered medium priority. A thorough understanding of DER impacts to distribution reliability will allow SCE to properly respond to system outage events and proactively prepare for necessary mitigation measures. This predictive reliability demonstration will prepare SCE for continuously effective system improvement programs under different levels of DER penetration.

EPIC DESCRIPTION	PROJECT EXPLANATION
EPIC primary or secondary principles met	This project provides clear electricity ratepayer benefits and supports the EPIC's primary principles of promoting greater reliability and lower costs by evaluating the reliability impacts of DERs for faster and safer mitigations and by examining the possibility of establishing an accurate reliability assessment to guide future system reliability improvement programs effectively.

PROJECT NAME: POWER SYSTEM VOLTAGE AND VAR CONTROL UNDER HIGH RENEWABLES PENETRATION

EPIC DESCRIPTION	PROJECT EXPLANATION
Technology or strategy to be demonstrated	The project is an extension of EPIC I Voltage and Var Control of SCE Transmission System. The voltage and reactive power management of the power grid has been an important and challenging subject for power system engineers and operators who are responsible for power system planning and operations. With the increasing penetration of renewable generation in both transmission and distribution systems, the voltage and reactive power management is becoming even more complicated than ever. The project will continue under the framework of the existing EPIC I demonstration project and addresses additional emerging aspects that are becoming more significant in Voltage and Var Optimization (VVO) solutions. • The variable nature of the renewable generation, especially the solar PV systems: High penetration of renewable generation exhibits steep upward/downward ramping during certain hours of the day. Forecasting of the ramping (besides loads), together with the “look-ahead VVO” is important to manage the voltage and reactive power effectively. • The cluster nature of the Distributed Energy Resources (DERs) and impacts from distribution to transmission systems: With more DERs being installed in the distribution system, how to manage the reactive power flows between transmission and distribution system, and how to leverage the distributed generation, are becoming critical. This project will demonstrate in a lab setting the effect of a Voltage & VAR management and control algorithm that optimizes the operation of the power grid, for both the transmission and distribution systems, by regulating voltage and controlling VAR resources optimally while maintaining the secure operation of the power grid.
Concern, problem or gap to be addressed	Power grids are facing major transformation with the increase in renewable energy. With high penetration of generation from renewables in the power grid, the challenges of operating the system reliably will increase given the variability of these resources, which directly affects the stability and reliability of the power grid. Over-voltage and voltage fluctuations are common problems seen in areas with high penetration of renewables due to the resource variability and lack of VAR control coordination. The scope of this project will demonstrate the required technology that is needed to maintain a reliable operation of the power system given the increased renewable integration.
Pre-commercial technology or strategy aspect	Technologies that coordinate transmission and distribution voltages are in an early developmental stage. While a significant number of studies and demonstrations in the voltage and VAR management for either transmission system or distribution system have been made, SCE has not yet come across a software or technology solution that adequately models and manages the transmission and distribution voltage.
How the project avoids duplication from other initiatives	SCE has benchmarked other investor-owned utilities (IOUs) across the nation and internationally that are studying this area, and there does not appear to be any similar work being performed.
Prioritization: High priority project	This project is considered high priority. Regulating and controlling VAR resources to optimize the grid, helps to ensure a healthy voltage profile under high penetration of renewables.

EPIC DESCRIPTION	PROJECT EXPLANATION
EPIC primary or secondary principles met	This project supports the EPIC's primary principles of promoting greater reliability and lower costs and also supports EPIC's complementary principle of Greenhouse gas emissions and adaption in the electricity sector at the lowest possible costs. Moreover, this project will not only increase system reliability, but also minimize cost of the power system operation by reducing power losses, equipment maintenance, and emissions.

PROJECT NAME: TOOLS AND TECHNOLOGIES FOR MANAGING SECONDARY SYSTEMS

EPIC DESCRIPTION	PROJECT EXPLANATION
Technology or strategy to be demonstrated	This project will examine advanced planning tools and use of technologies for enhancing power quality and maintaining regulatory compliance on secondary systems. The project will expand the planning engineering capability to analyze the voltage deviations and power fluctuations introduced by adjacent loads or as a result of events on primary systems – which is beyond the capability of conventional planning and analysis tools utilize today. However, due to increase in customer system sophistication and integration of distributed energy resources (DERs) and use of power electronics, there is a need to demonstrate mitigation solutions on secondary systems to determine their effectiveness in correcting harmonics, supra harmonics (frequencies up to 20 kHz), fast voltage variations, slow voltage variations, voltage unbalance, voltage sag and swell, and to manage power flow including reactive power compensation for power factor adjustment, and reverse power flow control. In addition, the method of integrating the secondary mitigation technologies in typical utility operation systems, such as D-SCADA and DMS through secure gateways and data concentrators will be examined to expand capability and visibility of utility operator into secondary systems. The tools and technologies will be demonstrated using hardware-in-the-loop (HIL) testing in a lab setting.
Concern, problem or gap to be addressed	The growing amount of residential PV systems and other customer owned DER systems, as well as the increase in the number of electric vehicle charging stations deployed at residential and small commercial facilities have been creating power quality concerns on secondary systems. Extreme under/over voltage situations can respectively occur, due to large demand or excess PV production. Traditionally the distribution grid has managed voltage, reactive power and power quality at primary systems (e.g. 12 kV feeders and laterals). Distribution system operators can be unaware of and simply unable of directly monitoring and controlling secondary systems, mostly due to the data which is often aggregated when it gets to control centers; being blind to system dynamics such as voltage sags and swells. Although smart inverters in residential PV applications or energy storage systems can potentially offer promising grid supporting capabilities, they are technically out of the direct control of the operators and may not be readily available for control of secondary system voltages or reactive power due to the customers' business preferences. In this environment, stand-alone secondary control devices deployed at service transformer level can provide the level of autonomy and dependency that is expected from the Utility for control and management of power quality issues.
Pre-commercial technology or strategy aspect	The project will focus on evaluating a new strategy for improving planning and analysis tools for investigating and mitigating power quality issues on service transformers, and also to determine best practices for integrating them in day-to-day operating procedures of the distribution systems. The project will also provide monitoring and control capability for operators to have visibility of secondary systems in real time.
How the project avoids duplication from other initiatives	Within SCE, there are no other groups that are working on a similar project. SCE has also benchmarked other investor-owned utilities (IOUs) across the state, and there does not appear to be any similar work being performed that considers mitigation solutions and development of advanced planning tools for secondary systems.

