BEFORE THE PUBLIC UTILITIES COMMISSION
OF THE STATE OF CALIFORNIA

Application of San Diego Gas & Electric Company (U 902 E) for Approval of Electric Program Investment Charge Plan for Years 2021-2025.	A.22-10-___ (Filed October 3, 2022)

APPLICATION OF SAN DIEGO GAS & ELECTRIC COMPANY (U 902 E) FOR APPROVAL OF FOURTH ELECTRIC PROGRAM INVESTMENT CHARGE PLAN FOR YEARS 2021-2025

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OF THE STATE OF CALIFORNIA**

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**APPLICATION OF SAN DIEGO GAS & ELECTRIC COMPANY (U 902 E)
FOR APPROVAL OF FOURTH ELECTRIC PROGRAM INVESTMENT CHARGE
PLAN FOR YEARS 2021-2025**

Pursuant to California Public Utilities Commission ("Commission") Decisions ("D.") 12-05-037, 11-12-035, and 21-11-028, and Rule 2.1 of the Commission's Rules of Practice and Procedure ("Rule or Rules"), San Diego Gas & Electric Company ("SDG&E") hereby submits this application ("Application") for approval of its fourth Electric Program Investment Charge ("EPIC") Investment Plan ("EPIC-4 Plan").[1] The EPIC-4 Plan is Attachment A hereto.

I. EPIC PROGRAM BACKGROUND

D.11-12-035 established EPIC to "provide public interest investments in applied research and development, technology demonstration and deployment, market support, and market facilitation, of clean energy technologies and approaches for the benefit of electricity ratepayers" of SDG&E, Pacific Gas and Electric Company ("PG&E") and Southern California Edison Company ("SCE") (collectively, the "IOUs" or "IOU Administrators").[2] D.12-05-037 established the purposes and governance structure for EPIC, and established the California Energy Commission ("CEC") as an administrator of the program with its own budget; each IOU is to administer its respective budgets. Funding for EPIC was initially authorized until

[1] D.21-11-028, ordering paragraph ("OP") 7 at 56-57, set October 1, 2022, as the filing date for EPIC-4 plans. Because the assigned date falls on a Saturday, by operation of Rule 1.15, this application is filed the following Monday, October 3.

[2] D.12-05-037 at 2.

December 31, 2020; the CEC and each of the IOUs were required to propose plans to the Commission for the use of EPIC funds every three years.[3]

A. SDG&E's prior EPIC plans

In the first three EPIC cycles, SDG&E gained valuable knowledge, data and tools through the completion of EPIC demonstrations, bringing value to ratepayers in the form of improved efficiencies, reliability, safety and reduced costs. SDG&E EPIC administration has applied a strategy of building and growing knowledge bases in the areas of Unmanned Aircraft Systems ("UAS"), advanced distribution system automation to support grid modernization and integration of distributed energy resources ("DERs"), interoperability of new technologies and emerging standards for communication infrastructure, just to name a few. These first three cycles, summarized below provide additional value as they inform SDG&E, the industry, and standards development organizations, and support Commission initiatives.

On November 1, 2012, SDG&E filed A.12-11-002, seeking approval for its first EPIC ("EPIC-1") Plan, in which it proposed to execute five smart-grid related projects. D.13-11-025 approved SDG&E's EPIC-1 application.

On May 1, 2014, SDG&E filed A.14-05-004, seeking approval for its second EPIC ("EPIC-2") Plan, in which it proposed to execute five individual technology development and deployment ("TD&D") projects, as well as a sixth project through which SDG&E will participate in industry research, development and deployment ("RD&D") consortia. D.15-04-020 approved SDG&E's EPIC-2 plan.

Filed May 1, 2017, SDG&E's A.17-05-009, sought approval of its third EPIC ("EPIC-3") Plan proposing seven TD&D projects: (1) Integration of battery, photovoltaic other DER system

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3 *Id*. at 31 and OP 11 at 102.

combinations into utility distribution system operations; (2) energy storage performance evaluation to test Vanadium Redox Flow ("VRF") batteries and lithium ion batteries to understand ramifications for integration with power system infrastructure and operations; (3) Application of Advanced Metering Infrastructure ("AMI") data to advanced utility system operations; (4) Safety training simulators with augmented visualization; (5) UAS with advanced image processing for electric utility inspection and operations; (6) Repurposing post electric vehicle batteries for utility, commercial, and mass transit; (7) Demonstration of multipurpose mobile battery for the Port of San Diego and/or other applications. D.18-10-052, OP 3 at 152, approved SDG&E's EPIC-3 application.

The Benefits Impact Reports included in Appendix A to the SDG&E EPIC-4 Investment Plan (Attachment A hereto) addresses the impact of SDG&E's first three EPIC cycle projects.

B. Commission modifications to the EPIC program

The Commission on its own motion, opened Rulemaking ("R.") 19-10-005 to consider the renewal of the EPIC program. This proceeding reviewed the program, considered whether and how to continue funding the program, and considered appropriate administrative and programmatic improvements. D.20-08-042 in this rulemaking renewed EPIC for ten years, through December 31, 2030, authorizing two five-year investment plan cycles (referred to, respectively, as EPIC-4 and EPIC-5). That decision continues the CEC as an administrator, with an annual budget of $147.26 million for the EPIC 4 investment cycle (2021-2025).[4]

D.21-11-028 directed the IOUs to file investment plan applications for EPIC-4 on October 1, 2022.[5] This decision instructed the IOUs to file EPIC-4 investment plans at the

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4 D.20-08-042, OP 3 at 32.

5 D.21-11-028, OP 7 at 56-57. By operation of Rule 1.15, the plans are due October 3, 2022.

Strategic Initiative level, similar to the CEC's filing instructions.[6] "Strategic initiatives are defined as the strategies EPIC Administrators employ to meet their high-level Strategic Objectives. EPIC Administrators shall propose funding levels for the Strategic initiatives and specify how these initiatives will be operationalized, including the proposed activities."[7] SDG&E's EPIC-4 Plan calls its proposed activities "research topics," and otherwise conforms to this direction.

C. General Requirements for EPIC plans

As summarized in this section, SDG&E's EPIC-4 Plan conforms to the Commission's requirements for the program. EPIC is designed to "be the primary vehicle for utility electric RD&D proposals other than the proposals submitted by the utilities for demand response and electric efficiency RD&D projects."[8] The IOUs may administer projects funded by EPIC only in the area of TD&D.[9]

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6 The CEC filed its EPIC-4 plan November 23, 2021, A.21-11-021, *Application of the CEC for Approval of EPIC: Proposed 2021 – 2025 Investment Plan.*

7 D.21-11-028, OP 8 at 57. This decision states (at 16-17):

> We understand … [the CEC's] concern to be that budgeting at the level of research topic areas would unnecessarily constrain the CEC's nimbleness and ability to shift funding between solicitations as needed due to unforeseen circumstances and emerging conditions. That outcome is not our intent, which is why text descriptions of research topic areas or individual projects are not binding. Our intent is that specifying funding at a Strategic Initiative level provides the Commission with the information it needs to clearly understand the administrator's priorities and what is to be accomplished through each investment plan, while preserving EPIC administrator's ability to plan and execute project portfolios that maintain a long-range perspective, are dynamic in nature, address emerging issues, and make the best possible use of resources… [W]e note that funding may be shifted among research topics areas within an approved Strategic Initiative without Commission approval.

8 D.12-05-037, conclusion of law ("COL") 15 at 96.

9 *Id*. at 2 and finding of fact ("FOF") 8 at 90.

D.12-05-037 requires that the four EPIC administrators submit "coordinated"[10] EPIC plans on May 1, 2017, that meet the following common requirements: (these requirements still apply to the current application)

- Any projects funded through EPIC must, first and foremost, demonstrate "the potential to produce electricity ratepayer benefits, defined as promoting greater reliability, lower costs, and increased safety;"[11]
- EPIC expenditures are to be guided by the complementary principles of providing societal benefits, assisting with the reduction of greenhouse gas ("GHG") emissions in the electricity sector at the lowest possible cost, supporting the Loading Order,[12] and contributing to goals related to low-emission vehicles and transportation, economic development, and efficient use of ratepayer monies;
- EPIC expenditures must follow the statutory guidance provided by California Public Utilities Code §§ 740.1 and 8360;[13]

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[10] *Id*. at 31 and FOF 9 at 91.

[11] *Id*., FOF 1 at 89.

[12] Since 2003, Commission-regulated utilities must procure resources to serve demand per the "Loading Order," in the following order of priority:

(1) Energy Efficiency & Conservation

(2) Demand Response

(3) Renewable Resources & Clean Distributed Generation, and

(4) Clean Conventional (Fossil) Generation, if necessary.

CPUC, Energy Action Plan, adopted April 18, 2003, available at http://docs.cpuc.ca.gov/published/report/28715.htm.

[13] D.12-05-037 at 18, COL 1 at 94, and OP 12(e) at 104.

- EPIC Plans must be mapped to the electric utility value chain identified in D.12-05-037;[14] and
- EPIC funds may not be used to fund duplicative activities.[15]

In addition, D.12-05-037 specifies the information that the EPIC plans must include, such as summaries of and responses to stakeholder comments, informational summaries of RD&D efforts underway through approved Energy Efficiency and Demand Response portfolios, and intended intellectual property ("IP") methodologies.[16]

As shown below and in Attachment A, SDG&E's EPIC-4 Plan satisfies these requirements.

II. SUMMARY OF THE APPLICATION

SDG&E's EPIC-4 Plan, provided as Attachment A, is fully consistent with and responsive to the requirements summarized in the previous section D.12-05-037, D.13-11-025, D.15-04-020 and D.21-11-028.[17] The Commission's directives, as well as SDG&E's demonstrated vision for EPIC-funded TD&D programs, warrant the Commission's approval of the SDG&E EPIC Plan. The research topics proposed, and the eventual projects selected, in the EPIC-4 Plan have the potential to provide Commission-mandated benefits of lower costs, greater reliability, and increased safety, while offering benefits to electric utility ratepayers and alignment with State energy policies and statutes.

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14 Per D.21-11-028 at 17 and OP 8 at 57, the language in D.12-05-037 OP 12 at 102, referencing "program areas" or "investment areas" is updated to "initiatives."

15 D.12-05-037 at 40 and FOF 9 at 91 (EPIC Administrators to collaborate to "to ensure there is no duplication of effort").

16 Including those found at D.12-05-037 at OPs 12(d) at 104 and 15 at 104-105; D.13-11-025 at 66-67; and D.21-11-028 at 17 and OP 8 at 57.

17 While SDG&E is not submitting any prepared testimony in support of its EPIC Plan in this application, it will make qualified witnesses available at the Commission's request.

III. SUMMARY OF SDG&E'S EPIC-4 PLAN

SDG&E's EPIC-4 Plan is comprised of two strategic objectives, each with a corresponding strategic initiative. This plan supports the Statewide goal of reducing GHG emissions and transition to carbon neutrality by 2045 through energy technology innovation of key existing and emerging technologies. The plan also contributes to resiliency and reliability needs for the electric grid. The two strategic objectives and their supporting strategic initiatives are summarized below; these are more fully described in Attachment A, including stakeholder outreach and budget. Attachment A addresses such matters as performance, metrics, impact on Disadvantaged Communities, and guiding principles.

A. Strategic Objective: create a more nimble grid to maintain reliability as California transitions to 100 percent clean energy

California's electric grid will require substantial changes as the state transitions to 100 percent clean energy. Solar and wind build rates must nearly triple and battery storage build rates must increase by nearly eightfold to meet the State's goals. More research is needed to define the optimal approaches to making this transition expeditiously while maintaining grid reliability. In its transition to high levels of intermittent renewable and distributed generation, California will need a more nimble grid to provide greater flexibility in terms of the amount, timing, and location of energy flows. Research and technology innovations will support the matching of generation and load.

For this objective, the corresponding strategic initiative is *Grid Modernization*. Technology advances are essential to reduce congestion, maintain reliability, and increase flexibility as more variable renewables, storage, and DER are added to the grid.

SDG&E further proposes 2 research topics for this initiative. The research topic sections of this investment plan provide details around how SDG&E plans to achieve the strategic initiatives' objectives and provide value to its ratepayers and the State as a whole. Specifically, SDG&E has identified the following candidate topic areas:

1. Communication and Control Infrastructure for Power System Technology Advancement; and
2. Mobile Microgrid.

These research topics are discussed in more detail in Attachment A at Section III.

B. Strategic Objective: Increase the Value Proposition of Distributed Energy Resources to Customers and the Grid

Distributed energy resources are key components of California's clean energy future and economywide decarbonization. This includes distribution-connected generation, electric vehicles, energy storage, energy efficiency, and load flexibility technologies. Distributed energy resources have the potential to deliver significant benefits to grid operators and end users in a high-renewables, high-electrification future. These benefits come in many forms, such as load flexibility, peak demand reductions, reducing or deferring grid upgrades and associated costs, and improving resiliency and grid reliability in the face of climate change. Even modest amounts of load flexibility, for example, can significantly lower the cost of achieving Senate Bill ("SB") 100 goals.

The strategic initiative corresponding to this object is *Distributed Energy Resource Integration.* Due to the operational and economic complexities of DER, additional technology advances are needed to optimize the integration of DER into the grid, improve power flow efficiencies, and maximize value.

SDG&E further proposes four research topics for this initiative. The research topic sections of this investment plan provide details around how SDG&E plans to achieve the strategic initiatives' objectives and provide value to its ratepayers and the State as a whole. Specifically, SDG&E has identified the following research topic areas:

1. Optimizing Real-Time Net Energy Metering ("NEM") Hosting Capacity;
2. Demonstrating Solutions for Inverter Integration Issues;
3. Integrated Distributed Energy Resources ("IDER") Operational Flexibility; and
4. Commuter Train Electrification.

These research topics are discussed in more detail in Attachment A at Section IV.

C. SDG&E's EPIC-4 Plan supports the State's energy and climate goals

SDG&E's EPIC-4 Investment Plan will help achieve California's energy and climate goals, such as SB 100's carbon neutrality by 2045[18] and SB 32's requirement to reduce GHG emissions by 2030.[19] In addition to advancing State goals, SDG&E's EPIC-4 Investment Plan supports the CPUC's key proceedings, such as the Integrated Resources Plan[20] and the High DER Ordering Instituting Rulemaking[21] to provide data from plan demonstrations.

D. Summary of Stakeholder Engagement in Investment Planning Process

1. Internal Engagement

SDG&E engages internal stakeholders from start to finish in the planning and execution of EPIC projects. Initial investment planning for EPIC-4 began through a stakeholder

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18 SB 100 sets a goal of requiring renewable and zero-carbon energy resources to supply 100% of electric retail sales and state loads by 2045.

19 SB 32 ordered a reduction in economywide emissions of 40% below 1990 levels by 2030.

20 R.20-05-003, *Order Instituting Rulemaking to Continue Electric Integrated Resource Planning and Related Procurement Processes* (May 7, 2020).

21 R.21-06-017, *Order Instituting Rulemaking to Modernize the Electric Grid for a High Distributed Energy Resources Future* (June 24, 2021).

engagement process involving Company departments at the Director level.[22] Each Director was asked to engage their staff in the plan creation process, requesting ideas, project proposals, and cost estimates. The stakeholder information was collected using a template form created by the EPIC Program Manager and resulted in numerous topic area submissions.

2. External Engagement

The SDG&E EPIC Website[23] serves as a comprehensive record of the public event presentations for EPIC-4 investment planning. To help inform the EPIC-4 application and provide necessary input from external stakeholders, the three IOU EPIC Administrators held five public workshops this year.[24]

The three EPIC IOU Administrators coordinated their efforts in planning the workshops to avoid duplication in their candidate topic areas and support related activities across each utility and the CEC. In addition, the IOUs met extensively with the CEC to ensure duplication of EPIC-4 activities did not exist, and to potentially identify areas where all four EPIC Administrators would work together. Summaries of each workshop are provided in Attachment A, Appendix B.

E. Overview of Investment Plan Budget Allocation

The Commission authorized SDG&E's EPIC-4 budget for $16,280,000.[25] SDG&E has no uncommitted EPIC-3 funds available to offset the authorized EPIC-4 budget. The

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[22] At SDG&E, Directors are senior managers just below the executive level – not to be confused with members of the board of directors of the corporation.

[23] *See* sdge.com/epic.

[24] These workshops are described in Attachment A at Section II.

[25] D.21-11-028, Appendix B at B3.

Commission directed the IOUs to "propose funding levels for the Strategic Initiatives."[26] As such, SDG&E proposes the following EPIC-4 budget, by strategic initiative, below in Table 1.

Table 1: SDG&E's EPIC 4 (2021-2025) Budget Allocation

Funding Item	Amount
Strategic Objective A: Create a More Nimble Grid to Maintain Reliability as California Transitions to 100 Percent Clean Energy	
Strategic Initiative: Grid Modernization	$7,285,300
Strategic Objective B: Increase the Value Proposition of Distributed Energy Resources to Customers and the Grid	
Strategic Initiative: DER Integration	$7,285,300
CPUC Administration	$81,400
SDG&E Administration	$1,628,000
Total	**$16,280,000**

While SDG&E employed a very rigorous process to define the broad set of 6 research topics in its EPIC-4 application, over the course of the cycle additional needs and opportunities may arise that were unforeseen at the time the investment plan was developed. As such, SDG&E requests that the Commission allow the IOUs to file Tier 3 Advice Letters to request approval to add any additional research topics to their plans, after their plans are approved. This would be consistent with the previous process for requesting approval to pursue additional projects for investment plans filed at the project level in EPIC-1 through EPIC-3.

IV. NO RATE INCREASE IS REQUESTED BECAUSE EPIC FUND COLLECTIONS HAVE ALREADY BEEN AUTHORIZED

SDG&E is not requesting approval for a rate increase in this Application because the collection of EPIC funds from electric utility ratepayers was previously authorized in D.11-12-

[26] *Id.* OP 8 at 57.

035,[27] D.12-05-037[28], D.15-04-020[29] and D.20-08-042.[30] SDG&E has been collecting funds in accordance with those decisions since January 1, 2012 through the electric Public Purpose Programs ("PPP") bill component.[31]

V. SDG&E'S EPIC-4 PLAN SHOULD BE APPROVED AS REASONABLE, APPROPRIATE, AND IN THE INTEREST OF RATEPAYERS

D.12-05-037 mandates that any program funded through EPIC must, first and foremost, be able to demonstrate its "potential to produce electricity ratepayer benefits, defined as promoting greater reliability, lower costs, and increased safety."[32] In addition, it must use various complementary and statutory principles to guide the plan's development and ensure the result is "just and reasonable to ratepayers."[33]

The SDG&E EPIC-4 Plan is fully consistent with and responsive to the requirements outlined in D.12-05-037. The SDG&E EPIC Plan has the potential to provide ratepayers with greater reliability, lower costs, and increased safety by modernizing the electric grid.[34] In addition, the EPIC Plan aligns with the complementary principles outlined in D.12-05-037, such

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[27] D.11-12-035, OPs 2 and 3 at 40-41 (establishing the EPIC surcharge and ordering the electric IOUs to collect EPIC funds from their ratepayers in the same manner as the expiring system benefits charge associated with Public Utilities Code Section 399.8).

[28] D.12-05-037, OP 1 at 99.

[29] D.15-04-020, Appendix B, Table 5 at 7.

[30] D.20-08-042, OP 5 at 32-33.