EPIC DESCRIPTION	PROJECT EXPLANATION
Prioritization: High priority project	This project is considered high priority; due to the growing use of sophisticated technologies by residential and commercial customers and also high penetration of DERs, there is an urgent need to improve planning and analysis tools for investigation and mitigation of power quality issues on service transformers. The project will also provide monitoring and control capability for operators to have visibility of secondary systems in real time.
EPIC primary or secondary principles met	This project provides clear electricity ratepayer benefits and supports EPIC's primary principles of promoting greater reliability and lower costs by evaluating mitigation solutions for the secondary networks leading to enhanced power quality and resiliency of the customer systems. Furthermore, evaluation of the requirements for enhancing power qualities, increasing visibility, and installation of power conditioning will help to enable faster interconnections and increase in penetration level of PV systems.

Appendix B

Energy Efficiency and Demand Response Emerging Technology Programs

Energy Efficiency and Demand Response Emerging Technology Programs

SCE provides this appendix, per the Commission's requirements summarizing the research, development, and demonstration (RD&D) activities undertaken in the Energy Efficiency (EE) and Demand Response (DR) portfolios. Moreover this appendix describes each project, including the purpose, funding, deliverables and progress to date.[1] The EE and DR projects described in this appendix confirm there is no duplication or overlap between SCE's proposed 2015-2017 EPIC Investment Plan and existing efforts in SCE's EE and DR programs.

<u>The Emerging Technologies Program (ETP)</u>

The ETP comprises SCE's current RD&D EE activities.[2] The ETP is a full spectrum RD&D program and its purpose is to support increased energy efficiency market demand and technology supply[3]. The ETP develops, assesses, and introduces new and under-utilized EE measures, such as technologies, strategies, practices and tools. The ETP also facilitates the wide-spread adoption of these EE measures to support California's energy and demand savings goals, such as those established in Commission's California Long Term Energy Efficiency Strategic Plan[4] and the California Global warming Solution Act of 2006. The ETP currently has 44 active projects. Due to the volume of active projects, SCE provides ETP project details in a spreadsheet as an attachment to this appendix.

See Attachment 1: ETP Active Projects

<u>The Emerging Markets & Technology Program (EM&T)</u>

The EM&T program supports the development of pre-commercial enabling technology solutions for SCE's current demand response (DR) programs portfolio. The goal of the EM&T Program is to facilitate the evaluation and market deployment of innovative hardware, software, and services that can enhance the customer enrollment and performance of DR rates, programs, and resources. The EM&T program currently has 16 active projects; please see the tables below for additional details[5]:

DR12.17 Field Testing of Climate-Appropriate Air Conditioning Systems	$100,000
<u>Purpose:</u> This field study was initiated to examine the long term potential for energy efficiency for a specific AC system technology, and has been incrementally enhanced for evaluating the current and potential DR capabilities of climate-appropriate AC systems, such as evaporative cooling and VCHP. Targeted DR and EE programs can help reduce high peak demand caused by increased AC use and address uncertainties about generation and consumption caused by extreme weather conditions. This field study will analyze how automated and optimized DR technology, combined with an understanding a building's heating, ventilation, and air conditioning (HVAC) capacity and thermal characteristics, can build and implement accurate relationships between DR lead time, customer incentives, DR duration, external environmental conditions, and building occupancy.	

[1] D.13-11-025, at OP 40.

[2] D.12-05-015, adopted EE Portfolios for 2013-2014.

[3] Defined as market breadth, depth and efficacy of product offerings.

[4] *Available at* http://www.cpuc.ca.gov/NR/rdonlyres/D4321448-208C-48F9-9F62-1BBB14A8D717/0/EEStrategicPlan.pdf.

[5] Project details are extracted from SCE's EM&T Demand Response Projects Semi-Annual Report: Q3-Q4 2016, filed April 3, 2017, as well as project updates from SCE personnel.

<u>Deliverables</u>: SCE will finalize the results and complete a final report in 2017 to assess the market potential and load impact of the devices when the DR technology is available. <u>Progress to Date</u>: Equipment construction is complete, and the vendor has implemented monitoring equipment in the field. The commissioning phase has been completed. Data collection was completed at the end of Q2 2016 and includes EE and DR functional potential. The first phase of the demand response controls equipment has been installed and commissioned for the specific systems under test and are now under final assessment for determining the broader market adoption.

DR12.21 Field Testing of DR-Ready End-Use Devices	$200,000
<u>Purpose:</u> Manufacturers are continuously introducing new DR-ready end-use devices, including appliances, into the consumer market. This project, a part of EPRI Subproject G, is selecting and testing one of these technologies, both in the lab and in the field, to determine its ability to meet SCE's demand- reduction objectives as an enabling technology for its Auto DR incentive program. <u>Deliverables</u>: The project is integrated into an EE/DR buildings contract with EPRI and is co-funded by EM&T to identify DR potential. SCE is awaiting the complete EPRI project team report on the field and lab testing of DR-Ready end-use devices. <u>Progress to Date</u>: The Project has completed the Field and Lab trials with collected findings on data reporting on a Friedrich Window AC (Internal DR module) and ThinkEco Modlet unit tested in EPRI's Knoxville laboratory and the ThinkEco Modlet units deployed in residential homes in the Southern California Edison Service territory. The draft report will also include recommendations for product enhancements to better support SCE's peak load reduction objectives for connected devices. SCE is finalizing drafts on field and lab data collection and analyses for the project report.	

DR12.40 Field Testing of Occupancy-Based Guest Room Controls	$60,000
<u>Purpose:</u> An occupancy-based guestroom energy management system senses when a hotel room is occupied and adjusts the energy systems—such as HVAC, lighting, and outlets—accordingly to save energy. The control capabilities of these occupancy-based control products could be used for DR. However, implementing this capability requires additional investment in software and communications, and hotels and motels have been reluctant to implement DR measures in guestrooms due to concerns about inconveniencing guests. <u>Deliverables</u>: The final report will be posted to the ETCC website when complete. It is being reviewed for accuracy and conformance for public release standards before being finalized. <u>Progress to Date</u>: Since project start, the team has identified customer sites, obtained signed agreements from customers, and installed the guest room controls. Further, the setup of vendors in the DR servers is complete. Two vendors have obtained certification for OpenADR 2.0a, and a third vendor is in the certification process. Data loggers have been installed and information is being collected and is under assessment at this time.	

DR13.05 Demonstrating Grid Integration of ZNE Communities	$80,000

Purpose:
This is an ET SCE partnership, through a CPUC/CSI solicitation, with EPRI as the awardee and other stakeholders, including a large production homebuilder (Meritage) to design, build and monitor a new ZNE residential community of 20 new homes in Fontana. SCE will act as the project's lead on emerging DSM technologies, battery storage integration, electrical grid optimization, and post-monitoring. There are some minor aspects related to DR enablement for the ZNE grid interactivity and the funding is an incremental component of the overall EE/DR collaboration.

Deliverables:
The main deliverable of this project will be a detailed report summarizing project findings and recommendations to help overcome market barriers to community-scale ZNE homes.

Progress to Date:
Currently, the project is in the post-occupancy monitoring phase, in which circuit-level monitoring is in progress for all 20 homes. The team is in the process of collecting high-resolution AMI interval kWh and kVAR data to better understand the impact of the 20 homes on the local distribution system. This approach to understand distribution level service impacts from the ZNE homes was taken up with Advanced Technology group in Q1 2017, and in Q2 a preliminary extract of data was retrieved and is under assessment by SCE internal staff.

DR13.07 EPRI EB III B- HVAC & Refrigeration Systems Using Advanced Refrigerants	$195,000

Purpose:
This project explores and documents advances in product development for advanced refrigerants in applications fueled by natural gas and electricity, with the goal of identifying products for laboratory evaluation and field deployment. Once appropriate systems are selected and laboratory tested, this project intends to field test systems using advanced refrigerants in commercial and small industrial applications at multiple sites in SCE’s service area to evaluate their effectiveness for energy efficiency and demand response.

Deliverables:
The larger draft report that contains the demand response sub-project has now been initiated by the EPRI team and a final report is expected in 2017.

Progress to Date:
The project team will continue progressing on the laboratory and field demonstrations that have taken longer than originally scheduled due to changes in the technology that will be included in the final report. The larger draft report that contains the demand response sub-project has now been initiated by the EPRI team and a final report was expected in Q1 2017.Current status of the demand response sub-project is on hold awaiting the final EPRI advanced refrigerants summary report.

DR14.01 Deep Retrofits in Low Income Multi-Family Housing	$40,000

Purpose:
This ZNE Deep Energy Retrofit sub-project of an overall ET project showcases a range of high-efficiency and DR technologies within a 30-unit subset of a 100-unit 1970s low-income multi-family (LIMF) development. These thirty units have been retrofitted to ZNE levels, with a 75kW PV array reducing grid load. Battery storage is being considered currently, and in conjunction with smart thermostats, will be examined to better understand how to be able to deliver energy savings during DR events.

Deliverables:
Final project report created by EPRI on the overall project with support from SCE and BIRA will include the assessment of DR technologies.

Progress to Date:
Thirty "Smart" Programmable Communicating Thermostats were installed in July 2015 in the thirty units that have been retrofitted. They have collected data for a year and partners are analyzing the data for findings to be included in the final project report, led by EPRI with support from SCE and BIRA. Ten each of three different brands were installed: Trane, Nest and Ecobee. Data collection from the LMF development is continuing to assess multi-seasonal variances in overall efficiency and performance of the end uses, and the specific thermostat load impacts.

DR14.02 ZNE Retrofit Commercial Training Facility	$40,000

Purpose:
This is a partnership with a large training facility (Electric Training Institute) in Commerce, California to retrofit the existing 140,000 SF commercial building towards achieving Zero Net Energy (ZNE). SCE will act as the project's expert and lead for emerging DSM technologies, including battery storage integration and post-monitoring.

Deliverables:
The main deliverable of this project will be a detailed report summarizing project findings and recommendations to help overcome market barriers to ZNE commercial retrofits.

Progress to Date:
Construction on this retrofit project was completed in early 2016. ETI is now seeking participation in a number of SCE programs in Savings By Design and possibly the Self-Generation Incentive Program. SCE is working with ETI to best determine an instrumentation plan but has not yet developed a research plan to examine how the ETI can contribute to the EM&T research agenda.

DR14.07 Conditioned Crawl Space (CCS)	$35,000

Purpose:
This DR project is being conducted within the larger CCS Field Study, which is endeavoring to discover if energy efficiency improves when the building envelope is modified by moving the pressure boundary (conditioned space) of the building envelope from the framed floor to the earth grade underneath the floor.

A second important element is to research the possibility of replicating these efficiency measures in modular housing. This housing sector is a significant segment of the housing/"relocatable" school building stock in SCE territory.

Finally, the project will help SCE drive new EE technologies by developing cost-effective/ incentive-ready emerging technology measures around the CCS area. This project will break ground on existing and new construction with CCS, using the PCT to signal DR events. The DR goal is to be able to shut off the AC compressors, but still run the fan to circulate the cool air from beneath the house, thus keeping the house cool through the DR event.

Deliverables:
The results will be analyzed and included in the project report.

Progress to Date: The measures have been installed in 4 homes in 4 CZs. Data collection is underway. DR tests were performed on several different days on all the homes.	

DR13.06 EPRI EB III A- Variable Capacity Space Conditioning Systems for Residential	$125,000
Purpose: This project evaluates the DR capability of VCHP systems. The tested products will include traditional “American-style” high-static ducted systems. Testing will focus on three products. The project team will leverage lab and field testing to evaluate the response of the VCHP system to demand control signals. An appropriate signaling/controlling method will be selected (such as OpenADR 2.0) to enable DR testing under varying operating conditions. Project plans include conducting a survey of technologies followed by developing and executing lab and field test plans. Steps for the field tests include generating and applying site selection criteria, creating site monitoring plans, and installing, commissioning, and testing the systems. Deliverables: Deliverables from the project will include documentation of the steps, test plans and results, and a final report. Progress to Date: Project is in the final stages of completion (summary data analysis, draft final report, and commercialization assessment). Vendor will continue data analysis/reporting. Vendor will deliver summary/raw data to project manager. Project manager will review findings and provide feedback. The project report has been initiated.	

DR13.08 EPRI EB III D- Advanced Energy Efficiency & Demand Response Concepts in Data Centers	$235,000
Purpose: The goal of this project is to conduct a field test of a software program that reduces computer power demand in response to an OpenADR signal. • A software program that reduces computer power demand in response to an OpenADR signal • Liquid cooling technology for data center servers • Replacement of existing computer servers with more efficient equipment The evaluations will cover the performance, customer acceptance, operational viability, demand reduction, demand response, and cost-effectiveness of the technologies. Deliverables: Report to be finalized and posted on the ETCC web site in early 2017 for public dissemination. Progress to Date: Field test completed and draft report submitted for SCE technical and prudency review.	

DR15.18 Wastewater Treatment Plant Demand Response	$175,000
Purpose: Wastewater processing is a continuous activity since it is typically not possible to store the incoming wastewater to be treated. Although the wastewater entering the plant and the ongoing process cannot be shut down for a DR event, recent development work has shown a significant reduction in blowers used for aeration, which requires 50% of the plant’s energy, is possible for a DR event. If only the	

aeration set points are curtailed, the DR event can span across consecutive hours. This modification to the plants operation needs to be fully demonstrated to verify that the operations can be changed for one or more hours without jeopardizing the stability of the plant and the ability to meet the wastewater discharge permit. This project will explore and test several changes to the operation, finding the one that meets the DR objective with the least impact to the plants operation and with the highest impact on power demand reduction.