[31] *See* Advice Letter ("AL") 2321-E, approved January 31, 2012 and effective December 22, 2011 (establishing SDG&E's EPIC surcharge and associated EPIC Balancing Account); AL 2375-E, approved August 14, 2012 and effective June 22, 2012 (revise its EPIC Balancing Account to align with SDG&E's 8.8% share of authorized funding beginning January 1, 2013); and AL 2402-E, approved January 3, 2013 and effective January 1, 2013 (revising SDG&E's electric PPP rates effective January 1, 2013 in accordance with OPs 1 and 7 of D.12-05-037). *See* AL 3616-E, approved and effective September 24, 2020, for SDG&E's adjustment to the EPICBA pursuant to D.20-08-042.

[32] D.12-05-037, FOF 1 at 89.

[33] *Id*. at 20 and OP 2 at 99.

[34] *See* EPIC-4 Plan (provided as Attachment A) at Sections III and IV.

as the efficient use of ratepayer monies and support for GHG emission reduction policies.[35] It also meets the statutory criteria outlined in Public Utilities Code sections 740.1 and 8360.[36] All six proposed research topic areas map to the applicable sections of the electric utility value chain.[37]

VI. SDG&E'S EPIC PLAN FULFILLS REQUIREMENTS OF PAST EPIC DECISIONS

A. In Accordance with D.12-05-037, SDG&E Has Collaborated and Consulted with Others During Plan Development

The Commission requires extensive coordination among the EPIC Administrators, as well as consultation with interested stakeholders. The Commission has stated that these collaborations between the EPIC Administrators are done under protection of the State Action Immunity doctrine from antitrust liability.[38] D.12-05-037 encourages the four EPIC Administrators to "offer a coordinated approach to clean energy RD&D"[39] through their EPIC plans "to ensure there is no duplication of effort."[40] D.12-05-037 also requires that the EPIC Administrators consult with stakeholders at specific times during the scoping and plan development process. As further described above and in the SDG&E EPIC Plan (Attachment A at Section II.D), SDG&E has satisfied these requirements.

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35 *See id*.

36 *Id*. at Appendix A.

37 *Id*. at Sections III and IV. SDG&E's EPIC-4 Plan maps to all sections of the utility value chain except for one: "Transmission" as SDG&E is not proposing any research topic area which touches the transmission level of its business. SDG&E would note that while its research topic areas touch on "Generation" it is not directly related to funding generation projects, which are prohibited through EPIC, but instead have indirect impacts.

38 D.13-11-025 at 108-110.

39 D.12-05-037, FOF 9 at 91.

40 *Id*. at 40.

B. The SDG&E EPIC Plan Provides a Sufficient Summary of SDG&E's Approved EE and DR Programs

In accordance with D.12-05-037, EPIC plans must provide informational summaries of RD&D efforts underway through approved Energy Efficiency ("EE") and Demand Response ("DR") portfolios. In D.13-11-025, the Commission instructed that "[t]he IOUs Administrators should provide more thorough informational summaries of their RD&D activities undertaken as part of their approved Energy Efficiency and Demand Response portfolios in their future EPIC investment plan applications. Each IOU investment plan application should include an appendix summarizing the RD&D activities undertaken as part of their approved Energy Efficiency and Demand Response portfolios, and this appendix should describe each RD&D project, including the purpose, funding, deliverables and progress to date."[41] The SDG&E EPIC-4 Plan at Attachment A fulfills this requirement by providing Appendix C, summaries of the RD&D activities undertaken as part of SDG&E's approved Energy Efficiency and Demand Response portfolios.

C. SDG&E Will Implement Intellectual Property Methodologies in Accordance with D.13-11-025 and D.15-04-020

In D-13-11-025 and D.15-04-020, the Commission responded by outlining numerous methodologies and requirements for Intellectual Property ("IP") developed with EPIC funds.[42] Therefore, pending any changes to the Commission's IP requirements through this proceeding, SDG&E will employ IP methodologies in accordance with D.13-11-025 and D.15-04-020 for its forthcoming projects in its EPIC-4 Plan.

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[41] D.13-11-025, COL 59 at 125.

[42] D.13-11-025, OPs 28 at 139 and 31-34 at 140-141; D.15-04-020, OPs 18 and 19 at 64.

VII. REQUESTED RELIEF

SDG&E respectfully requests that the Commission issue a decision:

1. Authorizing the IOUs to file Tier 3 Advice Letters to request approval to add any additional research topics to their plans, after their plans are approved. This would be consistent with the previous process for requesting approval to pursue additional projects for investment plans filed at the project level in EPIC-1 through EPIC-3;

2. Finding that SDG&E's EPIC-4 Application and Plan are in compliance with the requirements of past EPIC decisions (*i.e.*, D.12-05-037, D.13-11-025, D.15-04-020 and D.21-11-028);

3. Approving the SDG&E EPIC-4 Plan as reasonable, appropriate and in the interest of electric utility ratepayers;

4. Rendering other Findings of Fact, Conclusions of Law, and issuing Orders consistent with the foregoing requests; and

5. Any other relief as is necessary and proper.

VIII. STATUTORY AND PROCEDURAL REQUIREMENTS

A. Rule 2.1 (a) – (c)

In accordance with Rule 2.1 (a) – (c) of the Commission's Rules of Practice and Procedure, SDG&E provides the following information.

1. Rule 2.1 (a) - Legal Name

SDG&E is a corporation organized and existing under the laws of the State of California. SDG&E is engaged in the business of providing electric service in a portion of Orange County and electric and gas service in San Diego County. SDG&E's principal place of business is 8330 Century Park Court, San Diego, California 92123. SDG&E's attorney in this matter is E. Gregory Barnes.

2. Rule 2.1 (b) - Correspondence

Correspondence or communications regarding this Application should be addressed to:

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3. Rule 2.1 (c)

a. Proposed Category of Proceeding

The previous three EPIC proceedings, A.12-11-001 *et al*. A.14-04-034 *et al*., and A.17-05-009 were categorized as "ratesetting" proceedings.[43] SDG&E proposes that this proceeding also be categorized as a "ratesetting" proceeding.

b. Proposed Schedule and Issues to be Considered

SDG&E does not believe that approval of this Application will require hearings. The previous three EPIC triennial proceedings, A.12-11-001, et al., A.14-04-034, et al., and A.17-05-009 did not require testimony or evidentiary hearings. SDG&E has provided ample supporting information to create a record upon which the Commission may grant the relief requested. In

[43] *See*, *e.g.*, D.15-04-020 at 56.

addition, SDG&E has presented the draft SDG&E EPIC Plan to interested stakeholders, including Commission Staff, several times during the Plan's scoping and development during workshops, and has incorporated relevant feedback into the SDG&E EPIC-4 Plan.

Therefore, SDG&E proposes the following schedule:

PROPOSED SCHEDULE – NO HEARINGS	
ACTION	**DATE**
Application filed	October 3, 2022
Response/Protests	November 7, 2022
Reply to Response/Protests	November 14, 2022
Stakeholder Workshops	December 2022
Opening Briefs	January 11, 2023
Reply Briefs	February 1, 2023
Proposed Decision	March 6, 2023
Comments on Proposed Decision	March 20, 2023
Reply Comments	March 27, 2023
Commission Decision	April 2023

The issues to be considered are described in this Application. In the scoping memos for the EPIC-1, EPIC-2 and EPIC-3 plans, the Commission noted that the major issue to be considered is whether the EPIC plans adequately comply with the requirements of previous EPIC decisions.[44] The scope of this proceeding should be identical.

[44] A.12-11-001, Scoping Memo at 7-11 (issued January 7, 2013); A.14-04-034, Scoping Memo at 4-7 (issued July 28, 2014).

4. Rule 2.1 (d) – Safety[45]

SDG&E is committed to safety. Based on current information, SDG&E's EPIC-4 Plan will not result in any adverse safety impacts on the facilities or operations of SDG&E. Moreover, if its EPIC-4 Plan is approved, SDG&E intends to partner with skilled labor and vendors that demonstrate the necessary and applicable safety training, knowledge and/or certification. Bidders' proposals are examined to assess the proposer's approach for safety in performing the project work. In addition, SDG&E will comply with all applicable current safety laws, rules and procedures, including SDG&E's internal policies.

B. Rule 2.2 – Articles of Incorporation

A copy of SDG&E's Restated Articles of Incorporation as last amended, presently in effect and certified by the California Secretary of State, was filed with the Commission on September 10, 2014 in connection with SDG&E's Application No.14-09-008, and is incorporated herein by reference.

IX. SERVICE

SDG&E will serve this Application and its attachments on parties to the service list for R.19-10-005, the most recent EPIC proceeding (A.17-05-009), and all parties to the most recent general rate cases for SDG&E (A.22-05-016), PG&E (A.21-06-021), and SCE (A.19-08-013). Hard copies will be sent by mail to the Assigned Administrative Law Judge in each proceeding and Chief Administrative Law Judge Anne Simon.

X. CONCLUSION

WHEREFORE, San Diego Gas & Electric Company requests that the Commission grant SDG&E's Application as described herein.

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[45] In D.16-01-017, the Commission amended Rule 2.1 to require all applications to include a detailed showing of relevant safety considerations.

Respectfully submitted this 3rd day of October 2022.

By: /s/ E. Gregory Barnes
E. Gregory Barnes

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SAN DIEGO GAS & ELECTRIC COMPANY

By: /s/ *Miguel Romero*
Miguel Romero
San Diego Gas & Electric Company
Vice President – Energy Innovation

<u>OFFICER VERIFICATION</u>

Miguel Romero declares the following:

I am an officer of San Diego Gas & Electric Company and am authorized to make this verification on its behalf. I am informed and believe that the matters stated in the foregoing **APPLICATION OF SAN DIEGO GAS & ELECTRIC COMPANY (U 902-E) FOR APPROVAL OF ELECTRIC PROGRAM INVESTMENT CHARGE PLAN FOR YEARS 2021-2025** are true to my own knowledge, except as to matters which are therein stated on information and belief, and as to those matters, I believe them to be true.

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

Executed on October 3, 2022 at San Diego, California.

By: /s/ *Miguel Romero*
Miguel Romero
San Diego Gas & Electric Company
Vice President – Energy Innovation

Attachment A

SDG&E Fourth
EPIC Investment Plan
2021-2025

Fourth EPIC Investment Plan: 2021-2025 (EPIC-4)
San Diego Gas & Electric Company
October 3, 2022

I. Executive Summary

The Electric Program Investment Charge ("EPIC") was established by the California Public Utilities Commission ("CPUC" or "Commission") in 2011 to fund research leading to technological advancements and scientific breakthroughs supporting California's clean energy goals, with a focus on providing ratepayer benefits, including reliability, lower costs, and safety. EPIC investments advance pre-commercial clean energy technologies and approaches for the benefit of electricity ratepayers of California's three largest electric investor-owned utilities ("IOUs" or "utilities"): Pacific Gas and Electric Company ("PG&E"), San Diego Gas and Electric Company ("SDG&E"), and Southern California Edison ("SCE"). SDG&E's Fourth EPIC Investment Plan ("SDG&E's EPIC-4 Plan" or "EPIC-4 Plan") is the fourth of SDG&E's required EPIC plans and covers funding for years 2021 through 2025 pursuant to Decision ("D.") 21-11-028.

SDG&E developed the proposed EPIC-4 Investment Plan through a transparent process, conducting extensive stakeholder engagement. The IOUs held four public workshops, including two focused on gathering input from disadvantaged and underserved communities. The IOUs also provided a joint presentation to the Disadvantaged Communities Advisory Group ("DACAG"). SDG&E incorporated feedback from the DACAG to better embed equity into SDG&E's EPIC-4 Plan by applying DACAG's equity framework. Several meetings were held among the utilities to ensure their plans avoided duplication and complemented the California Energy Commission's ("CEC") EPIC-4 Plan.[1]

SDG&E and the other IOUs were instructed by the Commission to use the Strategic Objectives and Initiatives in the CEC's EPIC-4 Investment Plan.[2] SDG&E's EPIC-4 Plan includes two Strategic Objectives and two Initiatives, one aligning to each Strategic Objective. Within each Strategic Initiative, SDG&E's EPIC-4 Plan proposes certain candidate Research Topics for which SDG&E proposes to focus its EPIC-4 funds. Through SDG&E's proposed Research Topics, the plan will support the Statewide goal of reducing greenhouse gas ("GHG") emissions and the transition to carbon neutrality by 2045 through energy technology innovation of key existing and emerging technologies. The plan also contributes to resiliency

[1] Application ("A.") 21-11-021.
[2] D.21-11-028 Ordering Paragraph ("OP") 8 at 57.

and reliability needs for the electric grid. The two Strategic Objectives and their supporting Strategic Initiatives of the EPIC-4 Plan are summarized below.

A. Strategic Objective: Create a More Nimble Grid to Maintain Reliability as California Transitions to 100 Percent Clean Energy

California's electric grid will go through substantial changes as the state transitions to 100 percent clean energy. Solar and wind build rates need to nearly triple and battery storage build rates need to increase by nearly eightfold. More research is needed to define the optimal approaches to making this transition expeditiously while maintaining grid reliability. In its transition to high levels of intermittent renewable and distributed generation, California will need a more nimble grid to provide greater flexibility in terms of the amount, timing, and location of energy flows. Research and technology innovations will support the matching of generation and load.

Strategic Initiative: Grid Modernization

Technology advances are essential to reduce congestion, maintain reliability, and increase flexibility as more variable renewables, storage, and Distributed Energy Resources ("DER") are added to the grid.

B. Strategic Objective: Increase the Value Proposition of Distributed Energy Resources to Customers and the Grid

Distributed energy resources are key components of California's clean energy future and economywide decarbonization. This includes distribution-connected generation, electric vehicles, energy storage, energy efficiency, and load flexibility technologies. Distributed energy resources have the potential to deliver significant benefits to grid operators and end users in a high-renewables, high-electrification future. These benefits come in many forms, such as load flexibility, peak demand reductions, reducing or deferring grid upgrades and associated costs, and improving resiliency and grid reliability in the face of climate change. Even modest amounts of load flexibility, for example, can significantly lower the cost of achieving Senate Bill ("SB") 100 goals.

Strategic Initiative: Distributed Energy Resource Integration

Due to the operational and economic complexities of DER, additional technology advancement is needed to optimize the integration of DER into the grid, improve power flow efficiencies, and maximize value.

II. Introduction and Background

A. Regulatory Background

The CPUC established EPIC in 2011 to fund research leading to technological advancement and scientific breakthroughs supporting California's clean energy goals. The program focuses on providing ratepayer benefits, including reliability, lower costs, and safety. EPIC investments advance pre-commercial clean energy technologies and approaches for the benefit of electricity ratepayers of California's three largest electric IOUs: PG&E, SDG&E, and SCE.

The Commission established EPIC in D.11-12-035 and D.12-05-037 to provide public interest investments in research and development of clean energy technologies and approaches for the benefit of California's IOU electric customers.[3] SDG&E, PG&E, and SCE (collectively, the "IOUs," or "EPIC IOU Administrators") and the CEC (collectively with the IOUs, the "EPIC Administrators") are required to propose plans to the Commission for the use of EPIC funds every three years.[4]

Funding for EPIC was initially authorized until December 31, 2020. In 2019, the CPUC initiated a proceeding, Rulemaking ("R.") 19-10-005, to renew EPIC funding. In the first phase of that proceeding, completed September 2, 2020, the CPUC renewed EPIC for an additional 10 years, consisting of two five-year investment cycles.[5] Pursuant to D.21-11-028, the CPUC approved SDG&E as a continued program administrator and authorized a budget of $3.24 million per year for the first investment cycle of January 1, 2021, through December 31, 2025 (referred to as EPIC-4).[6] D.21-11-028 directed the IOUs to file investment plan applications for EPIC-4 on October 1, 2022.[7] For the first time, the CPUC instructed the IOUs EPIC Administrators to file EPIC-4 investment plans at the Strategic Initiative level, similar to how the CEC is instructed to file.[8] Strategic Initiatives are defined as the strategies EPIC Administrators employ to meet their high-level Strategic Objectives. EPIC Administrators shall propose funding levels for the Strategic Initiatives and specify how these initiatives will be operationalized, including the proposed research topic activities.[9]

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[3] D.12-05-037 at 2.
[4] *Id*. at 31 and OP 11 at 102.
[5] D.20-08-042 at 17.
[6] D.21-11-028 at 2.
[7] *Id*. at OP 7, at 56-57.
[8] *Id*. at OP 8, at 57.
[9] *Id.* at OP 8, at 57. This decision (at 17) also notes "that funding may be shifted among research topics areas within an approved Strategic Initiative without Commission approval."

B. Impact of SDG&E EPIC Program

In the first three EPIC cycles, SDG&E gained valuable knowledge, data and tools through the completion of EPIC demonstrations, bringing value to ratepayers in the form of improved efficiencies, reliability, safety and reduced costs. SDG&E's EPIC Administration has applied a strategy of building and growing knowledge bases in the areas of Unmanned Aircraft Systems ("UAS"), advanced distribution system automation to support grid modernization and integration of DERs, interoperability of new technologies and emerging standards for communication infrastructure, just to name a few. These projects provide additional value as they inform the Company, the industry at large and standards development organizations; and support CPUC proceedings.

The utilities were directed by the Commission to document the success of EPIC projects to date applying a Joint IOU-created benefits framework.[10] SDG&E and the other IOU EPIC staff began meeting bi-weekly, via Microsoft Teams meetings, to collaborate and develop a Working IOU EPIC Benefits Framework ("Benefits Framework"), which is designed to demonstrate the realized and potential benefits to ratepayers from EPIC research and demonstration investments. The IOU EPIC Administrators and staff presented the Benefits Framework to both the CEC and Commission staff and incorporated the parties' suggestions and comments into the final working framework. Once the Benefits Framework was finalized, the EPIC Administrators began developing their individual Benefit Impact Reports on each completed EPIC project. Meetings continued to ensure a uniform approach across the IOUs. The result of this continuous coordination process is reflected in the Benefit Impact Reports included in this Investment Plan as Appendix A.

Examples of SDG&E's EPIC project impacts include:

- Deployment of the Mobile Battery Energy Storage System ("MBESS") operation and maintenance ("O&M") cost reduction of $653,424[11]/10-years/diesel generator
- EPIC demonstrations of UAS evolved into SDG&E's Drone Investigation, Assessment and Repair ("DIAR") Program, supporting SDG&E's Wildfire Mitigation Program

[10] D.21-11-028, OP 12 and OP 13, at 57-58.
[11] SDG&E EPIC 3 Project 7 Module 1 Final Report, Section 7.2 Updated Benefits Analysis pp.55-56 found at sdge.com/epic.

- Value of reliability improvements from augmented reality applications for workforce training is estimated at $30,000,000/year[12]

C. Relevant California Goals Supported by the Program

SDG&E's EPIC-4 Investment Plan will help achieve California's energy and climate goals, such as SB 100's carbon neutrality by 2045[13] and SB 32's requirement to reduce GHG emissions by 2030.[14] In addition to advancing State goals, SDG&E's EPIC-4 Investment Plan supports the CPUC's key proceedings, such as the Integrated Resources Plan[15] and the High DER Ordering Instituting Rulemaking ("OIR")[16] to provide data from demonstrations.

D. Summary of Stakeholder Engagement in the Investment Planning Process

Internal Engagement

SDG&E engages internal stakeholders from start to finish in the planning and execution of EPIC projects. Initial investment planning for EPIC-4 began through a stakeholder engagement process involving all Company departments at the Director level. Each Director was asked to engage their staff in the ideation process, requesting ideas, project proposals, and cost estimates. The internal stakeholder information was collected using a template form created by the EPIC Program Manager and resulted in numerous research topic area submissions herein.