Deliverables:
The project is designed to develop an energy efficiency model that will optimize wastewater blower optimization. The project team will also identify DR strategies that could be coupled with either demand limiting actions (shape) or scheduled transfer of operations (shift) as well.

Progress to Date:
The wastewater DR project has been initiated with the selection of the Project Advisory Committee and demonstration site selection completed (Inland Empire Utility Authority (IEUA)). The procurement of the equipment to construct the oxygen transfer efficiency (OTE) analyzer, needed for controlling the plant during the DR event, is 50% complete.

DR15.21 LINC Housing- Low-Income Multi-Family ZNE New Construction	$40,000

Purpose:
The goal of this project is to conduct a field test to evaluate viable measures that could provide energy efficiency and demand response capabilities in the individual residential units and possibly in the entire residential complex as a whole.

- Smart thermostats to reduce electricity demand in response to an OpenADR signal or other DR initiation
- Battery storage and advanced controls for the entire building complex using VNEM to support grid stabilization
- Other possible DR options as the design team and stakeholders agree to utilize

The evaluations will cover the performance, customer acceptance, operational viability, energy efficiency, demand reduction, demand response, and cost-effectiveness of the technologies chosen. Steps in the project will involve identifying technologies to be evaluated, develop SOW, develop testing plans, installation of equipment/ software, commissioning, conducting DR and other tests, reporting results.

Deliverables:
The final report is slated for completion five quarters after first occupancy, likely Q2 2018.

Progress to Date:
Construction is in progress with foundational work and site preparation. To date, the project team is finalizing their plan for identifying specific technologies for evaluation.

DR15.20 Dispatchable Condenser Air Pre-Cooler	$269,179

Purpose:
This project is one aspect of an overall air conditioner efficiency portfolio of projects under contract to the UC Davis Western Cooling Efficiency Center. The project will conduct laboratory and field studies to determine the transient response and load profile reduction of a Roof Top air conditioning Unit (RTU) after an evaporative pre-cooler is turned on. This data will be used to determine the potential of using pre-coolers with AC systems as a dispatchable load balancing strategy.

Deliverables: The study will identify the efficiency of the pre-cooling strategy with load impacts and water usage, as well as market accessibility in a report in early 2018. Progress to Date: The project contract has been awarded and the Research Plan has been developed and approved. As the academic schedule and resource availability are coordinated, laboratory testing for this assessment is expected to commence prior to the summer of 2017.

DR16.08 Demand Response Clean-up for 2019 Title 24	$150,000
Purpose: The objectives of this code change proposal is to clean up and clarify the existing DR requirements so all sections of the standards use consistent terminology and approach. The goals are to improve comprehension of and compliance with the requirements and to make it easier for occupants of buildings to realize the economic benefits of their buildings' DR capabilities by enrolling in utility DR programs. The scope of this project also initially included a look into the feasibility of adding demand flexibility to Title 24. However, the team decided to defer demand flexibility consideration for future code cycles. Deliverables: Recommendations and comments from the meeting mentioned below are being used to develop the Codes and Standards Enhancement (CASE) Report for the 2019 Title 24 rulemaking process. Progress to Date: An initial stakeholder workshop was held in Q4 2016.	

DR16.02 Open Vehicle Grid Integration Platform (OVGIP)	$117,700
Purpose: The goal of this project is to evaluate the potential of Electric Vehicles (EVs) as a potential DR resource while participating in DR programs via an aggregator. To achieve this goal, the SCE will dispatch DR events to OVGIP. OVGIP is a platform that provides single interface to receive OpenADR signals from utilities and translates into proprietary automaker's software platforms. The automaker platform will dispatch vehicles with available capacity to provide the demand reduction. Deliverables: The final report is expected to be published in 2018. Progress to Date: The OVGIP platform is ready and is being enrolled with utility DRAS to begin functional testing. Automakers are preparing for customer enrollment.	

DR16.06 Market Characterization Study of ADR Capabilities of VRF	$70,000
Purpose: The objectives of this study are to understand the status of ADR-capable controls across VRF manufacturers, report on VRF controls compliance with the demand response (DR) requirements in both California's existing building energy code, as well as DR requirements in ASHRAE.	

This project helps make informed decisions about the ADR capabilities of VRF control systems and determine which are ready for accelerated commercialization in incentive programs. Specific objectives include:

- Research the status of ADR-capable VRF controls among different VRF manufacturers.
- Review whether VRF controls meet demand response requirements in the California energy code.
- Report on available plans by VRF manufacturers to offer ADR-capable controls

Deliverables:
The project report will provide findings and include recommendations for SCE to encourage the further development of ADR-capable control functions in VRF equipment.

Progress to Date:
The project report is in the draft stage, with the development of a research plan and market characterization schedule. The market assessment and technology road map for DR VRF capabilities are in development, as a secondary objective under the overall VRF market characterizations. To date, VRF control research, code compliance assessment, and vendor technology road map development are all in progress.

SCE Emerging Technologies Program - Active Project Listing

Project Number	Year	Project Name	Project Description	Budget Total	Expected Completion Date
ET11SCE2041	2011	ZNE Low Rise Office	Southern California Edison (SCE) is teaming up with an architect/developer to design, construct and monitor a new Zero Net Energy (ZNE) office building in South Pasadena. SCE will act as the project's lead on energy, emerging DSM technologies and will support the building's architect of record and owner. SCE will document the process of achieving the statewide goal of ZNE through a hands-on, engaged and collaborative approach. Primary goals of the project include increasing market exposure of already-proven EE/DR/DG/ES technologies and addressing market barriers to ZNE in support of CA's Strategic Plan (CLTEESP). DELIVERABLE: The main deliverable of this project will be a detailed report summarizing project findings and recommendations to help overcome market barriers to newly constructed ZNE commercial buildings.	$200,000	December 2018
ET12SCE1090	2012	Testing of Commercial Variable Capacity Heat Pump (VCHP) Systems for Small Commercial Office Buildings	This field study is evaluating the potential of variable capacity heat pump (VCHP) systems that have the ability to use smart integrated controls, variable-speed drives, refrigerant piping, and heat recovery to provide interior temperature control any products that can be controlled by a PCTsmart thermostat with attributes that include high energy efficiency, flexible operation, ease of installation, low noise, zone control, and comfort using all-electric technology. This project utilizes EPRI funding in the amount of $219,000.00 The expected outcome is the Validation of savings for workpaper/customized calculation development. DELIVERABLE: The deliverable of the project is a report and the validation of the equipment for energy efficiency and demand response.	$185,000	June 2017
ET12SCE1091	2012	Field Testing of Climate Appropriate Air Conditioning Systems	This project is a field study evaluating the potential and current DR capabilities of climate-appropriate air-conditioning (AC) systems. Targeted DR and EE programs can help reduce high peak demand caused by increased AC use and address uncertainties with respect to generation and consumption caused by extreme weather conditions. This field study will analyze how automated and optimized DR technology can build and implement accurate relationships between DR lead time, customer incentives, DR duration, external environmental conditions, and building occupancy by understanding a building’s heating, ventilation, and air conditioning (HVAC) capacity and thermal characteristics. The expected outcome is validation of savings for workpaper/customized calculation development, verification of market potential. DELIVERABLE : Final report on equipment savings from analysis of the monitoring results and the demand response capabilities of the system.	$135,000	June 2017
ET13SCE1220	2013	Variable Capacity Space Conditioning Systems for Residential Customers	The purpose of this project is to evaluate efficiency/performance of residential variable capacity heat pump (VCHP) systems. These are "traditional American-style" high static ducted systems. There will be one to two systems from three to five manufacturers. Laboratory testing followed by field testing will be undertaken to validate performance. DELIVERABLES: The deliverable of the project will be a final report with the following items: - Survey of available technologies - Lab test plan - Lab results - Site selection criteria document - Site monitoring plan(s) - System installation and commissioning - Field results - Final report	$125,000	July 2017