External Engagement

The SDG&E EPIC Website[17] serves as a comprehensive record of the public event presentations for EPIC-4 investment planning. To help inform the EPIC-4 application and provide necessary input from external stakeholders, the three IOU EPIC Administrators held the following public workshops or presentations, as shown below in Table 1.

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[12] SDG&E EPIC 3 Project 4 Module 1 Final Report, Section 5 Project Results and Value Proposition pp. 66-69 found at sdge.com/epic
[13] SB 100 sets a goal of requiring renewable and zero-carbon energy resources to supply 100% of electric retail sales and state loads by 2045.
[14] SB 32 ordered a reduction in economywide emissions of 40% below 1990 levels by 2030.
[15] R.20-05-003.
[16] R.21-06-017.
[17] *See* sdge.com/EPIC.

Table 1. Stakeholder Events to Inform the EPIC-4 Investment Plan

EPIC-4 Stakeholder Event Name	Date
Joint IOU EPIC Disadvantaged Communities (“DAC”) Workshop	June 21, 2022
Joint IOU EPIC Public Workshop	June 30, 2022
Disadvantaged Communities Advisory Group Presentation	August 19, 2022
Joint IOU EPIC DAC Workshop	August 25, 2022
Joint IOU EPIC Public Workshop	August 29, 2022

To engage stakeholders, gather feedback and comments regarding proposed initiatives and candidate research topic areas, SDG&E presented their draft EPIC-4 research topic areas at two Joint Utilities’ DAC EPIC Workshops held on June 21, 2022, and August 25, 2022. The DAC Workshops’ purpose was to obtain input from community representatives to aid in the development of the IOU’s respective applications in the EPIC-4 cycle. The workshops invited and received feedback and interactive discussion from a wide variety of participants.

In addition to the DAC Workshops, the Joint IOUs held two public workshops to engage external stakeholders in the planning process. The first of two Joint IOU EPIC public workshops was held on June 30, 2022, that included an overview of each Administrator’s proposed initiatives accompanied by a panel-led discussion by the Electric Power Research Institute (“EPRI”). The second workshop, held on August 29, 2022, included presentations of each EPIC Administrator’s Strategic Objectives, initiatives and candidate research topic areas, and allowed for participant questions and discussion to discover technology innovation priorities and/or missing IOU candidate topics.

The Joint IOUs also presented to the Disadvantaged Communities Advisory Group (“DACAG”) on August 19, 2022. The purpose of the presentation to the DACAG was to obtain input from key members of the DAC community to further energy equality through the respective IOU’s service territory as it relates to EPIC. The Joint Utilities received valuable feedback which was incorporated into their respective EPIC-4

Investment Plans. Specifically, SDG&E has incorporated feedback from the DACAG to better embed equity into SDG&E's EPIC-4 Plan by applying DACAG's equity framework.[18] Upon approval of this Plan, SDG&E will strive to provide DAC benefits directly or indirectly wherever possible.

The three EPIC IOU Administrators coordinated their efforts in planning the workshops to avoid duplication in their candidate topics and support related activities across each utility and the CEC. In addition, the IOUs met extensively with the CEC to ensure duplication of EPIC-4 activities did not exist, and to potentially identify areas where all four EPIC Administrators could work collectively together. Summaries of each workshop are provided as Appendix B.

E. Overview of Investment Plan Framework and Budget Allocation

As stated above, the Joint Utilities have coordinated their respective EPIC-4 investment plans to use the same structure as the CEC's EPIC-4 Investment Plan. SDG&E identified two Strategic Objectives which advance SDG&E's and the State's goals of reducing GHG emissions and transitioning to carbon neutrality by 2045. As such, SDG&E proposes two Strategic Initiatives comprising work in this EPIC-4 plan that provides opportunities and/or addresses challenges for the grid and SDG&E's customers. SDG&E further proposes six Research Topic Areas. The research topic sections of this investment plan provide details around how SDG&E plans to achieve the Strategic Initiatives' objectives and provide value to its ratepayers and the State as a whole. When evaluating various research topics, SDG&E considered both the needs of its customers and the Company, potential extensions of SDG&E EPIC 1, EPIC 2, and EPIC 3 projects, as well as feedback from the other EPIC Administrators, external stakeholders and EPRI.

The CPUC authorized SDG&E's EPIC-4 budget for $16,280,000.[19] SDG&E has no uncommitted EPIC-3 funds available to offset the authorized EPIC-4 budget. The CPUC directed the IOUs "to propose funding levels for the Strategic Initiatives."[20] As such, SDG&E proposes the following EPIC-4 budget, by Strategic Initiative, below in Table 2.

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[18] DACAG's equity framework includes: health and safety, access and education, financial benefits, economic development, and consumer protection.
[19] D.21-11-028 at Appendix B.
[20] *Id.* OP 8 at 57.

Table 2. SDG&E's EPIC-4 (2021-2025) Budget Allocation

Funding Item	Amount
Strategic Objective A: Create a More Nimble Grid to Maintain Reliability as California Transitions to 100 Percent Clean Energy	
Strategic Initiative: Grid Modernization	$7,285,300
Strategic Objective B: Increase the Value Proposition of Distributed Energy Resources to Customers and the Grid	
Strategic Initiative: DER Integration	$7,285,300
CPUC Administration	$81,400
SDG&E Administration	$1,628,000
Total	**$16,280,000**

III. Strategic Objective: Create a More Nimble Grid to Maintain Reliability as California Transitions to 100 Percent Clean Energy

California's electric grid will go through substantial changes as the State transitions to 100 percent clean energy. Solar and wind build rates need to nearly triple and battery storage build rates need to increase by nearly eightfold. More research is needed to define the optimal approaches to making this transition expeditiously while maintaining grid reliability. In its transition to high levels of intermittent renewable and distributed generation, California will need a more nimble grid to provide greater flexibility in terms of the amount, timing, and location of energy flows. Research and technology innovations will support the matching of generation and load. The research and development ("R&D") topics in this Strategic Objective will help realize an electric grid that is highly adaptive and reliable.

A. Initiative: Grid Modernization

Achieving SB 100 will require continuing technology advancements to power delivery system infrastructure, often referred to as "the grid". In this context, the grid means the infrastructure that is used to move electrical power from the power generation resources to the electrical load. It consists of the transmission system, which moves power at high voltages between areas, and the distribution system, which delivers power to customers and other users within an area. In addtion to the power lines, the power delivery infrastructure also includes substations, protection and safety systems, and communication and control systems to manage the power delivery processes. The communication and control systems include a high degree of automation and must have a high level of cyber security. Although there has been continual advancement of this complex infrastructure over its history, the advancement process needs to continue.

SDG&E's work in this Initiative during EPIC-4 will focus on the distribution system, but will consider the interaction with and impacts on the transmission system. The quantity and variety of controllable devices, such as DERs, switched capacitor banks, and power electronic equipment, being introduced into distribution system operations is expected to continue growing. It includes assets owned by the utilities and by other parties. In past EPIC cycles, SDG&E has funded work in this area pertaining to integration of distributed generation and storage, automation, new sensor technologies, improvements in fault location technologies, data acquisition and management, integrated volt/Volt-Amps Reactive (Volt/VAR) power management, and visualization and situational awareness capabilities. This work has also contributed to the evolving body of industry standards that are needed to make the integration of many different vendor products interoperable on a plug-and-play basis. A larger body of work has also been performed in these areas by the power industry (utilities and vendors) on an international basis. In EPIC-4, the work in this area needs to be continued to keep pace with the inevitable technology advancements that are expected while supporting technology advancements that help reduce congestion, maintain reliability, and increase flexiblity as more variable renewables, storage, and DER are added to the grid.

SDG&E has identified the following Research Topic Areas with details provided in the sections below:

i. Communication and Control Infrastructure for Power System Technology Advancement
ii. Mobile Microgrid

i. Research Topic Area: Communication and Control Infrastructure for Power System Technology Advancement

Innovation Need

Advancing power system infrastructure is a continuously ongoing process of integrating emerging technologies into the infrastructure. Advanced distribution automation is a key component of this process. It is essential to examine the technology options as they emerge and to perform pre-commercial demonstrations on a selective basis to aid in determining which new technologies to adopt commercially.

Description

This research topic area will include demonstration of communication and control concepts for advanced distribution system infrastructure. The demonstration will examine the current infrastructure, as a foundation, and identify gaps and improvements needed. The work in this research topic area will include not only the considerations of the continued assimilation of DER into the infrastructure, but also the assimilation of other emerging technologies in monitoring, power quality management, protection, power electronics, and visualization and situational awareness. The goal is to achieve successful interoperability of these various devices and subsytems, and assure maximum overall system performance. Relevant emerging standards from the Institute of Electrical and Electronics Engineerings ("IEEE"), the International Electrotechnical Commission ("IEC"), and elsewhere will also be evauated. Examples are updates to IEC 61850, and the IEEE 1547 and 2030 series.

Background, Previous Projects and Technology Trends

This research topic area builds on legacy work in past EPIC cycles and on recent advances in industry practices. In past EPIC cycles, SDG&E funded work in this area pertaining to integration of distributed generation and storage, automation, new sensor technologies, improvements in fault location technologies, data acquisition and management, integrated volt/VAR (reactive power) management, and visualization and situational awareness capabilities. The communication and control system is the essential infrastructure that needs to continue evolving to manage the increasingly complex power system. A larger body of work has also been performed in this area by the power industry (utilities and vendors) on an international basis. The work in this area needs to be continued to keep pace with the inevitable technology advancements that are expected.

Expected Outcomes

The work will lead to improved customer value and experience, stemming from the improved interoperability and performance of the distribution system components and subsystems. The results will also support the recurring revision work on industry standards pertaining to communication, control, and safety.

Metrics and Performance Indicators

This work will support distribution system advancement by improving the communication and control infrastucture that enables the assimilation of a variety of emerging devices and subsytems into distribution operation. The work in this research topic area will contribute to the evolving body of industry standards that are needed to make the integration of many different vendor products interoperable on a plug-and-play basis.

Primary Users and Beneficiaries

The primary beneficiaries of this work will be the utility customers and is attributable to the improved management and operation of the multitude of new technologies being assimilated into distribution system operations. Other benefits accrue to DER owners and suppliers of the various new technologies and to the associated industry standards development organizations.

Guiding Principles

The following are the guiding principles of the Communication and Control Infrastructure for Power System Technology Advancement Research Topic Area:

1) **Reliability:** This research topic area is in direct alignment with improved reliability. As more DER and other new devices are deployed, improvements in communication and control will help with the integration of those assets into the distribution system infrastructure, thereby improving their effectiveness and system reliability and resilience.
2) **Safety:** Safer infrastructure and operating practices will be enabled by the improvements in communication and control capabilities.
3) **Affordability:** The results will lead to advances in distribution system operating capabilities that achieve cost efficiencies for ratepayers.
4) **Equity:** Results are applicable to all communities, including DACs.
5) **Environmental Sustainability:** The improvements in system infrastructure will be an essential factor in making increasingly complex utility systems possible and sustainable.

Mapping of Communication and Control Infrastructure for Power System Technology Advancement Research Topic Area to the Electricity System Value Chain

The table below maps the research topic area to the electricity system value chain pursuant to D.12-05-037, OP 12. Primary impact is in the Distribution area of the value chain however, the research topic area touches on other areas as shown below:

Electricity System Value Chain	Investment Impact
Grid operations/market design	**X**
Generation	**X**
Transmission	
Distribution	**X**
Demand-Side Management	**X**

ii. Research Topic Area: Mobile Microgrid Demonstration

Innovation Need

To adapt to the ever-changing energy needs and landscape, utilities will need improved grid flexibility and reliability to provide reliable power to their customers. Microgrids are proving themselves as an effective method to improve grid resilience, offering consistent, clean, reliable, more flexible and cost-effective local energy generation and delivery.

Description

A logical next step from the EPIC-3 demonstrations on MBESS is to examine mobile microgrid capabilities. In addition to a MBESS and a mobilized transformer, the research topic area will include the investigation of additional requirements such as safety, communications, control, and protection needed to evolve the mobile battery concept into the mobile microgrid concept. Mobile microgrids may also include mobile generators, as an option.

The mobile microgrid will be capable of both stand-alone operation or in conjunction with stationary resources available at a site that can support both planned and emergency events. A mobile microgrid may include the option for a mobile generator, as well as a mobile battery.

Background, Previous Projects and Technology Trends

A key enabler of these self-sufficient energy systems is energy storage. The work in this research topic area will build on the previous EPIC pre-commercial demonstrations and experience on mobile batteries in SDG&E's EPIC-3 cycle.

Expected Outcomes

A mobile microgrid would provide a solution that can be deployed in planned or unplanned outage situations to reduce the duration of interruptions to critical loads. The work in this area would determine the desired design characteristics for mobile microgrids, assess the value proposition in specific use cases, and clarify the requirements for commercial adoption.

Metrics and Performance Indicators

1) Improved reliability metrics such as System Average Interruption Index ("SAIDI"), the minutes of sustained outages per customer per year and Customer Average Interruption Index ("CAIDI"), the average time required to restore service per year
2) Improved system resilience
3) Reduced GHG emissions
4) Reduced O&M costs

Primary Users and Beneficiaries

The primary beneficiaries from the deployment of a mobile microgrid would be the customers whose load interruptions are reduced by the deployment of mobile microgrids. The mobile microgrids may also have value in other use cases such as supporting utility system operations in an emergency or supporting wildfire mitigation efforts.

Guiding Principles

The following are the guiding principles of this Mobile Microgrid Demonstration Research Topic Area:

1) **Safety:** Sustaining power for customers improves public safety during both emergency and non-emergency events.
2) **Reliability:** Deployment during planned and unplanned outages minimizes or eliminates customer impacts and improves reliability.
3) **Environmental Sustainability**: When the mobile microgrid replaces a generator to support outages, diesel fuel emissions are reduced and therefore GHG emissions are reduced.

4) **Equity:** The deployment of microgrids in DAC or low-income communities and/or adjacent communities, improves air quality for residents.

Mapping of the Mobile Microgrid Demonstration Research Topic Area to the Electricity System Value Chain

The table below maps the research topic area to the electricity system value chain pursuant to D.12-05-037, OP 12. Primary impact is in the Distribution area of the value chain however, the research topic area touches on other areas as shown below:

Electricity System Value Chain	Investment Impact
Grid operations/market design	X
Generation	X
Transmission	
Distribution	X
Demand-Side Management	X

IV. Strategic Objective: Increase the Value Proposition of Distributed Energy Resources to Customers and the Grid

California has policies and programs in place that are accelerating the DER market. These programs include incentive programs for electrifying the building and transportation sectors and for deploying distributed solar and storage. However, due to the operational and economic complexities of DER, additional research is needed to optimize the integration of DER into the grid, improve power flow efficiencies, and maximize value. EPIC-4 Research Topic Areas in this EPIC-4 Plan support applied research, development, and demonstration ("RD&D") efforts to advance the integration of DER into the distribution system, enhance cost and performance attributes, and realize the full range of benefits to customers and the grid. Specific areas of focus include enabling reliability and resiliency with load flexibility; advancing planning tools and technologies to improve the efficiency, operations, and integration of DER; improving DER communication and control technologies. Together, the RD&D topics in this chapter will improve the value proposition of DER.

B. Initiative: DER Integration

As penetration of distributed energy resources in utility distribution systems continues to grow, new challenges arise related to their assimilation into distribution system operations. Electric system operators are faced with the reality of managing millions of small, distributed energy resources and thus utilities must invest in the technologies that will best manage these resources to maximize their benefits and reduce harmful impacts on operations.

SDG&E has identified the following Research Topic Areas:

i. Optimizing Real-Time Net Energy Metering ("NEM") Hosting Capacity
ii. Demonstrating Solutions for Inverter Integration Issues
iii. Integrated Distributed Energy Resources ("IDER") Operational Flexibility
iv. Commuter Train Electrification

Research Topic Area: Optimizing Real-Time Net Energy Metering Hosting Capacity

Innovation Need

The volume of NEM installations is continuing to grow at a rapid pace. For the SDG&E system, bi-directional power flow has become commonplace not just at feeder midpoints, but at feeder breakers, and in some cases, substation transformer banks. The resulting challenges to service voltage limits are, at times, resulting in NEM inverter trip events, which temporarily curtail renewable production levels. State energy policy continues to emphasize the adoption of all renewable sources. NEM systems represent a special challenge, as a resource not owned or operated by the utility that can appear at any location on the network. The IOUs must, however, enable the safe and reliable utilization of these resources, as a core responsibility. The IOUs also retain responsibility to ensure power quality, specifically proper voltage for the distribution system.

Description

The research topic area will include a pre-commercial demonstration of a closed loop, real-time control system to enhance the ability of distribution feeders to accept higher levels of NEM power injection. The demonstration will use existing control systems and equipment where feasible, including automated line capacitors. Accurate circuit modeling to confirm effectiveness of each approach is also a component of this research topic area.

Background, Previous Projects and Technology Trends

As load profiles on utility lines continue to become less predictable, the ability of individual components to respond dynamically becomes paramount. A centralized control scheme is a logical choice, as additional inputs can be used compared to the traditional methods of using only inputs form the subject field location.

Expected Outcomes

This pre-commercial demonstration will affirm if the renewable hosting capacity of distribution feeders can be enhanced through the application of a centralized and dynamic control system.

Metrics and Performance Indicators

The following performance indicators should be considered for the demonstration:

1) Power quality
2) Incrementally available hosting capacity, if any
3) Effect on system losses

Primary Users and Beneficiaries

The following users and beneficiaries are anticipated for the demonstration:

1) Electric utility customers served under the NEM tariffs
2) Utility distribution system operators
3) State policymakers interested in the continued adoption of distributed resources

Guiding Principles

The following are the guiding principles of the Optimizing Real-Time Net Energy Metering Hosting Capacity Research Topic Area:

1) **Environmental Sustainability:** Demonstrating an incrementally higher ability to accept additional output from NEM/solar systems advances the goal of sustainability by reducing the need for less sustainable resources.
2) **Affordability:** The demonstration will be compared against more traditional means for controlling voltage, including reconductor projects and additional line regulators, both of which are substantially more costly.
3) **Reliability:** The demonstration will illustrate the reliability of this control regime as compared to more traditional methods.
4) **Equity:** Customers served by older parts of the utility system could see a net benefit with the introduction of this control regime through an entire territory. The demonstration will inform if this is feasible/advisable.

Mapping of the Optimizing Real-Time Net Energy Metering Hosting Capacity Research Topic Area to the Electricity System Value Chain

The table below maps the research topic area to the electricity system value chain pursuant to D.12-05-037, OP 12. Primary impact is in the Distribution area of the value chain however, the research topic area touches on other areas as shown below:

Electricity System Value Chain	**Investment Impact**
Grid operations/market design	**X**
Generation	
Transmission	
Distribution	**X**
Demand-Side Management	

Research Topic Area: Demonstrating Solutions for Inverter Integration Issues

Innovation Need

As penetration of DER in utility distribution systems continues to grow, new challenges arise related to their assimilation into distribution system operations. Inverters are the primary electric interface device between the DER and the utility distribution system. It is important to assure that inverter performance and functional operations do not trigger harmful impacts on distribution system operations. It is also important to assure that switching operations or other events in the distribution system do not spoof inverters into unwanted actions. These issues could cause safety and reliability problems in distribution system operations, with associated cost consequences.