Project Number	Year	Project Name	Project Description	Budget Total	Expected Completion Date
ET13SCE1200	2013	Refrigerated Prep Tables for Food Service Applications	This task will encompass applying an industry-accepted standard test method to up to five different models of refrigerated preparation tables to support the development of a refrigerated preparation table database. Once populated, the database will be used to support workpaper development for a new program offering to promote energy-efficient refrigerated preparation tables. ASTM test summaries will be developed for each appliance tested and the results will be recorded in a central appliance performance database. DELIVERABLE: Results summary sheets and reports for each unit detailing outputs from ASTM testing.	$85,030	September 2017
ET13SCE1210	2013	Rethermalizers for Food Service Applications	This project will encompass applying an industry-accepted standard test method to up to five different models of electric rethermalizer ovens to support the development of a rethermalizer database. Once populated, the database will be used to support workpaper development for a new program offering to promote energy-efficient rethermalizer ovens. Results summaries will be developed for each appliance tested and the results will be recorded in a central appliance performance database. DELIVERABLE: Results summary sheets and reports for each unit detailing outputs from ASTM testing.	$55,000	June 2017
ET13SCE1230	2013	HVAC & Refrigeration Systems using Advanced Refrigerants	Evaluate performance of HVAC and refrigeration applications using advanced refrigerants. This project intends to explore and document advances in product development for advanced refrigerants in the refrigeration and HVAC applications. DELIVERABLE: The deliverable for this project is a final technical report detailing the results of paper studies and lab and field testing. Funding ET $590k (incl. 45k for labor), DR $195k (incl. 15k for labor), EPRI SDR funds $375k	$590,000	December 2018
ET13SCE1240	2013	EPRI EB III D - Advanced Energy Efficiency and Demand Response Concepts in Data Centers	EPRI Data Center Supplemental Project, EBIIID Sub-Project Da: Next phase of Demand Response demonstration using workload dispatch management. - Expand previous work on data center demand response with Intel's Cabezon Peak Controller (or equivalent) - Evaluate performance of a Data Center running real-world workloads under Demand Response (DR). - Evaluate the business trade-offs that would motivate Data Center operators to participate in DR programs. Sub-Project Db: Evaluation and Demonstration of Liquid Cooling for Data Centers - Provide a summary overview of liquid cooling technologies that are commercially available. - Develop a test protocol for laboratory assessment of the most compelling technology, evaluating its cooling performance and energy efficiency. Sub-Project Dc: Demonstration of State-of-the-Art Server Replacement - Evaluate how effective a utility sponsored server replacement program would be. - Perform 3 limited scale assessments in the field SCE portion: $550,000 (EE: $330,000; DR: $220,000) EPRI portion: $275,000 APPROACH: Various lab and field evaluations DELIVERABLE: The deliverable for this project is a final report with performance, cost and energy savings data and recommendations.	$550,000	December 2017
ET14SCE1060	2014	Demonstrating Grid Integration of ZNE Communities	Southern California Edison (SCE) is teaming up with EPRI and a large production homebuilder to design, build and monitor a new ZNE residential community in Fontana, CA. SCE will act as the project's lead on emerging DSM technologies, battery storage integration, electrical grid optimization and post-monitoring.	$320,000	December 2017

Project Number	Year	Project Name	Project Description	Budget Total	Expected Completion Date
ET14SCE1070	2014	Deep Retrofits in Low Income Multi-Family Housing	This project is an aggressive multi-disciplinary, comprehensive, whole building approach to designing and constructing a net zero energy retrofit of an existing low-income multi-family complex. To the best of our knowledge this will be the first Multi-family Net Zero/ Deep Energy Reduction (DER) retrofit in SCE service territory. This project will demonstrate DER to be practical to install, replicable in quality, energy savings, and economic impacts for both property owners and residents. DELIVERABLE: This project intends to develop a replicable & scalable financial model for implementing LIMF ZNE retrofits across SCE territory. The project will help SCE drive renewable Deep Energy Retrofits (DERs), (also called Very Efficient Retrofits VER, or Near ZNE) and new EE technologies by developing LIMF/cost-effective/incentive-ready emerging technology packages.	$360,000	September 2017
ET14SCE1100	2014	Conditioned Crawl Space	This Field Assessment is to test the potential energy performance of homes that have crawl spaces that will sealed and made to become part of the building envelope, hence conditioned space. This Field Assessment seeks to discover other, non-energy benefits to Conditioned Crawlspaces (CCS). The Field Assessments will be performed over a period of two years and four Climate Zones spanning the extremes within SCE territory. Year one will be identifying sites, signing Customer Agreements and gathering baseline data at all the homes. We are studying one home site in each of the four chosen climate zones (CZ 8, CZ9, CZ 10 and CZ 15). The will also be modular housing crawlspace testing in CZ10. Baseline data gathering as well as the CCS test data gathering will begin as soon as the site is ready. This is a true side by side test without the occupancy variable. Year two will be the Construction/ Retrofit and then Monitoring of the majority of the chosen crawl space test sites. DELIVERABLES: M&V data documenting the energy savings effectiveness of the CCS strategies and the impact of the CCS on the buildings and the occupants.	$175,000	December 2017
ET14SCE8020	2014	ZNE Retrofit Commercial Training Facility	SCE is teaming up with a large training facility in Commerce, CA to retrofit their existing 140,000 SF commercial training facility towards ZNE. SCE will act as the project's expert and lead on emerging DSM technologies, battery storage integration and post-monitoring. SCE will document the process of achieving the statewide goal of ZNE through a hands-on, engaged and collaborative approach. Primary goals of the project include increasing market exposure of already-proven EE/DR/DG/ES technologies and addressing market barriers to ZNE in support of CA's Strategic Plan (CLTEESP). DELIVERABLE: The main deliverable of this project will be a detailed report summarizing project findings and recommendations to help overcome market barriers to ZNE commercial retrofits.	$160,000	March 2018
ET14SCE7110	2014	Technology/Real Estate Transportation Proof of Concept	The demonstration project objective is to link building energy retrofits with electric transportation system linking buildings to public transportation. To scale adoption of key technologies including energy efficiency, energy storage, distributed generation, charging stations, and electric vehicles.	$50,000	March 2018
ET14SCE1120	2014	CLTC - Advanced Daylighting	This project will evaluate the ability of smart electric lighting, lighting controls, electrochromic windows, and shading systems to communicate and coordinate their operation using a single building management system (BMS) or other software platform. This will allow building owners and operators to more effectively deploy these technologies in commercial buildings. Sharing and considering data from multiple device types will improve overall system reliability and operation.	$293,216	July 2017
ET15SCE1100	2015	Solar-Assisted AC Units Study	A temperature-modulated panel of parabolic solar thermal collectors is used to heat hot refrigerant from the discharge line, adding heat and pressure without adding electricity. It works with VFD or multi-stage compression systems, and is able to reduce system energy usage by up to 40%.	$85,253	June 2017