Description

This research topic area will demonstrate solutions for resolving integration issues for multi-function inverters (sometimes called “smart” inverters) in distribution system advancement. A primary objective of the research topic area will be to identify key unsolved issues related to inverter functional performance and perform pre-commercial demonstration solutions for resolving the issues. The work will include the creation of specifications for interchangeable inverters to assure successful integration continues when inverter replacements become necessary.

Background, Previous Projects and Technology Trends

This work builds on project work in prior EPIC cycles and more broadly, on activities in the industry and standards development organizations.

Expected Outcomes

The work will lead to improved performance of inverters, reduced interoperability impacts of inverters on utility system infrastructure, and fewer disturbances to customers. The results will also support the recurring revision work on industry standards for inverters.

Metrics and Performance Indicators

1) Determination of failure mechanisms and interoperability issues for current inverters in distribution system operations
2) Identification and implementation of mitigation measures to address these issues. Improved monitoring capabilities to support pre-empting inverter-related problems
3) Contribution of findings to standards development organizations, such as IEEE

Primary Users and Beneficiaries

The work will simultaneously benefit inverter owners, vendors, standards development organizations, and utility system operations.

Guiding Principles

The following are the guiding principles of the Demonstrating Solutions for Inverter Integration Issues Research Topic Area:

1) **Affordability:** The results may lead to design changes in inverters or their software that are not a major cost increase. The system operating savings from improved reliability should far outweigh any cost increases in the inverter.
2) **Reliability:** Inverter outages and deleterious effects of inverters on utility operations will be reduced, leading to higher system reliability.
3) **Safety:** Reduce the safety risks to inverter users and to utility system operators.
4) **Equity:** Results are applicable to all communities in which inverters are used, including DACs.

5) **Environmental Sustainability:** This work is not expected to result in a major change in environmental sustainability, but it may support improved acceptance and adoption of inverter-based technologies.

Mapping of the Demonstrating Solutions for Inverter Integration Issues Research Topic Area to the Electricity System Value Chain

The table below maps the research topic area to the electricity system value chain pursuant to D.12-05-037, OP 12. Primary impact is in the Distribution area of the value chain however, the research topic area touches on other areas as shown below:

Electricity System Value Chain	Investment Impact
Grid operations/market design	**X**
Generation	
Transmission	
Distribution	**X**
Demand-Side Management	**X**

Research Topic Area: Integrated Distributed Energy Resources ("IDER") Operational Flexibility

Innovation Need

As DERs become more common in both commercial and residential applications, the demand for electric utilities to integrate and manage these resources, to maintain resilient and reliable power services, is increasing. The benefits gained in this research topic area will provide real-world experience in seamlessly integrating greater numbers of renewable energy and DERs, while harnessing the flexibility in the demand side of the system to lay the foundation for operational flexibility. In an end state, this research will contribute to a Distributed Energy Resource Management System ("DERMS") that enables SDG&E to dispatch DER-based on load, generation, weather forecasting, price signals, and California Independent System Operator ("CAISO") market signals in both normal and abnormal switch states.

Description

The purpose of this research topic area is to explore preferred integration options and patterns associated with the integration of DER into a DERMS environment. While California has defined IEEE

2030.5 and Common Smart Inverter Profile ("CSIP") as the default method by which some DERs are to be integrated and managed by Distribution System Operators ("DSOs"), limited real world experience exists in its use beyond test laboratories. SDG&E's goal is to leverage IEEE 2030.5 beyond its use as a means of telemetry collection. Additionally, SDG&E seeks to further explore its use in leveraging DER to meet one or more of the distribution level services as defined by the IDER and derivative use cases developed from the IDER services, such as Operational Flexibility. SDG&E seeks to incorporate both in-front-of, and behind-the-meter assets into this research topic area. The expectation of this research topic area is to understand and explore the trade-offs of using IEEE 2030.5 versus Distributed Network Protocol 3 ("DNP3") for managing larger DERs that provide critical services such as voltage and frequency management in situations like microgrid islanding and/or provision of large amounts of energy relative to overall microgrid load. Finally, the knowledge gained will position SDG&E to better establish its production DERMS integration requirements, including the coexistence of DERMS with existing SDG&E technology components to lead to the optimization of the overall DSO environment.

Background, Previous Projects and Technology Trends

1) Operational flexibility using mobile generators and battery energy storage systems - management of mobile, dispatched generators and battery energy storage systems to temporarily power remote communities and critical human services during planned and unplanned outages, which could include Public Safety Power Shutoff ("PSPS") events
2) SDG&E microgrid controller integration – the Borrego Springs Microgrid includes multiple battery energy storage systems which contribute to DERMS capabilities and how this might be integrated into enterprise DERMS
3) Support of critical customer demand at SDG&E owned and operated Wildfire Mitigation Plan ("WMP") microgrids – the Romana Air Attack Base WMP (i.e., firefighting) Microgrid[21] and the Cameron Corners Microgrid[22] are projects related to specific public safety initiatives to minimize PSPS outages[23]

Expected Outcomes

1) Test integration points with microgrid controllers using IEEE 2030.5 and DNP3 protocols to determine near-term and long-term capability gaps to focus on risks and future efforts

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[21] SDG&E's Ramona Air Attack Base WMP Microgrid became operational in January of 2022.
[22] SDG&E's Cameron Corner WMP Microgrid is expected to become operational in the 4th quarter of 2022.
[23] SDG&E will have two more WMP Microgrids online in late 2023 – Shelter Valley and Butterfield Ranch.

2) Test integration points with third party aggregators controllers using IEEE 2030.5 and DNP3 protocols to determine near-term and long-term capability gaps to focus on risks and future efforts
3) Expand and leverage upon current and past EPIC projects to increase SDG&E's knowledge base in DER management and optimal utilization of DER assets in distribution grid management

Metrics and Performance Indicators

1) Suitability of investigated protocols to handle current and future DER asset aggregators
2) Compatibility with multiple vendor aggregators and gateways which control individual DER assets
3) Interoperability with SDG&E's current distribution systems and associated network systems
4) Compatibility with cybersecurity best practice policies to ensure distribution grid service delivery

Primary Users and Beneficiaries

The following users and beneficiaries are anticipated for the demonstration:

1) Distribution Operations – visibility and control into all DERs on the distribution system
2) SDG&E ratepayers in managing near real-time energy demand
3) CAISO – for system resiliency and options for the energy market
4) Achieve California's renewable energy goals for a decarbonized future

Guiding Principles

The following are the guiding principles of the Integrated Distributed Energy Resources ("IDER") Operational Flexibility Research Topic Area:

1) **Reliability –** SDG&E is focused on reliable delivery of power services to ratepayers, regardless of the environmental or other constraints, and the reduction of PSPS events to increase power grid resiliency.
2) **Safety –** This research topic area will not only provide increased resiliency of the distribution grid services for SDG&E employees, but also for essential services, hospitals, and critical care residents for SDG&E's service territory.

Mapping of the Integrated Distributed Energy Resources ("IDER") Operational Flexibility Research Topic Area to the Electricity System Value Chain

The table below maps the topic area to the electricity system value chain pursuant to D.12-05-037, OP 12. Primary impact is in the Distribution area of the value chain however, the research topic area touches on other areas as shown below:

Electricity System Value Chain	Investment Impact
Grid operations/market design	X
Generation	X
Transmission	
Distribution	X
Demand-Side Management	X

Research Topic Area: Commuter Train Electrification

Innovation Need

Many commuter railroads continue to use diesel or diesel-electric drive systems for their locomotives. The cost to install overhead catenary systems to enable electrification can be significant, in addition to the cost for new rolling stock to use it. Finding alternative, cost-effective, solutions are beneficial.

Description

This research topic area explores the capabilities to introduce battery powered locomotives into the existing inventory of diesel-powered locomotives on the rail lines within San Diego and the SDG&E territory. The demonstrations would show if the conversion of one or more trainsets to 100 percent electric power, using battery-driven locomotives, could be integrated economically with existing diesel-powered rolling stock, including fast charging equipment at one or both ends of the rail line.

Background, Previous Projects and Technology Trends

While trains using overhead catenary supplies for traction and other power needs are common, the use of battery powered trains remains novel. At least one manufacturer does offer such equipment, and this suggests an opportunity for a demonstration project in North America, and California in particular.

As many commuter railroads do use diesel powered equipment, it will be important to also demonstrate how the different traction power schemes will initially co-exist, at least until the end of service life for the diesel units.

Expected Outcomes

The pre-commercial demonstration of how the newer battery-powered trains can be implemented on existing diesel-powered lines will provide a template for other operators to follow as they consider their own plans for sustainability and electrification efforts.

Metrics and Performance Indicators

The following metrics are suggested:

1) Battery powered train service reliability
2) Avoided emissions
3) Estimated health benefits, especially as related to DACs found along the rail route
4) Decreased total cost of ownership
5) Decreased operating cost, including "fuel" and maintenance
6) Cost and environmental impact due to the disposition of battery systems as they reach end-of-service life. Note: It may be possible to apply retired locomotive batteries to traction power charging stations as a method to help moderate electric utility demand charges. It may also be possible to provide some level of ride-through in the event of a prolonged utility outage, to demonstrate resiliency

All these metrics should be considered comparisons against existing diesel-powered equipment, considering inherent advantages and drawbacks.

Primary Users and Beneficiaries

Individual commuter railroad operators and their customers are both users and beneficiaries. In addition, individuals working or residing within proximity of the route are beneficiaries of cleaner air.

Guiding Principles

The following are the guiding principles of the Commuter Train Electrification Research Topic Area:

1) **Environmental Sustainability:** This demonstration will affirm the feasibility of implementing this kind of traction power for existing commuter rail services.

2) **Affordability:** The demonstration will affirm the economics associated with implementing battery powered traction power. If favorable, it may help moderate future increases in fares for users.
3) **Reliability**: The demonstration will affirm the reliability of the newer rolling stock and associated charging equipment, especially as compared to existing diesel-powered units.
4) **Safety**: The demonstration will affirm safety factors of implementation, especially those associated with charging facilities which will likely include high voltage equipment.
5) **Equity:** Commuter trains can go directly through DACs which will benefit from incrementally improved air quality.

Mapping of the Commuter Train Electrification Research Topic Area to the Electricity System Value Chain

The table below maps the research topic area to the electricity system value chain pursuant to D.12-05-037, OP 12.

Electricity System Value Chain	**Investment Impact**
Grid operations/market design	
Generation	
Transmission	
Distribution	**X**
Demand-Side Management	

V. Program Administration

A. Collaboration with Program Administrators

As stated in Section II, SDG&E has coordinated extensively with the three other EPIC Administrators as required by prior EPIC Decisions. Throughout the EPIC-3 process, as well as the EPIC-4 Investment Plan development, SDG&E worked collaboratively with the other three Administrators by conducting conference calls, participating in one another's public workshops, and coordinating on a number of virtual joint portfolio review meetings to coordinate Investment Plans and ensure investments were complementary and not unnecessarily duplicative. The EPIC Administrators will continue to work together to address common goals, consistent with the State's energy and environmental policies and the EPIC Program's updated guiding as established in D.21-11-028.[24]

B. Administration and Governance of SDG&E's EPIC Investment Plan

Treatment of Intellectual Property

SDG&E will continue to administer and protect intellectual property rights in accordance with the guidelines provided in the Commission's EPIC decisions.[25]

EPIC-4 Portfolio Governance Process

Upon the approval of its EPIC-4 Investment Plan, SDG&E will evaluate the current environment of the electric utility industry in order to prioritize its RD&D efforts to best fit the Company's and State's climate goals. Specifically, SDG&E will utilize projects, which fall under research topic areas, to prioritize funds which benefit SDG&E's customers, the electric utility industry, and wherever possible provide meaningful value for DACs.

Upon approval of its EPIC-4 Investment Plan, SDG&E will employ the following program governance to extract the most value:

- Develop a scoring and prioritizing criterion for projects
- Determine a director champion for each selected project, and create a steering committee available to evaluate necessary project decision making items
- Develop project specific planning, including a project-specific scope and metrics, equipment needs, tests to be performed, analyses to be performed, staffing requirements, contractor and procurement requirements, equipment and equipment procurement requirements, documentation requirements, and equipment disposition requirements
- Once the specific project details are developed, a final coordination process will be done to identify any opportunities for collaboration with other EPIC Administrators

SDG&E would note that further governance processes could be developed upon implementation of this Plan in order to extract the most value for SDG&E and its ratepayers.

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[24] D.21-11-028, Appendix A.

[25] D.13-11-025 at OP 32, OP 34, and OP 50, and D.15-04-020 at OP 18 and OP 19.

In selecting and allocating the budget to the forthcoming individual projects, as required by D.21-11-028,[26] SDG&E will manage the budget allocation established at the initiative level, as described in Section II above. If SDG&E anticipates a need to reallocate more than 15 percent of the total program funds among its initiatives, it will file a Tier 2 Advice Letter and obtain CPUC approval before doing so pursuant to D.21-11-028.[27]

While SDG&E employed a very rigorous process to define the broad set of 6 research topics in its EPIC-4 application, over the course of the cycle additional needs and opportunities may arise that were unforeseen at the time the investment plan was developed. As such, SDG&E requests that the Commission allow the IOUs to file Tier 3 Advice Letters to request approval to add any additional research topics to their plans, after their plans are approved. This would be consistent with the previous process for requesting approval to pursue additional projects for investment plans filed at the project level in EPIC-1 through EPIC-3.

C. Program Budget

As stated above in Section II, SDG&E does not have any uncommitted EPIC-3 funds. Consistent with D.21-11-028,[28] SDG&E will administer its EPIC-4 program within the 10 percent administrative budget cap. Additionally, SDG&E will manage its administrative budget according to the CPUC's approved joint administrative framework.[29]

VI. Benefits Metrics & Evaluation of IOUs EPIC-4 Investment Plan

Pursuant to D.21-11-028, SDG&E tracked and provides herein reporting of past EPIC project level benefits through the development of an initial, and updated, benefits analysis that is included in every EPIC project's final report. Benefits are aligned with the guiding principle of EPIC to provide ratepayer benefits within the CPUC defined areas of increasing reliability, improving safety, increasing affordability, improving environmental sustainability, and improving equity. SDG&E expects to include both qualitative and quantitative metrics in evaluating the potential and realized benefits of its past EPIC projects. In compliance with D.21-11-028, SDG&E coordinated with the Commission's Energy Division ("ED") staff, and the SCE and PG&E EPIC Administrators to develop a Working IOU EPIC Benefits

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[26] D.21-11-028 OP 8, at 57.
[27] *Id.* OP 11, at 58.
[28] *Id.* at Appendix B.
[29] *See* SDG&E's Advice Letter ("AL") 3940-E, PG&E's AL 6478-E, SCE's AL 4700-E and the CEC's AL 121-2 filed January 24, 2022, and approved March 14, 2022.

Framework ("Benefits Framework"), which is designed to demonstrate the realized and potential benefits to ratepayers from EPIC RD&D investments.

The benefit framework was applied to each completed project in SDG&E's EPIC-1 through EPIC-3 Cycle. Additionally, this benefit framework will be used as a basis for the formulation of initial and updated benefits analysis components for each forthcoming EPIC-4 project and their corresponding final reports upon approval of SDG&E's EPIC-4 Plan, and implementation of forthcoming projects as a result of the aforementioned approval. SDG&E's Benefit Impact Reports are included in this Investment Plan as Appendix A.

VII. Conclusion and Next Steps

SDG&E's EPIC-4 Investment Plan contains two strategic objectives with corresponding initiatives that have been carefully vetted with internal and external stakeholders. The development of the Plan has been coordinated with the other EPIC Administrators. This plan also provides various mappings to policy and value chain issues.

The research topic areas presented in the plan are timely in terms of priorities of the Commission, SDG&E, electric customers, and the energy industry and are designed to help create customer value by achieving improvements in safety, distribution system infrastructure and operating practices. The topic areas were screened to avoid duplication with SDG&E's Energy Efficiency and Demand Response activities, which are provided in Appendix C. The plan's budget estimate makes efficient and effective use of the EPIC-4 funds that SDG&E is responsible for administering. For these reasons, SDG&E respectfully requests that the Commission approve SDG&E's EPIC-4 Plan in its entirety.

APPENDICES

Appendix A – SDG&E's EPIC Benefit Impact Reports

Appendix B – EPIC Public Workshop Summaries

Appendix C – Summary of SDG&E's Approved Energy Efficiency (EE) and Demand Response (DR) Portfolios

Appendix D – Abbreviations and Acronyms

Appendix A – SDG&E's EPIC Benefit Impact Reports

Table of Contents – Appendix A

Introduction

San Diego Gas & Electric (SDG&E) developed the following EPIC Benefit Impact Reports to convey to the Commission and general audiences, the value of the SDG&E EPIC Program through both qualitative and quantitative methods. The analysis summarizes the realized and potential benefits resulting from demonstrations conducted in the EPIC 1, EPIC 2 and EPIC 3 Cycles.

Coordination

In D.21-11-028, the IOUs were instructed to coordinate with the CEC and Commission staff on a single, uniform benefits analysis framework and set of metrics.[30] During the second quarter of 2022, SDG&E and the other IOU EPIC Administrators and staff began meeting bi-weekly, via MS Teams meetings. As a result of these meetings, IOU staff developed the Working IOU EPIC Benefits Framework, which is designed to demonstrate benefits to ratepayers from EPIC research and demonstration investment. The IOU EPIC Administrators and staff presented the Working Benefits Framework to both the CEC and Commission staff and incorporated the parties' suggestions and comments into the Final Working Framework. Once the Benefits Framework was finalized, the IOU EPIC staff began developing their respective Benefit Impact Reports. They continued to meet to ensure a uniform approach across the IOUs. The result of this continuous coordination process is reflected in the following SDG&E Benefit Impact Reports.

Working Benefits Framework

The following benefits framework aligns with the mandatory guiding principle of EPIC, to provide ratepayer benefits within the CPUC-defined areas of increasing reliability, improving safety, increasing affordability, improving environmental sustainability, and improving equity. Because the IOU-funded portions of the EPIC program involve the demonstration and evaluation of pre-commercial technologies, benefits are dependent on both qualitative and quantitative factors. To capture the benefits of pre-commercial demonstrations' inherent knowledge and data seeking objectives, supplemental quantification and qualification can be attributed to the following benefit areas: Adoption of EPIC Technology, Effectiveness of Information Sharing and Technology Development Progress. The following measurement areas are the most closely aligned of the benefits in D.13-11-025 Attachment 4, though in the future there may be additional benefits from Attachment 4 that may be applicable to EPIC projects. The resources and tools used by the IOUs to identify, qualify, and quantify benefits are listed in Table 1, below.

Table 1. Joint Utilities Working Benefits Framework

Benefit Area	Measurement	Resources/Tools Applied
Reliability	1. Equipment service life extension	• Final Reports • Internal Presentations

[30] D.21-11-028, OP 12, at p. 57.

Benefit Area	Measurement	Resources/Tools Applied
	2. Outage number, frequency and duration reductions 3. Reduction in system and equipment failures 4. Improved reliability to Disadvantaged Community (DAC) customers	• SME Estimates • ICE Calculator • Various Models
Safety	1. Worker safety improvement and hazard exposure reduction 2. Public safety improvement and hazard exposure reduction 3. Safety improvements targeted towards DAC	• Final Reports • Internal Presentations • SME Estimates • https://www.energy.ca.gov/data-reports/energy-almanac/zero-emission-vehicle-and-infrastructure-statistics/light-duty-vehicle • Various Models
Environmental Benefits	• Habitat area disturbance reductions • Reduce GHG emissions (MMTCO_2e) • DAC Residents impacted by reduced emissions	• Final Reports • Internal Presentations • SME Estimates • https://www.californiadgstats.ca.gov/charts/ • CalEnviroscreen 4.0 • Various Models
Economic Benefits	1. Maintain/reduce O&M costs 2. Maintain/reduce capital costs 3. Peak load reduction 4. Reduced cost of DER adoption	• Final Reports • Internal Presentations • SME Estimates • Various Models

Benefit Area	Measurement	Resources/Tools Applied
	5. Reduced cost of DER adoption for DAC. 6. Avoided customer energy use 7. Follow-on funding to projects 8. Customer bill or interconnection savings 9. CO_2 equivalent savings	
Effectiveness of Information Sharing	1. Number of industry sharing events/papers presented 2. Number of times reports are cited in scientific journals and trade publications for selected projects 3. Number of information sharing forums held 4. Stakeholder attendance at workshops 5. Results provided to standards development organizations	• Final Reports • Internal Presentations • External presentations • Other published papers • SME Estimates
Adoption of EPIC Technology	1. EPIC project results referenced in regulatory proceedings 2. Number of technologies/use cases demonstrated, in direct use post-EPIC	

Benefit Area	Measurement	Resources/Tools Applied
	3. Number of technologies included for funding in the GRC, or for which post-EPIC funding has otherwise formally been committed	
Technology Development Progress	1. Technology Readiness Level (TRL) Scale Assignment	
Support of CPUC Proceedings or State Policy	1. Specific CPUC proceedings or state mandates	
Informed Industry and/or Company Standards	1. Specific standards which were created or updated	

The section below summarizes the identified benefits resulting from the project work in EPIC Cycles 1, 2, and 3. Benefits are aligned by EPIC cycle and project or by project bundle. Projects are bundled where there is a common focus, and as a result, the benefits are reasonably aggregated. SDG&E EPIC Project Final Reports that are referenced can be found on www.sdge.com/epic. Dollar figures for estimated benefits are in current dollars at the time the reports were published except where noted.

EPIC-1

Project 1 – Smart Grid Architecture Demonstrations Program and Project 3 – Distributed Control for Smart Grids

These two EPIC projects are related in their focus on addressing the impacts of higher penetrations of smart devices in the distribution system and the resulting knowledge gained from the investigation and prototype demonstrations conducted. Project 1 included demonstrations of key candidate building blocks of the SDG&E smart grid architecture to determine the suitability for adoption in the architecture. The prime candidate for consideration for communication architecture was International Electrotechnical Commission (IEC) 61850 because of its emerging premier status at the time for operating power systems of the future.

Project 3 demonstrated a distributed control system capable of utilizing both conventional and new types of actively controllable devices in the distribution system in response to dynamically changing operating conditions. A comprehensive list of distribution automation applications was compiled and evaluated.

These projects resulted in a better understanding of the options available, providing a set of recommendations, including pros and cons of each option, to guide the company and other stakeholders toward the best path forward in the architecture and distributed control system areas.

Benefits

- **Reliability** – These projects demonstrated the potential of improving reliability through implementing breaker failure, automatic transfer, protection coordination, and DER integration using IEC 61850. The use of digital signals over analog signals using IEC 61850 has the potential to help improve reliability by providing relevant data for effective electric system operations.
- **Economic Benefits** – The IEC 61850 approach relies on virtual interconnections and offers the ability to test the logic and automation as they are being engineered and parameters are applied, as opposed to waiting for physical switchgear to be assembled and tested. Utilizing IEC 61850 as the communication standard and engineering devices based on IEC 61850 digital models, has the potential to lower costs for integration of devices and applications that can help utilities operate their electric infrastructure efficiently and, in a cost-effective manner.

Quantitative Benefits Summary

	Measurement
	Reduced Capital Costs
Communication Standard IEC 61850	10-30% estimated savings[31] potential

[31] SDGE-EPIC-1 Final Report, Section 3.16 Cost comparison – IEC 61850 vs a conventional design, found at SDGE.com/epic

Project 2 – Visualization and Situational Awareness Demonstrations

This project examined how data currently unexploited and separately processed can be integrated and visually presented for strategic use by system operators. When transformed and presented in a visually integrated manner, this data can be invaluable for utilities to optimize grid operations as well as provide insights into the performance of the overall utility system. This visual framework also provides insights into customers' energy consumption behavior to serve them more effectively, foster energy conservation, and reduce peak demand. Demonstrations were conducted to determine how data collected from sensors and devices can be processed, combined, and presented to system operators in a way that enhances utility system monitoring and situational awareness. The initial scope of the project was expanded to accommodate further demonstration of applications.

Enhanced monitoring and situational awareness are achieved by providing a geospatial context for a wide variety of operational, historical, and metering data. Consequently, through the numerous use cases undertaken within this project, it was illustrated how the data commonly used to support diverse business needs at SDG&E, can be combined with geospatial data to significantly enhance insights resulting in the benefits below.

Benefits

- **Adoption of EPIC Technologies** – Use cases demonstrated in the project, currently in production, include Transmission Fault Location; Load Curtailment; Advanced Metering Infrastructure (AMI) for Operations; Historical Outages and Automation of Quarterly Electric Utility Reports.
- **Economic Benefits** – The improved availability for operators to visualize occurring events in near real time, helps deploy maintenance crews more efficiently and effectively. The aim is to be able to see the data sources visually, in a geographic context, as opposed to searching for the data via file and folder names. This saves time and effort in organizing large volumes of data. Cost saving estimates applied to the transmission fault location use case are calculated at $2,891/overhead outage and $1,440/underground outage for a total savings estimate of $118,543/year. To see more details of this cost estimate, please refer to Figure 1. EPIC 1, Project 2 Transmission Fault Location Visualization Use Case Savings Calculation provided in *Attachment I - Supporting Information to Appendix A Benefit Reports.*
- **Effectiveness of Information Sharing** – The project included a pilot demonstration of Esri's Utility Network Model, and visualization options for Light Detection and Ranging (LIDAR) data, imagery and 3D data. The results were placed in the public domain in the final project report, where they can be used by standards development organizations (SDOs).
- **Safety** –
    - Utility worker safety improvement and hazard exposure reduction are accomplished by improving the access of real-time 3D data to company-wide applications. Field teams can better estimate the field conditions (steep slopes, obstructions etc.) before visits. The imagery management use case demonstrated how LiDAR data can be useful for this purpose. In this use case, SDG&E

discovered that between various departments and projects, there are about 7,000 LiDAR tiles that can be used in Geographic Information System (GIS) 3D applications.

  - Public safety improvement and hazard exposure reduction can also be accomplished by advanced visualization tools. For example, the AMI for operations use case, where the voltage swell and sag are visually monitored for 19,000 smart meters, was increased to approximately 300,000 in Q3 2022. This feature is used for monitoring in emergency scenarios, such as red-flag fire alerts and earthquakes.

Quantitative Benefits Summary

	Measurement	
	Technologies in Direct Use Post-EPIC	**Reduce O&M Costs**
Visualization and Situational Awareness	5 use cases	$118,543/year

Unmanned Aircraft Systems for Advanced Image Collection and Analytics

This project module, also a part of the visualization and situational demonstrations, explored how Unmanned Aircraft Systems (UAS) can be used for advanced image collection, ingestion and storage of UAS data, and how advanced data analytics can be conducted through means of a platform especially adapted to meet SDG&E's organizational requirements.

The work in this project module demonstrated the value of having a central repository to store, catalog, and sort data and make it visually available to multiple stakeholders concurrently. The stakeholders' ability to create custom views for their area of operations and perform deep learning analytics on the vast amount of data provides actionable results to important test cases ranging from automatic identification of equipment on poles to tracking vegetation encroachment on power lines. Several use cases were explored demonstrating the potential to perform virtual asset inspections, enhancing safety and reliability of power system equipment.

Benefits

- **Economic Benefits** – The technologies and tools demonstrated in this project significantly reduce the number of physical inspections that need to be conducted. Additionally, having up to date imagery can greatly improve inspection planning, which reduces the number of hours the inspections take and frees up resources to work on other tasks.

- **Environmental Benefits** – Not only is the use of UAS more cost effective than most other data collection methods, but it is also much more beneficial for the environment. UAS can be sent out quickly and easily to conduct aerial inspections and surveys, while generating minimal disturbance and noise to the surrounding wildlife and habitat. By eliminating the need to have “feet on the ground”, plants and wildlife are not affected by humans conducting physical inspections.
- **Safety** – The use of UAS technology enables remote asset management and keeps utility personnel away from hazardous and dangerous terrain. In addition, advanced data analytics decreases the amount of field work needed to identify and change, features and equipment within the network area. During emergencies, such as wildfires or other natural disasters, UAS technology can act as a first line of defense in monitoring and tracking the situation remotely, therefore ensuring the safety of personnel and mitigating harm to people and property.

Project 4 – Demonstration of Grid Support Functions of Distributed Energy Resources (DER)

The project focused on determining the value proposition for various grid support functions, for example using a DER as a partial solution for Volt/VAR regulation or as a sensor in the system. The demonstrations in this project provided information about the viability of specific DER functions and helped identify which ones should be pursued in advanced distribution system automation. Each function was evaluated for its contribution to greater reliability, lower cost and increased safety.

The project also evaluated the emerging communications standard at the time, IEEE 2030.5 for performing grid support functions of DER.

Finally, the project included a comparison of the Electric Power Research Institute’s (EPRI) Distribution Resource Integration and Value Estimation (DRIVE) tool, to SDG&E’s Iterative Integration Capacity Analysis (ICA) tool. The comparative analysis resulted in a recommendation that SDG&E keep DRIVE available as one of the tools for future hosting capacity analyses while monitoring the future advances in DRIVE and the emergence of other tools.

Benefits

- **Adoption of EPIC Technology** – A Real-Time Digital Simulator (RTDS) model for a typical distribution circuit for use in Power Hardware in the Loop (PHIL) demonstration was developed in this project and is still available and in use at SDG&E’s Integrated Testing Facility (ITF).
- **Economic Benefits** – One example of many grid support functions tested was using the DER as an alternative to spinning reserve to provide support during different system conditions as compared to diesel generators. The DER can remain in idle mode with minimal loss of charge unlike the conventional diesel generators, which consume fuel even when they are not outputting power. The emissions from the diesel generators are also avoided. Because of these benefits, a battery storage system is attractive as an alternative to spinning reserve. Depending on circumstances, they can also be a more efficient and reliable source to provide grid support during a disturbance or outage. They provide clean energy, enhance environmental sustainability, and provide ease of operation and maintenance. The estimated potential savings are roughly $119.78/hour of run time. To see the details of this cost savings estimate,

please refer to the *EPIC 1 Project 4 Fuel Savings Calculations* provided in *Attachment I - Supporting Information to Appendix A Benefit Reports.*

- **Reliability** – In response to emergencies, a DER inverter can be started and stopped to connect and disconnect from the system. The output can be modified, and the ramp rates can be changed depending on the need. In addition, the ramp rates and gains for the Volt-VAR, frequency-watt and volt-watt functions can be changed to suit different scenarios. Overall, this flexibility provides reliable operation with increased safety.

Quantitative Benefits Summary

	Measurement
	Reduced O&M Cost
DER as Spinning Reserve	$119.78[32]/hour generator runtime

Project 5 – SMART Distribution Circuit Demonstrations

The work performed in pilot demonstrations of smart distribution circuit features and associated simulation sought to identify best practices for integrating new and existing distribution equipment in these circuits. The project also included a demonstration of methodologies and tools for energy storage integration into smart distribution circuits. The work demonstrated in this project (together with the results of Project 1 through 4 above) provided a springboard for additional work, informing and providing advancement in the areas of:

- Distributed Energy Resource Management System (DERMS) roadmap and requirements
- Advanced Distribution Management Systems (ADMS) roadmap and requirements
- Field Area Network (FAN) communications and requirements
- Community microgrid requirements and design

Benefits

- **Economic Benefits**
  - The improved analysis process gained through the demonstration work enables SDG&E to identify potential problems sufficiently in advance to pursue the most cost-effective solution. In addition, the integrated modeling of the capacity deferral and markets benefits allows for proper comparison of the net present value (NPV) of traditional infrastructure versus capacity deferral based on Energy Storage System (ESS) applications and related market benefits.
  - Based on the understanding and research carried out in this project, the potential for recommending enhancements to the existing infrastructure was made possible. The implementation of the recommendations would aid in improving the lifespan of various distribution equipment, reducing associated maintenance costs.

[32] SDG&E EPIC 1 Final Report, Cost p. 210, found at sdge.com/epic

- **Safety** – One of the recommendations resulting from the project, downed conductor detection using high impedance fault (HIF) contributes to improved safety as it assists in addressing the challenge of detecting, locating, and isolating HIFs due to downed or broken energized conductors. An energized conductor on the ground for even a brief amount of time is a safety hazard.
- **Reliability** –SDG&E's multiple microgrids have helped reduce customer impacts of planned outages to accommodate wildfire safety upgrades in various regions of the service territory.
- **Effectiveness of Information Sharing** – A common benefit of the EPIC program is the technology and knowledge sharing that occurs both internally within SDG&E and across the industry. To facilitate this knowledge sharing, SDG&E conducted a panel discussion at the IEEE Power and Energy Society (PES)General Meeting held in July 2017 as well as sharing the results via the publicly available final report.

EPIC-2

Project 1 – Modernization of Distribution System and Integration of Distributed Generation and Storage

Building on the knowledge gained from Project 1 in EPIC-1, Smart Grid Architecture Demonstration Program, this project performed a pre-commercial demonstration in a laboratory of the IEC 61850 standard, with specific emphasis on generic object-oriented substation event (GOOSE) and sampled value (SV) messages. The GOOSE messaging feature provides the ability of peer-to-peer messaging between components in the system rather than from a higher level of control and is now the basis for what is known as the digital substation of the future.

This project also examined the pros and cons of IEC 61850, investigated vendor interoperability issues, and provided recommendations on commercial adoption. A primary benefit of this project was in the advancement of knowledge to aid future adopters of IEC 61850. The project demonstrated that the use of IEC 61850 enhances interoperability of multiple manufacturers' products. It also demonstrated that SV and GOOSE could provide protection system performances equal to or better than the traditional hardwired solution. The foundational experience created also supported the work of the IEC standards development groups.

Benefits

- **Reliability** – Operational efficiency can be improved using IEC 61850 equipment, especially with the new peer-to-peer communication feature, which allows major improvements of operations. With the ability to monitor and operate more equipment, there is a reduction in the cause of outages and an improvement in efficiency.
- **Economic Benefits** – Although the current equipment cost for the new merging units is higher, the long-term cost is lower due to savings on engineering efforts and design time and reducing the labor cost for wiring.
- **Safety** - Reducing the volume of wiring reduces the risk of fire due to a short in wires or a failure, because the substation racks in a digital system would use fiber optics. Due to the peer-to-peer communication feature, automatic disconnection of lines is possible in the event of a failure, which prevents human delay associated with traditional systems that can cause damage to the network and the grid.

- **Effectiveness of Information Sharing** – A common benefit of the EPIC program is the technology and knowledge sharing that occurs both internally within SDG&E and across the industry. The final report resulted in industry discussions on process bus implementation and interoperability at consortia and conferences, including the Western Protective Relay Conference, DISTRIBUTECH, and the Power Delivery Design Conference. The final report is publicly available to support the work of SDOs. A training program around IEC 61850 to cover the technology, testing, and operations was presented to SDG&E staff at SDG&E's Integrated Test Facility, to facilitate tech transfer and support follow-up actions.

Quantifiable Benefits Summary

	Measurement
	Information Sharing Activities/Publications
Modernization of Distribution System and Integration of Distributed Generation and Storage	5 events

Project 2 – Data Analytics in Support of Advanced Planning and System Operations

Using advances in machine learning, and taking advantage of the existing Hadoop Data Lake, a centralized repository that ingests and stores large volumes of data it its original form, this project integrated several data sources for ongoing ingestion, built preliminary predictive models for major electric distribution asset management use cases, and provided visualizations using Microsoft Power Business Intelligence (BI) Dashboards to provide insight into the health of various assets in the utility system. The project laid the groundwork for further data systems and model development and refinement.

Benefits

- **Reliability** – The use of advanced analytics to predict equipment failure into daily asset planning and operations practices increases reliability and enhances the overall risk management model for the electric infrastructure.
- **Safety** – Preventive maintenance prescriptions using advanced analytics on vast amounts of historical equipment and operating data helps enhance safety by avoiding unexpected outages, maintaining assets before catastrophic failures, and aids in managing the overall asset risk profile.

- **Effectiveness of Information Sharing** – SDG&E engaged other utilities to gain real-time feedback and share results of this project at industry events. Other utilities confirmed the validity of the use cases chosen and provided some hypotheses as to what factors were of most significance in their own findings.
- **Adoption of EPIC Technology** – Lessons learned from the project contributed to SDG&E's Enterprise Asset Management Program, a project focused on building the SAP HANA Data Lake, a repository designed to accommodate analytics and reporting use cases. The SAP HANA Data Lake is accessible to a wider user community and supports a wider variety of projects than the Hadoop Data Lake, increasing the benefits around reliability and safety mentioned above.

Project 3 – Monitoring, Communication and Control Infrastructure for Power System Modernization

The chosen project focus was a demonstration of Open Field Message Bus (OpenFMB) with respect to SDG&E's existing architecture and vision for the future. The project included assembly of a test system to demonstrate OpenFMB in a controlled environment within SDG&E's laboratory. The project demonstrated the potential value of OpenFMB in addressing interoperability issues that exist in the electric system today with multiple vendor technologies/systems unable to interface or interact with each other in a seamless manner. OpenFMB could provide a framework that enables the coexistence of traditional intelligent electronic devices (IED)s or devices that operate in a centralized manner with new IEDs or devices (especially DERs) that have the capability to operate in a decentralized manner. A primary benefit of the demonstration is the increased body of knowledge available to aid users in making decisions regarding their future power system communications architecture. It was found that more work is needed in the industry to define and mature OpenFMB into accepted industry standard before widespread commercial adoption is likely.

Benefits

- **Economic Benefits** – Using OpenFMB as a framework for deploying multiple technologies has the potential to lower costs for integration of devices and applications that can help utilities operate their electric infrastructure efficiently and in a cost-effective manner.
- **Reliability** – The use of OpenFMB to address interoperability challenges may provide greater reliability through potential improvements in distribution system operations through automated peer-to-peer Volt/VAR control, DER management, or enhanced automatic feeder deployment.

Project 4 – System Operations Development and Advancement

In this project, a highly distributed and modularly scalable control platform for monitoring, aggregation and control of DERs was proposed and demonstrated. Through use cases and evaluation of test results, it was concluded that DERs in secondary systems can play an essential role in supporting primary DERs for the purpose of emergency dispatch, voltage and reactive power control. It was concluded that the proposed control platform can provide a promising solution for aggregating and managing control and operating of non-conventional resources – both utility-owned and non-utility-owned, such as solar photovoltaic (PV) systems, ESS units, electric vehicles, and controllable loads.

Although the platform offered the benefits described below, business and commercialization efforts would require formation of a suitable commercialization team.

Benefits

- **Reliability** – Higher level of awareness and greater reliability indices are expected from a system that can effectively utilize DERs across the system to manage loads and generation locally and provide near real-time estimates of system status to the operator.
- **Economic Benefits** – Effective use of resources at the local and regional scale allows for improved reactive power flow management, voltage control and localized load balancing, all of which will support reduction in losses and increase in system efficiency.