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ET15SCE1180	2015	Weather-based Algorithm for EE Residential Smart Thermostats Field Test	Weather-based algorithms (WBA) for smart thermostats combine compatible thermostats with detailed weather data, rate information, and analytics-informed behavioral techniques to optimize existing customer thermostat set points for EE while maintaining occupant comfort. The goal of this study is to conduct a field study for 1,250 residential homes with a WBA solution. The results of this study are expected to provide sufficient data to support work paper development.	$200,000	March 2018
ET15SCE1210	2015	Laboratory Evaluation of Condenser Air Pre-Coolers	Provide a internationally recognized performance standard whereby different evaporative pre-cooling technologies can be compared. Publish this Standard thru ASHRAE (American Society of Heating, Refrigeration, and Air conditioning Engineers).	$84,119	March 2018
ET15SCE1240	2015	ZNE Low Income Multi Family New Construction	The project is a 3 story Multi-family dwelling consisting of 46 units on an infill lot in Pomona, with an estimated construction cost of $6.1 million. The targeted occupants are low-income, with half the units designated for those that are homeless. It is planned to be built to LEED Platinum. The units vary from one to three bedrooms. It has underground parking (3 stories on top of the parking), community laundry, management offices and a courtyard area. In addition to standard LEED practices, the owner is also installing PV. The owner's construction team is in place, schedules set and basic funding approved. The intent is to give LINC technical design assistance, as well as funding assistance to take the project from LEED Platinum to ZNE. Some of the measures being installed/ considered: 1. Closed cell spray foam in the exterior of the building envelope, aiding the reduction of air infiltration/ exfiltration. 2. More efficient windows 3. Smart T-stats 4. HVAC upgrade 5.Time clocks and Photo cells, Motion Sensors and Lighting control panels 6. Water measures 7. Energy Star appliances 8. Upgrade to Foam white roof from built up roof	$366,000	March 2019
ET15SCE1250	2015	Laboratory and Field Evaluation of RTU Optimization Package	Laboratory test a combination pre-cooler and fan/compressor speed controller provided by a major manufacturer installed with WCEC control algorithms. Use laboratory-test data to refine algorithms and optimize controls as needed. Field test the Roof Top Unit optimization package using one RTU at a field test site. DELIVERABLE: The main deliverable of this project will be a detailed report based upon laboratory and field Test Report of the RTU Optimization Package	$314,043	March 2019
ET15SCE1260	2015	Field Evaluation of Remote Evaporative Condenser	Remote evaporative condenser retrofit, for connection to packaged AC units. This technology replaces the packaged AC unit's air-cooled condenser with a separate, evaporatively-cooled condenser. One condenser can serve multiple AC units. Project is a field assessment of one condenser serving (2) air conditioning units. Study purpose is to document installation and operational issues of technology, and to record peak kW reduction and kWh reduction. DELIVERABLE- The deliverable of this project is a final report validating performance of technology.	$128,982	March 2018
ET15SCE1270	2015	Savings Estimates and Support for Market Transfer of Climate Appropriate HVAC	Develop and refine a new building energy simulation tool for EnergyPlus that will allow users to estimate the annual savings that can be achieved from certain climate appropriate solutions. Develop and validate performance of evaporative pre-cooling of condenser air and outside air with this simulation tool. Include calculation of associated water usage.	$224,316	March 2018

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ET15SCE1280	2015	Market Facilitation for Accelerated Adoption of Climate Appropriate HVAC	Investigate problems and assess the feasibility of proposed solutions for distribution and sales of HVAC energy efficiency products. Observe and interview key stakeholders involved, including decision-makers and facilities personnel. Develop specifications and best practices for creating a market facilitation strategy to encourage rapid adoption of emerging technologies. Document best practices in a manual which shall include strategies to address market readiness, stakeholder coordination, alignment of incentives, cost effectiveness, customer segmentation and demonstration of value, sales and purchase decision-making processes, customer resistance to adoption (e.g., water use), and persistence of savings.	$162,629	March 2018
ET15SCE1290	2015	Laboratory Method of Test for FDD	In 2013, ASHRAE Standard Project Committee (SPC) 207P was formed to develop a nationally-recognized laboratory method of test for Fault Detection and Diagnostics (FDD) technologies pertaining to commercial packaged rooftop unit (RTU) air-conditioning equipment. The purpose of the standard is to define an FDD technology's function and to test its performance. Consultant will: • Chair the ASHRAE 207P Committee. Support development of Method of Test.	$56,079	March 2018
ET15SCE1300	2015	Residential Applications of Dew Point Fluid Cooler	Report on Residential Applications of a Dew Point Fluid Cooler. In this project WCEC will run various simulations using a residential building model to determine water flow rates (from a fluid cooler) and air flow rates (from a residential air hander) required to meet cooling demand for single family residential home in climate zones in SCE territory. Design a condenser replacement strategy, including specifications for the Dew Point Fluid Cooler, air-to-water heat exchanger for air handler, and variable speed blower. Determine the thermal storage required to expand applicability of Dew Point cooler to climate zones for which loads are not met by the Dew Point Fluid Cooler. Thermal storage with nighttime cooling will lower the temperature of the water available. Determine rainwater storage required to meet 50% of the Dew Point cooler water needs, and whether or not typical annual rainfall would provide this water.	$145,805	March 2018
ET15SCE1310	2015	Water Use Management for Evaporative Cooling Technologies	• Evaluate potential water sources, including stored rainwater, for use with evaporative condensers. • Systematically test influential water quality parameters (calcium, magnesium, alkalinity, pH, and hardness) on the formation of scale in bench-scale evaporative condensers. • Construct and test a model to determine an optimized bleed rate to minimize scale creation based on water source and its composition. • Complete a bench-scale test using rainwater in an evaporative condenser to evaluate bacterial growth and corrosion.	$213,100	March 2018
ET15SCE1320	2015	Assessment of Temperature Swing Adsorbent Pre-cooler	The UC Davis Western Cooling Efficiency Center will perform a feasibility study and explore design options for an adsorbent heat and mass exchanger. The scope includes: evaluate the amount of moisture available in a year-long period using TMY data, develop a one-dimensional heat and mass exchange model with Matlab or Engineering Equation Solver using data provided by PNNL on the performance of its adsorbent material, perform a feasibility assessment of temperature swing adsorption.	$78,511	March 2018
ET15SCE1330	2015	Solar Driven Absorption Chiller Performance	This is a new proof-of-concept project to laboratory test an absorption chiller component to advance a solution for dramatic reduction in electricity consumption for cooling in large commercial facilities. It would use solar cooling as an alternative to vapor compression technology, in which minimal electrical power is required. The cycle operates using an ammonia-based refrigeration cycle, which consists of an absorber, desorber/generator and a pump. Deliverable is a Laboratory Test Report of Absorption Chiller Performance	$168,237	March 2018
ET15SCE7010	2015	HVAC Load Predictions	Project proposes to compare predictions from EnergyPlus, DOE-2.1e and eQUEST (DOE-2.2) with measurements from LBNL's new FLEXLAB test facility to determine which building energy simulation engine is (more) accurate correct by identifying and investigating significant deviations between building energy simulation's predicted performance versus actual performance as measure in FLEXLAB, at least for simple buildings, starting with key test cases in ASHRAE Standard 140	$260,000	March 2018