Project 5 – Integration of Customer Systems into Electric Utility Infrastructure

The project demonstrated new technologies and analysis methods for monitoring, visualization, and root-cause analysis of distribution systems by using various measurement techniques, data sources and integrating them into one platform to provide a unique monitoring and visualization user experience.

As part of the demonstration, it was shown that there are many monitoring features and analysis capabilities that can be added to existing systems to greatly support the needs of operation and engineering users. New capabilities are essential for evaluating system performance and analyzing dynamic events associated with DER and customer-introduced technologies.

Benefits

- **Reliability –** The proposed advanced monitoring and data processing platform utilizes various sources of data at the same time to calculate a series of performance indices for the operation and analysis of the system. Redundant data and combining data from various sources not only increase the observability and deterministic aspects of the system, but also ensures that events can be analyzed, and conclusions can be reached faster to make informed decisions on various events and either prevent a failure or more quickly determine the root-cause and resolve the situation.
- **Safety** – Because the focus on the advanced monitoring and analysis system is on improving the system visibility and providing faster and more reliable methods for operating the system, safety and integrity enhancement of the system, is a main target. Fast actions are becoming possible based on processing and visualizing high resolution of field data.

- **Economic Benefits** – The demonstrated technology enables many fast monitoring and control applications that collectively suggest the prospects of a very high benefit-to-cost ratio.

Project 6 – Collaborative Programs in RD&D Consortia: Demonstration of Methodology and Tools for Estimating Propensity for Customer Adoption of Photovoltaics

The focus of this project was to identify methodologies and tools for determining the primary drivers for residential PV adoption, predict residential PV adoption over time, and to demonstrate selected methods on a use case (e.g., propensity to adopt PV on the ZIP code [1]) level. The effort also developed recommendations about whether or not to adopt all or some of the methods and tools on a commercial basis. The project team focused specifically on residential sector PV market adoption, envisioning that, depending on the degree of success in the demonstration, the methods and tools might someday be applicable to other areas, such as energy efficiency (EE), demand response (DR), non-PV distributed generation (DG), storage, electric vehicles (EVs), and microgrids. Additionally, the project team conducted machine learning analytics on Disadvantaged Communities' ZIP codes and evaluated the difference in propensity to adopt solar PV between DAC and other ZIP codes.

Benefits

- **Reliability** – More accurate DER forecasting techniques will be required as these technologies have a greater impact on SDG&E's distribution system. It has become evident through circuit load data that residential PV is now playing a role in daily load shapes. To ensure the system is properly designed for future needs, PV adoption forecasts must be carefully analyzed to anticipate future electric system requirements and reduce the risk of outages.
- **Economic Benefits** – PV adoption will likely have a direct impact on the type and location of distribution system, and possibly, transmission system upgrades. Applying the most appropriate resources at the most beneficial locations will inherently keep costs lower than the alternatives. Improved forecasting methods should enable the allocation of those resources to be applied in the most appropriate way.

Collaborative Programs in RD&D Consortia: Unmanned Arial Systems Data Lifecycle Management and Deep Learning Demonstration

This project demonstrated tools that ingested and analyzed data collected by means of UAS, existing Red, Green & Blue (RGB) imagery, Geographic Information Systems (GIS), Power Line Systems – Computer Aided Design and Drafting (PLS-CADD) and other various inspection data types. The project team demonstrated the tools' ability to automatically identify, and tag assets shown in RGB imagery, specifically avian covers, in real-world locations through machine learning. UAS provides a unique opportunity for SDG&E to obtain, disseminate and use aerial sensor data, providing cost savings to its ratepayers and improving safety to SDG&E personnel and the public. SDG&E is moving forward with widespread adoption of these capabilities.

Benefits

- **Safety** This project studied several use cases for using UAS technology and machine learning analytics to remotely observe, measure and catalog electrical facilities and surrounding terrain. The technology and process remove utility workers from conducting physical inspection in situations which in many cases require access through hazardous terrain and in close proximity to energized facilities and equipment. Additionally, the use of UAS technology enables remote asset management thereby helping utility field crew with tools that promote their safety. During emergencies such as fire or other natural disasters, UAS technology can act as a first line of defense in monitoring and tracking remotely, thereby enhancing safety of personnel and mitigating harm to people and property.
- **Reliability** – Greater reliability of systems can be achieved using UAS for data collection and running deep learning analytics to identify issues before they occur. It also helps various stakeholder groups (e.g vegetation, environmental and other groups in utilities) to effectively plan asset management activities, thereby improving reliability of service.
- **Economic Benefits** – Asset inspection costs can be reduced using advanced technology such as UAS to complement inspections by field crew. Crews can be deployed more effectively and in a more cost-effective manner, thereby making efficient use of ratepayer monies.
- **Environmental Benefits** – UAS technologies allow for a remotely operated aerial device to access sensitive habitats without impacting the land through vehicular intrusion. The use cases demonstrated a process to capture and analyze data from electrical facilities, surrounding vegetation and terrain features from an aerial drone.
    - Wildlife fatality reductions (electrocutions, collisions) – This project studied the feasibility of combining UAS derived imagery with deep learning analytics to determine the location and condition of avian covers on electrical facilities. The avian covers provide a level of protection against electrocution for birds with large wing spans resting on electrical distribution and transmission poles. Typically, avian covers are assessed by physical inspection taken from ground observation on scheduled maintenance intervals. UAS data capture and associated deep learning analytics could provide increased inspections, and improved evaluation of the presence and condition of avian covers, resulting in reduced risk to wildlife.
- **Adoption of EPIC Technology** – The intelligent image processing research performed in this project is supporting the Drone Investigation and Repair (DIAR) Program, supporting SDG&E’s Wildfire Mitigation Program. The intelligent image processing technology uses machine learning to assess power lines and automatically identify necessary repairs or improvements, reducing the risk of wildfire.

EPIC-3

Project 3 – Applications of Advanced Metering Infrastructure (AMI) Data to Advanced Utility System Operations: AMI System as a Voltage Network and Phase Identification Tool

These two Project 3 modules demonstrated capabilities for leveraging SDG&E's AMI system with its 1.4 million electric meter endpoints to provide actionable secondary voltage data and analysis to SDG&E staff and other prospective users. The first module focused on using AMI data for a voltage sensor network, while the second focused on using AMI data to identify endpoint phasing and meter-to-transformer mapping.

This project demonstrated a utility planning network model anomaly detection tool, a phase identification tool, and a meter-to-transformer mapping algorithm proof-of-concept. It also analyzed the impacts of PV smart inverter settings. The tools used AMI measurement data to estimate the primary voltages, identify planning model inaccuracies, and automate phase and meter-to-transformer mapping.

Benefits

- **Effectiveness of Information Sharing** – Interim results of this project were presented at the 2019 IEEE PES General Meeting and a National Renewable Energy Laboratory (NREL) Department of Energy Workshop in 2019. Since then, NREL presented the final results at the 2021 and 2022 IEEE PES General Meetings. To see a list of publications that came from this project, please refer to *Attachment I - Supporting Information to Appendix A Benefit Reports.*
- **Environmental Benefits** – The efficient PV smart inverter settings may increase the PV hosting capacity of the distribution feeders, allowing more renewable generation. Improved phase balancing, Volt/VAR optimization and other network controls based on the accurate network models, further support the higher levels of renewable generation. The tools demonstrated in this project are collectively geared toward reducing the dependence on traditional fossil fuels for our energy needs, thus lowering the associated GHG emissions. The reduction of travel associated with field visits/field verification, would also reduce GHG emissions and free up time availability of field personnel.
- **Economic Benefits** – This project demonstrated a phase identification tool that performs automated customer phase mapping based on AMI data. Traditionally, utilities perform the same task manually by sending a crew to the field for the identification of the customer phasing. This manual process, performed periodically, is expensive and time-consuming. The phase identification tool greatly simplifies this process and determines the customer phase connectivity more economically, thus providing savings for the ratepayers.
  The PV smart inverter results may help achieve the desired power quality (Voltage and VAR profiles) by using existing smart inverters and thereby reduce or defer investments in network upgrades. This approach has the potential to help contain the cost of electric service, which in turn benefits ratepayers through lower electricity bills.

Quantitative Benefits Summary

	Measurement
	Industry Sharing Events/Papers Published
Applications of AMI Data to Advanced Utility System Operations	5 events/publications

Project 4 – Safety Training Simulators with Augmented Visualization

Project 4 demonstrated and evaluated augmented/virtual reality (VR) applications for workforce training in field focused design, operations, and asset monitoring and management solutions in utility power systems. The project was split into two modules with the first centered on focused patrol for the benefit of operator trainees and the second on safety procedures for underground distribution field work.

Benefits

- **Reliability** - Focused patrol training allows for quicker fault identification, effectively reducing crew effort and therefore potentially reducing the overall System Average Interruption Duration Index (SAIDI) impact of outages, making the Distribution System Operator more efficient. It will also increase customer satisfaction and reduce their exposure to wildfire-related issues and other risks associated with outages. An analysis conducted and included in the final project report calculated the potential impact to SAIDI improvement at 13 minutes. To see more details of the calculations used for SAIDI improvements and value, please refer to EPIC 3 Project 4, Safety Training Simulators with Augmented Visualization SAIDI available in *Attachment I - Supporting Information to Appendix A Benefit Reports.*
- **Economic Benefits** – Focused patrol training allows for quicker fault identification, effectively reducing the patrol time required to find the fault location, isolate the fault and restore service more quickly. Faults often occur after normal work hours, and thus crew call outs to restore outages are often associated with overtime labor rates. Shortening the restoration will reduce overtime costs and can reduce the number of crews called to help patrol the line. During normal work hours crews will become more efficient in the restoration, allowing them to get more work done during their workday or shift.

  The Personal Protective Grounding (PPG)/Equal Potential Zones (EPZ) procedures allow the work to be performed in a localized environment and thereby reduces power outage duration, due to the increased skill level of employees. The reduced outage duration helps SDG&E reduce the cost of system operations. Foremost, electrical safety for the workforce is enhanced through the elimination of hazardous differences of potential (voltage) at the work site.

Using the Interruption Cost Estimate Calculator at http://icecalculator.com/home, which was developed by Lawrence Berkeley National Laboratory funded by the Department of Energy Office of Electricity, the impact of the reliability improvement is valued at approximately $30M per year. To see more details of this calculation, please refer to Figure 2 in *Attachment I – Supporting Information to Appendix A Benefit Reports.*

- **Safety** - As part of the focused patrol module, SDG&E explored use cases, such as foreign objects in lines and intrusion of trees and vegetation. The goal of these use cases is to quickly pinpoint the location of faults so that SDG&E can quickly deenergize the circuit, if necessary, and dispatch crews to patrol and fix the issue. This focused patrol use case improves safety by avoiding wildfires ignited due to downed wires and improves public safety by avoiding accidental contact with energized downed wires. In the context of the personal protective grounding module, the interest of workforce safety is served by providing a superior training experience for the implementation of correct techniques used when completing tasks on underground systems, where the assumption is that the conductors will remain clear of hazardous potentials for the full duration of the work.
- **Adoption of EPIC Technology** - The virtual reality training methods demonstrated in this project were integrated into SDG&E's Apprentice Training Program as part of the Phase III Underground Curriculum. SDG&E is currently evaluating the application of VR into the EPZ annual refresher training.

Quantitative Benefits Summary

	Measurement	
	SAIDI Improvement	**Value of Reliability Improvement**
Safety Training Simulators with Augmented Visualization	13.1 minutes	$30,000,000/year

Project 5 – Unmanned Aircraft System (UAS) with Advanced Image Processing for Electric Utility Inspection and Operations

Project 5 built on the extensive work on UAS applications in previous EPIC cycles, conducting analysis of high-quality images and data from UAS to effectively aid in time sensitive operations in many applications. The work in this project expanded the analysis of UAS capabilities to asset aging issues and wildfire mitigation, supporting and increasing staff efficiencies in several SDG&E internal departments including Aviation Services, Electric Distribution Engineering, Distributed Energy Resources, Fire Risk Mitigation, Fire Science and Coordination, Transmission, Construction and Maintenance; and Distribution Operations and Engineering. Pre-commercial demonstrations provided evidence of the following benefits.

Benefits

- **Safety** - All the use cases demonstrated in the project reduce safety risks in hard-to-reach areas within the SDG&E service territory as their implementation either supplements or replaces the requirement for manned aircraft and/or field deployments, reducing risks to workers and the public.
- **Economic Benefits**
  - The project team assessed 20-230 kV and 4-138 kV transmission structures taking a total of 46 minutes of flight time using the UAS. Traditional methods would have taken the thermographer seven hours with some structures inaccessible due to terrain. The typical cost savings is approximately $100 per labor hour with the number of hours varying from site to site.[33]
  - The Indoor Confined Space Inspections use case was applied to an inspection area 300 feet in height that could potentially cost $38k annually to build the scaffolding that is needed to complete this annual inspection. The scaffolding build process alone takes days, and then the inspector will use the scaffolding to inspect the confined space which takes many more labor hours. During the test case, an actual inspection was tested and was successfully completed in one and a half hours. Current practices would have taken an estimated two weeks or more.
- **Adoption of EPIC Technology** - This project successfully demonstrated the value proposition for UAS and the newly mounted sensors that were tested. Several use cases identified in the project final report were adopted for commercial use, including PSPS/Wildfire Mitigation Program, Coronal Cameral, Confined Indoor Space Inspections, and Line Pulling.

Quantitative Benefits Summary

	Measurement	
	O&M Costs Reduced	**Technologies in Direct Use Post-EPIC**
Unmanned Aircraft Systems	$100/labor hour (Corona Camera Use Case)	4 use cases

[33]SDG&E EPIC 3 Final Report Project 5, Updated Benefits Analysis p. 56 found at sdge.com/epic

	$38k/year/inspection (Indoor Confined Space Use Case)	

Project 7 – Demonstration of Multi-Purpose Mobile Battery for Port of San Diego and/or Other Applications: San Diego Port District and Community Resource Centers

This project performed pre-commercial demonstrations of mobile battery energy storage systems (MBESS) examining the value proposition from using MBESS across multiple sites and use cases and included two modules. The first module demonstrated and evaluated the stacked benefits identified using a mobile BESS in multiple use cases including, safety, load factor corrections, load smoothing, peak shaving, demand response and load blackstart. The second module was a demonstration of the MBESS as a backup power solution during planned safety outages and in emergency events such as response to wildfires. The demonstrations were completed at two community resource centers in areas that are highly susceptible to Public Safety Power Shutoffs, running for 24 hours at each location to ensure the battery could provide reliable power for an extended period. The demonstration at the two sites clearly showed the viability and value of utilizing MBESS for supplying the customer loads during a specific period when supply interruption (outage) is expected. The approach alleviates the need for maintaining a stationary backup generation source at a facility year-round. It also showcased an alternative to conventional diesel generators, which are highly prone to noise pollution and greenhouse gas (GHG) emissions. A third module is in progress that will explore use cases for applying IEEE 2030.5 standard to control the MBESS, providing additional operational flexibility, and other use cases that were not previously demonstrated.

Through the performance of these demonstrations, SDG&E contributed to the emergence of an MBESS supplier industry, which was discovered to be in a fledgling state when the work was first initiated. Additional potential benefits of an MBESS deployment are provided below.

Benefits

- **Reliability** – The MBESS was able to demonstrate a successful load black start and coordinate the integration of other connected DERs to carry downstream loads for 24 hours. It also successfully shaved peak loads up to and exceeding its 362kW rating and load smoothed peaky customer loads down to a rate of change of 126 Watts/sec. When considering associated temperature decreases due to amperage reductions at the substation, the MBESS has the potential to increase grid infrastructure by 2.78 years, worth an estimated $170,389 over 10 years. The MBESS can also be used to offset planned grid upgrades, worth an estimated $141,618 per year.
- Environmental Benefits - When an MBESS is used in place of a diesel generator, there is a diesel fuel consumption reduction, generating cost savings and GHG emissions reductions. Based on 2021 data, an average 285kW diesel generator rented by SDG&E consumed 303 gallons of diesel fuel over the course of a year. At roughly $5.95/gallon of fuel (based on 2022 data), this is approximately $1,800 in fuel

savings. By not burning diesel fuel, and using EPA standard emissions equivalence factors[34], the result is a reduction of three metric tons of CO_2 equivalent (MCO2e) per generator per year.[35]

- **Economic Benefits** – When compared to a diesel generator, the MBESS demonstrated $653,424[36] more in net benefits than a diesel generator rental over a 10-year period.
- **Safety** - The MBESS contributed to a safer worksite through the development of customized deployment safety protocols and emergency stop functionality. It also proved to reduce runtime of more traditional diesel generators, decreasing the risk for a fuel spill and contributing to a quieter work environment with better air quality. Reduction of noise pollution is estimated at up to 60 decibels.
- **Equity** - The deployment of the MBESS at the Port District, which is adjacent to some of SDG&E's most concentrated DAC-designated areas, improves air quality for residents.

- **Adoption of EPIC Technology –** SDG&E is currently in the process of deciding to, either buy a fleet of MBESS, rent the MBESS units or adopt a combined approach, as is the case for diesel generators.
- **Support of State Policy** – Demonstrations of the MBESS supports the state initiative to reduce emissions of GHG by providing augmentation for current emergency backup solutions (i.e. diesel generators) through alternative energy solutions such as MBESS. Assisting with the reduction of GHG emissions contributes to goals related to low emissions vehicles and transportation, economic development, and efficient use of ratepayer monies.
  - Assembly Bill (AB) 628 authorizes the San Diego Unified Port District, in conjunction with San Diego Gas & Electric, to prepare an Energy Management Plan to reduce air emissions and promote economic development in the District.
  - AB 32 required the State to reduce its GHG emissions by 80% below 1990 levels by 2050.

Quantitative Benefits Summary

Measurement		
O&M Costs Reduced	**Reduced GHG Emissions**	**Worker Safety Improvement and Hazard Reduction**

[34] https://www.epa.gov/sites/default/files/2021-04/documents/emission-factors_apr2021.pdf
[35] SDG&E EPIC 3 Project 7 Final Report Module 1, Section 6.1 Results Discission p. 55 found at sdge.com/epic
[36] SDG&E EPIC 3 Project 7 Final Report Module 1, Section 6.1 Results Discission p. 56 found at sdge.com/epic

Mobile Battery Energy Storage	$653,424/10-years/diesel generator rental $1800/year/generator	3 metric tons of Carbon Dioxide Equivalent (CO_2e)/diesel generator/year	Reduction of noise pollution from up to 60 decibels for diesel generators to minimal noise output of the mobile battery

Conclusion

As illustrated in the previous sections, SDG&E's EPIC Program contributes to the goals of a more reliable, safe, affordable, environmentally sustainable, and equitable electric grid. The SDG&E EPIC Program enables a path forward for the adoption of promising solutions that stabilize the electric grid, improve operational efficiencies and costs, and mitigate the threats of safety hazards to SDG&E personnel and its customers.