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ET15SCE7060	2015	Fault Detection and Diagnostics	ASHRAE is developing a nationally recognized laboratory method of test, SPC 207P for Fault Detection and Diagnostics (FDD) on commercial air cooled packaged HVAC equipment. The purpose of the standard is to define and FDD tools function and to test its performance. SCE is supporting the development of the method of test.	$56,079	March 2018
ET15SCE8060	2015	Mid-market Whole Building PRP Scaled Field Placement	The goal of this project is to develop new innovative ways to deploy integrated whole building strategies targeted to the mid-market sector in the Preferred Resources Pilot (PRP) region. The project will aim to demonstrate the feasibility of innovative retrofit approaches, obtain information on market barrier and influences, and identify pathways to mitigate market barriers for mid-market customers to increase adoption of EE, DR, and DERs. The scope includes: - Demonstrating the delivery of an integrated, whole-building retrofit approach in the PRP area by using a suite of existing EE measures, - Obtaining market intelligence through customer interviews or surveys regarding issues and/or barriers to participation including threshold of incentive levels that would yield greater market penetration, - Explore validation metrics that may include pay-for-performance contracting using AMI data and/or other approaches to measure grid-level impact.	$1,200,000	December 2017
ET15SCE8080	2015	Retrofitting Existing School Buildings to ZNE - Phase 1	A. Proposition 39, the California Clean Energy Jobs Act of 2012 (“Prop 39”), provides up to $500 million per year to improve energy efficiency and increase the use of clean energy in public schools and community colleges. B. On October 24, 2014, the California Public Utilities Commission (“CPUC”) issued Decision (“D.”) 14-10-046, which requires, among other things, that the California investor-owned utilities develop a ZNE-focused pilot program for eligible local educational agencies and community colleges (“ZNE Pilot Program”). C. Customer operates Santiago High School, and is an eligible local educational agency or community college under Prop 39. D. Customer desires to utilize the ZNE Pilot Program to find solutions to reduce energy usage and costs at Santiago High School – Building Y located at 12342 Trask Ave., Garden Grove, CA 92843 (“Facility”). E. SCE desires (i) to assist Customer in finding solutions to reduce energy usage and costs at the Facility, (ii) to perform and publish an analysis of the performance, energy use, and costs of the combined package of energy efficient measures (“EE Measures”) and on-site renewable energy measures (“Renewable Measures”) intended to achieve the goal of ZNE or near-ZNE, as defined by the 2014 Integrated Energy Policy Report (IEPR) at the Facility (the EE Measures and Renewable Measures are referred to collectively as the “Energy Solutions”), and (iii) to demonstrate the Energy Solutions to other potential users in order to disseminate information on this technology and encourage its widespread application.	$2,100,000	December 2019
ET15SCE1120	2015	Flat Panel High Temperature Thermal Cooling/Heating Study	High temperature (up to 400 degree F) solar thermal energy is produced using proprietary non tracking solar thermal panels to drive proprietary ammonia absorption chiller that for every 1 Btu thermal input produces 0.6 Btu chilling AND 1.6 Btu hot water simultaneously. We will also use waste heat from the process unit and thermal energy storage to be able to provide renewable and reliable energy on 24/7 basis. The thermal energy storage will use glauber salts that are produced at the host site and phase changes at 95 degree F. We will work with Cal Poly Pomona researchers that have studied and published papers on glauber salt thermal storage and can advise how to add other materials to achieve optimal storage temperatures ideal for our system.	$460,000	August 2018

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ET15SCE1130	2015	UC Deep Energy Efficiency project Study	Southern California Edison (SCE), The Gas Company (SCG), University of California, Irvine (UCI) and the University of California Office of the President (UCOP), are partnering on this project to develop and apply a whole-building measurement and verification (M&V) approach in two UC Irvine campus buildings: Anteater Instructional and Research Building (AIRB) and Langson Library. The goal of this project is to establish a whole building M&V approach based on the short-time interval energy use data (collectively known as "M&V 2.0") for the University and possibly Public Sector environment that is simple to apply but accurately captures real savings from existing conditions in a defensible and repeatable way. The project will demonstrate how to apply the approach practically in campus buildings, and will document other noteworthy issues and benefits that inform its application to other buildings. These issues may include: capturing savings beyond retrofits such as from behavioral, operational, and hard-to-quantify measures not typically included in projects; integrating energy tracking and on-going commissioning methods to assure persistence in savings; accounting for onsite generation; facilitating payment of performance-based incentives over time; and defining methods for addressing unexpected impacts on energy use.	$170,000	December 2017
ET15SCE1170	2015	Real Time Aeration Efficiency for Wastewater Plants	Wastewater aeration requires 50% of the energy use in wastewater treatment plants. A real-time analyzer that measures aeration efficiency was developed with CEC funding and has been demonstrated with SCE funding at several wastewater treatment plants over a one year period. To achieve the full benefit from this technology it is necessary to integrate the analyzer signal with the dissolved oxygen probe signal that currently controls the wastewater aeration blowers in all wastewater treatment plants. At the completion of this one year developmental demonstration, every wastewater facility will desire to install this low cost analyzer and software (i.e., cost similar to existing dissolved oxygen probes) to utilize the oxygen transfer efficiency and dissolved oxygen signals as the key to controlling the aeration blowers output to operate as efficiently as possible, reducing significant kWh continuously.	$110,000	March 2018
ET15SCE1230	2015	Thermal Energy Storage Battery Technology	This refrigeration technology utilizes water in an ionic, time delayed, freeze-point suppression cycle to provide -35C cooling to freezer environments while consuming 45% less electricity than conventional vapor compression systems. Incorporating embedded energy storage tailored specifically for freezer applications enables the use of water-based storage materials, 40°C industrial waste heat and off peak electricity to offset retail freezer loads. Efficiency and energy storage benefits enable foodservice, food processing and retail facilities the opportunity to reduce their refrigeration costs by as much as 65% through a 45% reduction in total electrical purchases and time-of-use (TOU) rate arbitrage.	$100,000	May 2017
ET16SCE1010	2016	Environmentally Friendly Refrigerants for HVAC	This project seeks to understand the changing nature of refrigerant options in HVAC systems, as they move toward low global warming potential (GWP) compounds. It will explore and explain the drivers for the move to environmentally friendly refrigerants, and it will evaluate technologies that have near-term value in the HVAC energy efficiency space. Customers will be faced with changes regarding refrigerant options and requirements in HVAC systems, for which they will turn to the utilities both for explanation and for guidance on advancing energy efficiency with these new systems. This project will produce data, discussion and analysis to provide that guidance, as well as identifying energy and demand impacts. The key objectives of this project are: - Explain the landscape of current and future changes in HVAC system refrigerant use in California - Define the drivers of change focusing on the legislative and regulatory players, both at the Federal (Ex: EPA, DOE), and State (Ex: CARB) levels - Explain the impact to customers in various building segments - Explore the potential for gains in energy efficiency, demand reduction, water use or other values for the customer & society. - Evaluate candidate technologies for future piloting in the SCE service territory	$550,000	June 2018

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ET16SCE1070	2016	PCM for Hotels Field Evaluation	This project is a small scale field evaluation at two hotels in SCE territory of the HVAC energy savings of a phase change material (PCM) product. The PCM will be incorporated into artwork and other interior décor. The scope of this project the following tasks: - Task 1: Develop M&V Plan - Task 2: Installation and Collection of Field Monitoring Data - Task 3: Data Processing and Savings Analysis - Task 4: Energy Modeling A total of 8 hotel rooms will be monitored: 4 with PCM, 4 without PCM. The two hotels will be in two climate zones and one will have packaged terminal air-conditioning and the second will have a central chilled water system with fan coil units. An energy model of a hotel room will be created and calibrated to the field data.	$100,000	December 2017
ET16SCE1080	2016	Retrofit Zoning Enhancement and Balancing Controls Field Assessment	Retrofit Zoning Enhancement and Balancing Controls 1. Wireless zone controllers monitor temps, damper position and airflow temps (supply air) 2. The CCU collects the information form all the zones and sends it to cloud servers to be analyzed with current weather to create a thermal model of the building, to predict energy requirements and damper position requirements of the zones 3. The calculations are sent back to the CCU with sends the required damper control points to the zone controllers 4. The CCU then turns on the HVAC cooling or heating coil Features this technology enables: 1. Enhanced HVAC zoning & balancing w/ occupancy scheduling 2. Enhanced HVAC zoning & balancing w/ occupancy detection control 3. Support for VFD ID fan 4. Support for Demand control ventilation 5. Support for DR cycling control	$117,000	June 2018
ET16SCE1090	2016	Assess High Performance Walls and Attics (BIG-2)	Advanced monitoring for temperature, moisture and energy use in two (2) houses per development as called for by the technology, strategy or assembly being installed. Monitoring is necessary to confirm energy savings, temperature reductions and moisture mitigations heretofore untested and only inferred from building energy and hydrothermal modeling results. Monitoring results will be used as part of program case studies which will be created for each development to highlight project challenges and successes and to further the market's understanding of these measures. Deliverables - Monitoring plans for each house - Monitoring equipment installation for each house - Monitoring report for each house (if data is available by end of contract) - Case study for each development	$65,700	December 2017
ET16SCE1110	2016	Predictive Energy Optimization	Predictive Energy Optimization acts as an automated supervisory control system for HVAC systems in commercial buildings, designed to reduce energy consumption, operating costs and CO_2 emissions. It connects to most existing building management and control systems (BMCS) using industry standard interfaces and is compatible with both new and existing building stock.	$250,000	April 2018

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ET16SCE1030	2016	Cement Plant Waste Heat Recovery - ID Fan EE Project	The cement plants produce significant amount of high grade (> 1,000 deg. F) waste heat as part of cement making process. This waste heat can be captured to produce electric or mechanical power to permanently offset plant electric energy/demand with the application of certain technologies/systems. The proposed design concept is such a system and is based on the application of well established (however, un-utilized in the U.S.) waste heat recovery mechanical cogeneration concept to cement plant processes. In essence, the cement process recovered waste heat is converted to steam energy that will power the steam turbine (S-T) drive. And the S-T drive will replace the current electric drives (i.e. motors) that operate plant process ID fans, thus saving electric energy/demand; and also results in GHG reduction.	$80,000	December 2017
ET16SCE1050	2016	Low Charge Ammonia Refrigeration Laboratory Evaluation	The commercial and industrial refrigeration landscape is changing due to pressures to reduce global warming potential (GWP) and ozone depletion potential (ODP) of refrigerants. In response to these changes, manufacturers are producing new technologies which are designed to accommodate the required changes, and provide equivalent or improved efficiency, capacity and overall performance.	$560,000	December 2018
ET17SCE7030	2017	Smart Breaker - Collaboration with EM&T	Energy Management Circuit Breaker (EMCB) is a collaborative supplemental project with EPRI member utilities. Each utility will field test the beta version of the Eaton EMCB and Eaton EMCB for Evs.	$225,000	December 2018
ET17SCE1020	2017	Cooling Tower Water Use Optimization- EPIC/EPRI	The use of physical water treatment technologies for water-cooled cooling towers is growing the U.S. and has been more widely used primarily in the EU where restrictions on chemical discharge and environmental policies encouraging lower chemical usage are wide spread. Physical Water Treatment technologies if properly applied can offer advantages in controlling the primary water metrics of scale, corrosion, fouling and bacteria when applied properly for water, energy and chemical usage savings in cooling towers. VPT has been used successfully in Europe and can address the California strategic goals for water and energy savings.	$325,000	June 2019