Figure 1. EPIC 1 Project 2 Transmission Fault Location Visualization Use Case Savings Calculation

Project	**Visualization & Situational Awareness Demonstrations**					
Use Cases	**What does the technology solution do in the use case?**	**What are the cost savings to SDG&E for each event in which it is used?**	**How many events in typical year?**	**What is the total annual cost benefit (product of the above two items)?**	**Are there any additional operating efficiencies that are achieved by commercial use of the technology solution and can they be quantified?**	**What is the grand total cost savings benefit, including the attained operating efficiencies?**
Transmission Fault Location Visualization	At SDG&E, substation relays are equipped with a function to compute a linear distance (i.e., a distance from the substation housing the relay along the line) to the line fault. When a fault occurs, relays detect it and compute the linear distance. This information eventually flows into the PI data historian archiving system, from which an existing program called PI Notification sends text e-mails to relevant users with information about the fault. The intent of Use Case #1 was to demonstrate the Transmission Fault Location application that will enhance situational awareness about the fault by: (1) extending the e-mail message with a link to a specific web page on the ArcGIS Portal; (2) demonstrating the functionality to generate the target web page and show a geospatial map on the page with the electric circuits and fault indicators at the exact location of the fault; and (3) showing any other geospatial layers, such as weather, fire, earthquake, etc., that may be available in the GIS system.	OH Outages = $2891.56/outage, UG Outages = $1440.52/outage	40 OH outages, 2 UG outages	OH Outages = $115,662.40/year, UG Outages = $2881.04/year, Total Savings = $118,543.44/year	Another benefit of knowing the location in SPARC is during storms, we can reference the location and if there was lightning in the area to give a probable cause. Finding lightning strikes midspan is very difficult so this allows the patrollers to provide extra focus during their flights or ground patrol in that area. This greatly increases the turnaround on fault findings.	Total Savings = $118,543.44/year

EPIC-1 Project 4, Demonstration of Grid Support Functions of Distributed Energy Resources (DER) - Fuel Savings Calculation

On performing a comparative analysis in terms of economic benefits in fuel savings, ease of operation, response time, and reliability, it is evident that the use of a DER over diesel generators is considerably more beneficial, in terms of both cost and operation. The results from the comparative study in terms of various aspects are presented below.

The capital cost of installing the DER is the only major cost involved in the battery storage system because the overall operation cost along with the idle charge losses is negligible. There is no fuel that needs to be replenished frequently as in a diesel generator, and hence the operational cost is considerably lower.

Compare the performance of the diesel generator of a similar rating of 1 MW, whose approximate fuel flow rate is specified as:

Fuel flow (GPH) 1.1312 x MW (% of the rated MW) + 10.01

The total fuel cost of the diesel generator based on the average cost of diesel of $5.95 per gallon (as of third quarter, 2022).

Fuel cost during idle period for a period of one hour:

Fuel cost = fuel flow (gallons per hour) x 1 hour x $5.95/gallon

Fuel cost = 10.01 x $5.95 = $59.56

The fuel cost for a generation of 845.6 kW (.08456) for a period of one hour is calculated as follows:

Fuel cost = (1.312 x .08456 + 10.01) x 1 hour x $5.95/gallon = $60.22

Total Fuel Cost = $119.78

The timelines considered here are solely for comparison; however, the actual idle runtime can exceed more than an hour, which increases the cost of operation rapidly. This cost is considerably higher than a negligible operational cost of the DER system, and hence a DER system is a more economic source of spinning reserve than a diesel generator system because the idle loss of the diesel generator is almost half of the operation cost incurred by it.

EPIC-3 Project 3, Applications of Advanced Metering Infrastructure (AMI) Data to Advance Utility System Operations: AMI System as a Voltage Network and Phase Identification - Related Publications

1- H. Padullaparti, S. Veda, J. Wang, M. Symko-Davies, and T. Bialek, "Phase Identification in Real Distribution Networks with High PV Penetration Using Advanced Metering Infrastructure Data," presented at 2022 IEEE Power & Energy Society General Meeting (PESGM), 2022.
2- M. Netto, J. Hao, H. Padullaparti, and V. Krishnan, "On the Use of Smart Meter Data to Estimate the Voltage Magnitude on the Primary Side of Distribution Service Transformers," presented at 2021 IEEE Power and Energy Society General Meeting, 2021.
3- J. Wang, H. Padullaparti, S. Veda, M. Baggu, M. Symko-Davies, A. Salmani, and T. Bialek, "A Machine Learning-based Method to Estimate Transformer Primary-Side Voltages with Limited Customer-Side AMI Measurements," presented at 2021 IEEE Power & Energy Society General Meeting (PESGM), 2021.
4- H. Padullaparti, S. Veda, S. Dhulipala, M. Baggu, T. Bialek and M. Symko-Davies, "Considerations for AMI-Based Operations for Distribution Feeders," presented at 2019 IEEE Power & Energy Society General Meeting (PESGM), 2019, pp. 1-5.
5- H. Padullaparti, "AMI for Operations," presented at 2019 Workshop on Advanced Distribution Management System (ADMS) Test bed, Nov. 2019.

EPIC-3 Project 4, Safety Training Simulators with Augmented Visualization SAIDI Calculation

Metrics

Focused patrol training will allow for a quicker fault identification reducing the overall SAIDI and CAIDI.

Recent analysis showed that the troubleshooting time for a typical overhead outage that occurs on a distribution branch or circuit is approximately 84 minutes during working hours and approximately 111 minutes during non-working hours. This is the time measured from initial outage report to the time the outage cause was recorded by a troubleshooting crew. As described in ***Error! Reference source not found.***, that would be the elapsed time from T0 until T5. This excludes all outages that were local at a service transformer or secondary where there would be no patrolling time required.

The average time it took the troubleshooter to arrive and begin patrolling for these branch and circuit outages was 53 minutes during workhours and 73 minutes during non-workhours. As described in ***Error! Reference source not found.***, that would be the elapsed time from T0 until T4. Thus, actual patrol time averaged 31 minutes during working hours and 48 minutes during non-working hours. Since the additional data identified in this study will allow the fault location to be identified to a relatively small segment of line, the patrolling should be reduced to the just the time required to get to the predicted area and confirm and/or patrol the smaller segment. It is reasonable to assume that the additional information available will reduce patrol time by at least 66% since it is typical for the fault to be downstream of one of a multiple number of branches and the savings would be based upon not having to patrol all the possible branches, assuming an average of 3 potential branches and the ETS crew only having to travel to the fault on one the three branches. This results in a Customer Minutes of

Interruption savings of 20.5 minutes for working hour outages and 31.7 minutes for non-working hour outages.

The number of branch and circuit outages that occurred was 497 outages during working hours and 602 outages during non-working hours. Using these numbers, it is possible to estimate what would be the potential impact on system SAIDI, including Major Event Days (MED), and excluding transmission and planned outages). The calculation is summarized in the table below.

Table 1. Calculation of potential SAIDI Impact

Item	Value	Combined	Working Hours	Non-Working Hours	Units	Notes:
1	Outage Start to Cause Determined (T0-T5)	97.5	84.0	111.0	minutes	From SDG&E data
2	(Outage Start to On Scene) T0-T4	58	53.0	63.0	minutes	From SDG&E data
3	Patrol Time (T5-T4)	39.5	31.0	48.0	minutes	Item 1 - Item 2
4	Reduction in Patrol Time	66%	66%	66%	percentage	Estimated, based upon average of 3 possible branches to patrol
5	Improved Patrol Time	13.4	10.5	16.3	minutes	Item 1 - Item 2
6	CMI improvement for branch and circuit outages	26.07	20.5	31.7	minutes	Item 3 - Item 5
7	2018 Distribution SAIDI (including MED, excluding transmission and planned outages)	73.9			minutes	From page 8 of SDG&E Electric Reliability Report for 2018
8	2018 CAIDI (including MED)	112.3			minutes	
9	2018 SAIFI (including MED)	0.7			interruptions /cust	
10	Number of customers served	1458900			# Customers	From 2018 Annual Report
11	Total CMI	107768943			Customer Minutes	Item 7 * Item 10
12	Total number of circuit and branch outages (Jan-Sept 2018)	1099			Interruptions	From SDG&E data
13	Estimated Full year	1465			Interruptions	Convert 9 months to full year, assume uniform
14	Number of customers in average circuit/branch outages (customers)	500			# Customers	Estimated average size of circuit and branch outages

Item	Value	Combined	Working Hours	Non-Working Hours	Units	Notes:
15	CMI improved	19100620			Customer Minutes	Item 6*Item 13*Item 14
16	New Total CMI	88668323			Customer Minutes	
17	Estimated New Distribution SAIDI (including MED, excluding transmission and planned outages)	60.8			minutes	
18	SAIDI improvement	13.1			minutes	

Using the Interruption Cost Estimate Calculator at http://icecalculator.com/home, developed by Lawrence Berkeley National Laboratory and funded by the Department of Energy Office of Electricity, the impact of the reliability improvement is valued at approximately $30 Million per year as shown in Figure 2.

Figure 2. ICE Calculator Benefits Report

Home | Interruption Costs | Reliability Benefits | Manage Models | ICE Calculator 2.0 | Documentation | About | Contact Us

ICE CALCULATOR

Value of Reliability Improvement

This module provides estimates of the value associated with a given reliability improvement.

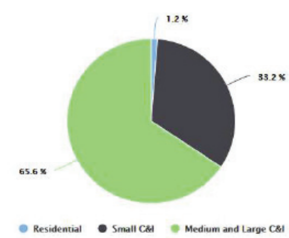
Focused Patrol

Initial Year: 2021 | Lifetime (Years): 10 | Inflation Rate: 2.0 % | Discount Rate: 6.0 % | #Residential: 1,293,600 | #Non-Residential: 150,700 | California

Sector	# of Customers	Total Benefit (2015$)	Benefit per Customer (2015$)	Year	Without Improvement (Baseline)	With Improvement	Total Benefit
Residential	1293600	3,031,730.92	2.34	2021	307,744,078.88	277,484,190.42	30,259,888.46
Small C&I	125189	85,064,766.16	679.49	2022	313,898,960.46	283,033,874.23	30,865,086.23
Medium and Large C&I	25511	167,961,979.90	6,583.90	2023	320,176,939.67	288,694,551.71	31,482,387.96
All	**1444300**	**256,058,476.98**	**177.29**	2024	326,580,478.46	294,468,442.75	32,112,035.72
				2025	333,112,088.03	300,357,811.60	32,754,276.43
				2026	339,774,329.79	306,364,967.84	33,409,361.96
				2027	346,569,816.39	312,492,267.19	34,077,549.20
				2028	353,501,212.72	318,742,112.54	34,759,100.18
				2029	360,571,236.97	325,116,954.79	35,454,282.19
				2030	367,782,661.71	331,619,293.88	36,163,367.83

Distribution of Benefits

Sector	# of Customers	Total Benefit (2021$)	Benefit Per Customer (2021$)
Residential	1,293,600	$3,031,730.92	$2.34
Small C&I	125,189	$85,064,766.16	$679.49
Medium and Large C&I	25,511	$167,961,979.90	$6,583.90
All	**1,444,300**	**$256,058,476.98**	**$177.29**



The impact of the reduced usage of test closure to identify fault location, and the resulting longer asset life is not calculated, but it is a noted benefit not quantified, but likely to result in additional savings.

Appendix B – EPIC Public Workshop Summaries

Overview

SDG&E expended a considerable effort gaining stakeholder feedback for development of the EPIC-4 Investment Plan. The Commission requires the Public Administrators to hold at least two public stakeholder workshops during the development and execution of the Administrator's respective plans. The utilities held four joint public engagements, two public workshops and two workshops targeting Disadvantaged Communities (DACs).

The workshop slide presentations of the DAC workshops are available on SDG&E's EPIC Website. A summary of the DAC workshops and stakeholder feedback from each Workshop is provided below:

I. Joint Utilities EPIC DAC Workshop, June 21, 2022

1. Overview of Electric Program Investment Charge (EPIC)

1.1. Overview

- California statewide program funded by ratepayers that allows utilities and CEC to invest and pursue innovative energy solutions focused on increased safety, improved affordability, reliability, environmental sustainability, and equity
- Three CPUC-designated work categories for EPIC are Applied Research & Development, technology Demonstration & Deployment, and Market Facilitation
- Utilities can work only in the Technology Demonstration and Deployment category (not permanent commercial deployments but proof of concept demonstrations to determine the value proposition for emerging innovations)

1.2. Scope Range and Constraints for IOU EPIC Projects

- Flexibility to demonstrate a wide range of technology solutions
- CPUC-designated constraints *(see Workshop ppt. slide #7 for a list of constraints)*

1.3. Funding Allocations for Project Work

- •Funding allocation for five-year EPIC-4 cycle: 80% CEC, 20% IOUs
- •Funding is broken down between the three IOUs in proportion to total revenue collection (see Workshop ppt. slide #8 for more details)

1.4. Implementation Process

- IOU EPIC-4 applications are due on Oct. 1, 2022
- Schedule is comprised of a series of activities specified by CPUC (see Workshop ppt. slide #9 for details)
- EPIC-4 applications will be designed around strategic initiatives and topics within those strategic initiatives (not individual projects); not all approved topics within approved strategic initiatives will have funding available, so they will require prioritization to determine which projects in support of the approved topics would proceed.

Examples of Past EPIC Projects with DAC Benefits

2.1. PG&E DAC Demonstration Benefits

2.1.1. Advanced Distributed Energy Resource Mgt Systems (DERMS) & Advanced Dist. Mgt. System (ADMS)

- A telemetry solution that solves the problem of high-cost connectivity of customer distributed energy resources of 1MW+ into the utility
- Previous cost could be up to $150,000 to connect per the mandate
- With the new system created under the EPIC program, the cost is significantly lower
- Connects into the grid operations center to ensure safe and reliable operations of the grid for larger types of DER
- One of the three demonstration sites is the Blue Lake Rancheria (BLR) in Humboldt County; BLR is a DAC with PV DER concerned about high cost of the state requirement for telemetry

2.1.2. System Harmonics for Power Quality Investigations

- Harmonics are disturbances to the flow of power causing negative impact on customer equipment
- Previous methods to address issues required placement of specialized equipment to collect, analyze and correct
- Smart meters allow for remote access to understand issues more quickly, avoids truck rolls, improving safety and customer experience
- Demonstration Sites - In Central Valley there are many DACs affected by harmonics thrown off by nearby solar farms, agriculture pumps, etc. Most of the project's meters are installed in these DAC areas to allow for more responsiveness in these areas
- Participant Question: Are the smart meters used for the demonstration the standard meters or are they retrofitted in their hardware/software? Answer: They are a newer, more capable version of the current generation smart meters; they can perform high quality analysis and recording and for the demonstration are added next to the current generation smart meter. In a deployment this newer type of smart meter would replace the current generation smart meter.

2.2. SDG&E DAC Demonstration Benefits

2.2.1. Demonstration of Multi-Purpose Mobile Battery Energy Storage System (MBESS)

- Determine the value proposition for MBESS in different use cases at different sites and determine a rationale for rotating the MBESS to alternative sites to maximize the use of the MBESS
- Encouraging the emergence of an MBESS supplier industry as it has been observed to be a fledgling industry
- Benefit areas of the project include: Peak Demand Reduction, Community Services & Climate Change, Grid Modernization & Resiliency, Economic (see Workshop ppt. slide #17 for details)
- Sample use cases o Support islanding in rural community to maintain critical loads; mobile battery serves as auxiliary resource during planned or unplanned outages

- Support community resource centers during public safety power shutoffs and other emergencies
- Participant Question: The mobile battery can be used for either cost reduction or GHG reduction and the current price signals and the GHG signals are not compatible. Are there any thoughts on how to bridge that gap so you cannot have one or the other but both? Answer: It wasn't part of the project to investigate price signals; however, these issues may be part of the commercial implementation stage as we move from the EPIC demonstration into commercialization. We would examine issues like this in the deployment stage, but individual benefits were examined separately and tallied without considering the interaction of price signals. MBESS are primarily intended for use in emergency situations and not to participate in the markets.

2.2.2. Safety Training Simulators

- Module 1: For safe operation of the network requiring various technologies/applications: Configure existing software to channel real-time data into a common platform for future use by system operators in the real-time environment. Set up and demonstrate an associated training capability for operators.
- Module 2: For Journeymen Lineworkers: Use of virtual reality training to improve the training experience. The abundance of DER in the form of both solar and energy storage is increasing and the related threat of back feed during grid outages is thereby increased. This threat adds to that already posed by inductive coupling with nearby energized circuits. Augmented virtual reality technology would allow personnel to perform the tasks in training and improve their performance in the real world, on potentially energized systems. The chances for a misapplication of these safety-sensitive tasks are reduced. Student learning is enhanced by the VR technology.

2.3. Southern California Edison DAC Demonstration Benefits

2.3.1. Service and Distribution Center of the Future

DAC ability to replace diesel buses with electric buses on the J or Silver line in the LA Metro territory

- Help LA Metro and other transit agencies through the journey of electrifying their fleets
- Facility in El Monte will be LA Metro's first fleet depot electrification supporting over 200 buses
- Electrifying a fleet of this size takes a significant infrastructure investment to support the charging
- Level of investment and the complexity can be affected by managing the infrastructure and optimize with the fleet operations
- Leveraging other programs and opportunities with EPIC concurrently i.e. Charge Ready where SCE is helping customers in different sectors put in electric vehicle charging infrastructure
- Key benefit stream is reduced diesel emissions on the bus line (see Workshop ppt. slide #23 for the areas impacted) and outage resiliency of bus charging with energy storage
- Goal is to use DER to more cost effectively support electric bus charging services
- In terms of long-term affordability, project is leveraging the same work on microgrids to implement a strategy at the site

- Use cases include: Load Management/Demand Response, Grid Support, Resiliency, Building Electrification, EV Charging Submetering

3. Workshop Question: Are there preferred resources and/or types of demonstrations that would be most beneficial to DACs and under-resourced communities?

Q: Does the CPUC or CEC have or maintain a list of DACs that have expressed interest in participating in demonstrations?

A: SCE has the largest number of disadvantaged communities of the three California utilities. There is a disadvantaged community advisory group that does speak on behalf of disadvantaged communities, but not aware of a specific list. CEC has designated a specific percentage of their budget of EPIC funds for DACs and a smaller percentage for underserved communities, so they are a possibility for more information, and we will follow up as well.

Update: The state maintains an on-line resource for finding DACs at the link below:

https://gis.water.ca.gov/app/dacs/

Participant Comment: Something to think about as we speak of the disadvantaged community topic, I think many of us are aware that there is also in process an infrastructure bill, IIJA. To be more specific and equally as EPIC, the IIJA is looking at how do we also take advantage of this type of funding and help our disadvantage communities? As you know in some cases, we might be able to leverage some of the EPIC funding with the IIJA to do things that sometimes we might not be able to do given the number of resources we get through EPIC. The work we do here for DAC can inform the IIJA.

A: Good input and it connects with another thought; if you do something like that, you go out and reach out to others for match funds and you bring in other partners. That all adds to the timeframe for a project, and if it's a large EPIC project, the process can get very complex in that regard. You would need to really stretch out and have a well-thought-out time schedule and allow for all these steps in the project plan.

One of the examples that has come out of our ideation internally is the idea of electrifying one of the light rail trains down in the San Diego County area and putting some new charging infrastructure at the stops along the way. It's now diesel, so it has all kinds of neat connections like emission reductions and goes through multiple DACs. However, to do something like that would probably consume our entire EPIC-4 budget. But remember, we have the smallest budget, so the general point here is that we can only go so far with the EPIC dollars the IOU's have, and we could be doing a very small number of projects. In the case of SDG&E, it might be as small as one.

4. What can communities do to get involved in demonstrations?

4.1. SCE – Engagement

Communities can follow some of the considerations SCE uses to source demonstration locations and can partner with SCE to identify those considerations.

4.1.1. Technical Considerations

- What problems are we trying to solve in planning or operations and the potential benefits: reliability, resilience, environmental impact or a combination of all
- Site considerations include electrical capacity, access & security, telecommunications possibilities, existing customer assets, i.e., solar, storage, charging infrastructure

4.1.2. Social Considerations

Community characteristics include:

- How can the project help the community and communities like it in the future?
- High fire risk areas and high wind events
- Costs and funding partnership create more opportunity
- Communities with high level of interest

4.2. PG&E – Engagement

Point of this workshop is to generate interest and engagement as we move into EPIC-4. How to partner with the IOUs for projects is the key question. PG&E notified our community-based advisory group and will continue to work with them to engage communities in upcoming workshops for comments. As we get into projects within the EPIC-4 cycle, which runs 2020 through 2025 of initiating projects, that's certainly one thing that we always look for, is there some intersection? Is there some way that this project could be cited in a disadvantaged community that provides benefits? Blue Lake Rancheria had reached out to PG&E which is always great when the communities can come to us. We're looking to do more of our own outreach as well and are hoping for collaboration on project ideas.

4.3. SDG&E – Engagement

- Current activity in the schedule is for ideation and trying to get the applications into the Commission, but then there's another period after the applications approved where we're implementing projects and that's where we would reach out. As we learn which projects we are actually doing at SDG&E, we would reach out to specific DAC or community organizations to see if there's a project that is uniquely suited to them. We don't want to spend a lot of time and effort conjecturing what projects we would do now, because that gets decided later. We invite input at any time. Reach out to any of the three utilities or the CEC with any ideas you want to present using the contacts provided (see Workshop ppt. slide #28 or on the front of this document).
- Another way to stay aware of what is concluding in EPIC-3 or forward looking to EPIC-4, is to monitor the three utilities' public websites and/or the CPUC has established a public database. https://database.epicpartnership.org. The database provides a broad view of everything that has happened under EPIC across all four administrators, including DAC projects which may help formulate new ideas.
- Finally, the projects could run longer than 2025. The year 2025 is the end of the period by which the money must be committed, but execution of the work can continue beyond 2025, once the project funding is committed.

5. Closing

- No further questions were raised therefore, follow up will occur via email between participants and the utilities. A summary will be provided to provide additional fuel for thought for new questions.
- Thanks to all participants, presenters and organizers!

II. Joint Utilities EPIC Public Workshop, June 30, 2022

1. Theme: Create a More Flexible Grid to Maintain Reliability as California Transitions to 100% Clean Energy

a. Topic Discussion – Ultra-Low Latency Communications

Brian Deaver, Sr Technical Executive, EPRI

What use cases were identified that would be the first ones you'd want to evaluate with this kind of communications technology?

b. Topic Discussion – Inertia Substitution

Brian Deaver

Any early effects of this nature, more penetration of DER the more widespread effects. Has anyone experienced that?

Patrick Saxton

Are the IOUs active participants in the Universal Interoperability for Grid-forming Inverters (UNIFI) Consortium?

Panel Discussion

IOUS are all actively involved; we will have a candidate topic for EPIC-4 Investment Cycle

Haresh Kamath, EPRI

Will this address the degree to which inertia can be addressed with grid-forming inverters?

c. Topic Discussion – Adaptive Communication and Control Infrastructure for Advanced Distribution Systems

Brian Deaver

Is the thought process here, not just having DER monitored and tracked but also bringing it into utility control algorithms in the ADMS?

Haresh Kamath, EPRI

Will this topic include work towards standardization of open-standard communications and control protocols for DER as well as existing utility assets?

d. Remote Grid and Microgrid Enablement

Achintya Madduri, CPUC

Has any of the micro grid research looked at the capabilities of smart inverter functionality beyond volt/var? E.g., freq/watt or volt/watt? These other functions are intended to provide some form of virtual inertia.

Haresh Kamath

Might the research in the Remote Grid and Microgrid topic address the relatively high cost of microgrid deployment, beyond standardization of designs

e. Topic Area Discussion - Individual Customer Resiliency

Haresh Kamath

Might the Individual Customer Resiliency topic include research into utility programs for front-of-the-meter assets?

f. Topic Area Discussion – Long-Duration and Alternative Advanced Energy Storage Systems

Haresh Kamath

How much work will be done in determining exactly how much long-duration storage is necessary and what the duration should be? Will there be work into assessing how long-duration needs (especially for contingencies) might be satisfied with a portfolio of short-duration assets?

g. Topic Area Discussion - Mobile Microgrids

Haresh Kamath

When it's said we need long-duration energy storage, I believe the real meaning is we want long-duration energy storage at a low $/kWh price.... if we absolutely had to have long-duration storage at any price, it would be possible to run short-duration storage at longer durations, though such an approach would be expensive. Is there a price target for long-duration storage?

Jeff Malin

What is the current schedule or timing for any LDAAESS analysis reports?

Judith Ikle

Mobile microgrids have so many interesting use cases. How are you able to design to serve disadvantaged or underserved communities? Please include wide variety of users in project design need finding.

Bridget Horan

The production and use of customer sided DERs is inherently a human enterprise. Applying social and behavioral science research to energy policymaking is therefore vital for creating a more efficient and comprehensive solution to our energy needs. In order to continue to provide power to the people while limiting environmental harm, what factor of the human element is understood and incorporated into the DER strategy as discussed?

Patrick Saxton

Harmonics on the secondary side of transformer, correct? What utility assets are potentially damaged?

2. Theme: Increase the Value Proposition of Distributed Energy Resources to Customers and the Grid

a. Topic Area Discussion - V2G Technology Development and Interoperability

Liang Min

Do you also look into the ways for EVs to participate in CAISO market?

Jordan Smith

Here is a link to one of the several V2G CAISO market pilot reports.
https://www.energy.ca.gov/sites/default/files/2021-06/CEC-500-2018-025.pdf

b. Topic Area Discussion – Interconnection Enablement

Bridget Horan

The production and use of customer sided DERs is inherently a human enterprise. Applying social and behavioral science research to energy policymaking is therefore vital for creating a more efficient and comprehensive solution to our energy needs. In order to continue to provide power to the people while limiting environmental harm, what factor of the human element is understood and incorporated into the DER strategy as discussed?

Liang Min

Besides solar, will you also consider storage?

3. Theme: Inform California's Transition to a Zero Carbon Energy System

a. Topic Area Discussion - Long Term Grid Planning

Liang Min

Great project, especially T&D coupling and long-term planning.

CAISO released the first-ever 20-yr transmission planning early this year. How do you coordinate this project with CPUC LTPP & CAISO TPP?

Will you look into the sector coupling issues, such as power to hydrogen, power to heat, power to liquids, storage and EV?

b. Topic Area Discussion – End-to-End Advanced Simulations and Analytics

Jonathan Mele

Can anyone share thoughts on distribution system analysis, specifically what are main gaps with popular tools like CYME and Synergi? Or if anyone's evaluating/piloting other tools?

Mehdi Ganji

For those utilities such as PG&E and SCE who operates the non-electric infrastructure have you looked at interdependencies between non-electric and electric infra.?

c. Topic Area Discussion – Light Rail Electrification

Liang Min

Industrial sector accounts about >20% of the total CA GHG emission… I would encourage IOUs to explore the industrial sector electrification/decarbonization? such as electrifying the processing heat.

Judith Ikle

Transit is important to address. Please expand discussion we just had re barriers to deployment of light rail in SD. Also helps with access to clean transportation.

4. Theme: Advance Toward a Climate Resilient Electric System

Christopher Parkes

Promising undergrounding technologies

III. Joint Utilities EPIC DAC Workshop, August 25, 2022

1. Open Discussion – Requesting Comments from Community Representatives

Written Comments

Anna Solorio, Non-Profit Community Housing Opportunities Corporation
Have you done an analysis of number of LI (Low Income) owners of EV in DACs for the buyback battery idea, EV ownership tends to cluster in high income brackets.

Organizers' Discussion
The EPIC team has not done this yet, but this is a topic we could work with our internal equity team on to understand those analytics and the potential opportunity there. A fair point for the transportation electrification topic area, we need to be mindful what the adoption, and the ability to adopt is, in the DACs as a starting point.

This is an example for EPIC-4 to better coordinate and leverage customer programs to bring what is done with EPIC out in the field to be more collated and coincident with the customer service organizations in order to help customers with adoption. This is an opportunity in the EV space but also in different types of programs as well.

Oral Comments

Rich Tree, Representing City of Oroville
Following up on the re-purposing of EV batteries, we have a fleet of heavy-duty transit buses that are battery powered and in secondary life. It's exciting to see the advancement and wide range of topics discussed for EPIC-4. One area for future consideration that is maybe an expansion of what's already been discussed today is the opportunity for battery swapping as it has a lot of purposes within it. A large

facility can be charging these batteries at the most optimal time and swap them quickly in vehicles but also expand on that as potential energy storage in the meantime as a dual focus.

We have partnered with out utility provider who has helped us a lot with their programs to transition our fleet. Currently we've been successful with two charge-ready transportation projects. The infrastructure is in place but maybe there is an opportunity to revisit the agreement to expand on the infrastructure to include a microgrid to create resiliency and build on this investment, and/or add energy storage to that project as well.

Organizers' Discussion

For consideration on the utility side, is the value of taking a demonstration site and building on that to leverage what has already been done to serve as a "living laboratory". This must be weighed against ensuring that we're also working with other communities and allowing them the opportunities to benefit from the limited resources we have. A challenge is how to make that trade off to build on things we've done but also make sure we're being inclusive and giving opportunities to other communities.

PG&E is broadly interested in exploring alternative charging technologies and are considering wireless magnetic charging and the battery swapping concept as mentioned. We are still defining topics but there are a range of possibilities in this area we are exploring to demonstrate in the field.

Anna Solorio

In relation to the Inflation Reduction Act that just passed, there may be significant tax credits for EVs. This might be an opportunity especially in DACs. Suggesting you partner with community-based organizations in DACs to help further identify products that might be useful/valuable to support equity in these communities.

Organizers' Discussion

At SCE we are proactively thinking about how to best leverage the potential Federal funding opportunities that are coming. How to help DACs are already a factor in consideration but we will further double check and validate that we are thinking about what areas, there is potential to move the needle in EV adoption in DACs.

Moving from topics to a project after the initiatives are settled; light rail electrification for example, could very easily consume all of SDG&E's budget so we have to be mindful of total cost, go through the feasibility phase and try to engage community support in helping to raise co-funding. We are supportive of the concept of community engagement and partnering and it may be necessary in the projects SDG&E ends up doing.

2. **Open Discussion – Do you see opportunities in the highlighted EPIC-4 topics?**
   Are there technology innovation areas of relevance/importance to DACs not covered in our EPIC-4 topics?

Anna Solorio

In terms of working in DACs and being successful in DACs it's really important to have partners that know and work in the area. I would add to your thinking to work on developing some partners or reaching out to CBOs. Other efforts have put together Low-Income Advisory Boards in DACs to help them be successful. I wanted to offer that as an additional idea as you roll out these projects.

Organizer Discussion

One of the avenues for PG&E outreach was going to the members of the relatively new PG&E Community Advisory Council. Is this a good place to start or do you have any other ideas for the PG&E service area?

Anna Solorio

Start with the PG&E Council and then TECH Clean California has a low-income ambassador board providing advice on how to increase the adoption of heat pump water heaters in DACs and low-income communities. They are another good resource and from there you could find additional resources for feedback, ideas and how to increase your success in those areas.

IV. Joint Utilities Public Workshop, August 29, 2022

1. **Open Discussion on Strategic Objective: Create a More Nimble Grid to Maintain Reliability as California Transitions to 100% Clean Energy**

Oral Comments

Ben Wender, CEC

How much do the utilities envision doing laboratory or specific controlled testing versus demonstrations on live systems and getting technologies out in the field?

Organizers' Discussion

SCE: One thing we can comment on is the factors and tradeoffs which include: doing things in the field is very expensive and time consuming relative to the lab so one of the considerations is, when emphasizing lab work, we can touch more areas and evaluate more potential solutions. On the other hand, there is no substitute for real world experience to get a sense if something is going to integrate well or not. The best portfolio of projects for us is a mix of the two, not all one or the other. We are still trying to figure out what the optimum is but maybe a smaller number of field demonstrations that present the opportunity to incorporate multiple subject areas provides certain economies of scale. Another dimension to that question is what efficiencies can be achieved by grouping certain projects and activities as well.

SDG&E: To add a few points, in EPIC 1, we had largely a laboratory-based program. Our entire portfolio in EPIC 1 was an initiative in advanced distribution automation that touched on several areas including, visualization and situational awareness, system architecture, grid support functions of DER and others. We tried to do a lab phase that would ultimately lead to a field phase, but we were limited because of cost. So, in some cases in EPIC 1, we stopped at the laboratory phase. As we moved to EPIC 2 and 3, we intentionally tried to get more into field demos with some success and got into programs such as UAS and advanced SCADA augmentation safety training simulators. These projects targeted a field phase right out of the gate or after an initial lab phase such as in the mobile battery project. We had an initial lab phase but got the battery out in the field as quickly as we could. It will probably be a mix going forward, but we prefer to go to the field phase eventually. When we make project choices, we will limit the number so that we can get into the field phases and limit the amount of work in the lab. We seem to have had enough success in moving toward field phases with a smaller number of projects, so we'll continue that path.

SCE: When we come across something that is relatively new to us and will clearly add value and is feasible, sometimes we find that it can be incorporated into capital investment. The limitations we have with EPIC funding doesn't necessarily mean we are precluded from advancements overall. Part of the process is also evaluating how mature is the new opportunity and if it's something that should go in EPIC or go to capital investment.

SDG&E: We do the same thing with our small EPIC budget; we look for opportunities to go right to a capital project. An example is the commercial deployment of phasor measurement units (synchrophasors). We had used them at transmission and went right to a commercial program to deploy them at the distribution level without doing R&D first.

PG&E: In working with the DACAG, DACS, with CPUC and CEC and also individually as IOUs; we look for field demonstrations within DACs. Looking at the EPIC 3 portfolio we have several field demonstrations that are examples of how there is no substitute for field testing. Sometimes there's no opportunity for testing in a laboratory. A field demonstration can get you closer to the path to production and with confidence. For example, in the data analytics projects we've been doing, we are taking data from the field and developing algorithms and techniques, and even though it is taking place in a laboratory, we can rapidly go to production with these analytics systems during the projects.

SCE: Another important opportunity is also leveraging CEC programs which may create opportunities for IOUs in that territory to collocate some of their work. We should continue to proactively pursue as those opportunities arise.

SDG&E: Another question that comes up is, "what is the field?". An example is a project in EPIC 3 on augmentation to our advanced distribution management system which is a control system in our infrastructure. We piloted some new features for the ADMS, which we tried in the EPIC project to ensure it worked, before we permanently adopted the features in the ADMS. The EPIC work established that the value proposition was sufficient for commercial adoption.

SCE: Labs can mean different things too. We have a lab that's located at a substation that allows us to do things in an environment that looks and feels like the field. We call it a lab because it's a controlled environment and we can test things there without affecting any customers.

SDG&E: We have our Borrego Springs Microgrid that's been evolving over time. We consider it a field laboratory even though it is a real working microgrid. We've been deploying and testing new concepts there regularly.

<u>Qing Tian, CEC</u>

Do you have the budgeted amount for each of the topics presented? If you don't have it, are you expecting to include it in your final submission to CPUC? We have some areas that have some potential overlap, and it would be helpful to know what is budgeted for the research topic areas to coordinate for future solicitations.

<u>Organizers' Discussion</u>

SCE: What we will file will allocate budget across initiatives. We are still working through how we want to allocate.

SDG&E: The same is true for SDG&E. We aren't choosing projects in the investment plan; we are only giving candidate topics within an initiative. There will be budget allocations made to the initiatives. Until you've chosen the projects, once the investment plan is approved by CPUC, you can't really start a detailed estimate of the requirements of an individual project. So, we'll be budgeting by initiative.

<u>Ben Wender, CEC</u>

In terms of priorities for the IOUs and thinking about the process by which the IOUs and CEC can coordinate, are there specific topic areas that are priorities? Long duration storage might be one that can be prioritized to work closely with CEC, thinking about how we can make our investments complementary and synergistic. Are there other topic areas you want to flag/start thinking about, and do you have thoughts so far on the mechanism and process on how that coordination would happen over the EPIC-4 duration?

<u>Organizers' Discussion</u>

PG&E: we are hyper focused on the Oct. 1 filing date so after that we want to make sure that as the CPUC evaluates the plans, we coordinate with CEC a lot. Starting in October we want to look at the full process. I think this was your idea, to get a template for the partnership so that we can make this a simpler and more efficient process for EPIC-4. The fourth quarter is the time we want to dig into that. As far as other topics, the biggest opportunities for alignment with CEC are long duration energy storage and micro grid enabled topics, both areas where we've already had a lot of conversations with the CEC. I think it's about coming up with the right model or blueprint for how to do joint or partner projects with the CEC in these areas going forward.

SDG&E: Long duration storage is a good example of where collaboration is not only desirable but also necessary. Batteries are just an interim stop gap solution. For the amount of long-term storage that is going to be needed in the mix of resources, we've got to get beyond batteries. Options like thermal storage can be coupled with concentrating solar power, storing thermal energy from the concentrating solar system when it's not needed and using it when it is needed will extend the daily cycle potential of solar energy. Other examples are compressed air energy storage, liquid air energy storage, and further down the road, superconducting magnetic energy storage (SMES). All these things are going to be expensive to pursue in EPIC, certainly beyond the SDG&E budget limitation. However, we are seeking additional money in our GRC for long duration energy storage. Even with that, it's much bigger than SDG&E can't do alone; so all the Administrators need to collaborate in this area. Superconducting magnetic energy storage requires development, and only CEC is allowed to do the development phase in EPIC. The utility could perhaps get involved in the storage aspect, but we can't get involved in the generation work with EPIC funds. Those are some of the constraints that push toward collaboration with CEC and/or industrial partners.

SCE: We are pleased about the focus on long duration storage in terms of an area for collaboration. Amongst the four administrators we need to work together so we can try more things and not duplicate efforts in terms of trying new technologies. Another thought is to how to identify further in advance, where and when the CEC may be supporting projects so we can figure out collectively how to fund and support what the utility can do to support a DER type project to get more value for the customer and help acquire a good location and partner in working through the utility side of DER integration.

<u>Divya Softa, Peak Power Inc.</u>

A question for Southern California Edison, wondering if you could expand on the information related to the seamless grid flexibility topic, specifically, what are some of the pain points you've been able to flag?

<u>Organizers' Discussion</u>

SCE: Between the complexities of DERs, new EV charging load, resiliency considerations including but not limited to, wildfire PSPS situations, there is more changing more quickly on the grid on a regular basis. Having both the analytical tools and the control and communication capabilities to more quickly make adjustments on how the distribution system is configured will help us more cost effectively and quickly respond. For example, when changes occur, customers that are getting power from a certain distribution circuit becomes heavily loaded. Perhaps there's a nearby circuit where changes can be made in some of the switching configurations such that we can have the less loaded circuit support the affected customers. I think with additional technical capabilities, we can resolve issues more quickly.

2. **Open Discussion Strategic Objective: Increase the Value of Proposition of Distributed Energy Resources to Customers and the Grid**

Written Comments

Patrick Saxton, CPUC

For SCE on NEM optimization: How does this complement Smart Inverter functionality? Is it the control system to make better use of that existing functionality?

Organizers' Discussion

SCE: There are two elements from the utility perspective, one is the communication and ensuring all is working properly and we have established the appropriate protocols. There is still work to do implementing the protocols and making sure we're able to do so consistently and reliably. Then there is the control. The CEC and IOUs have already done great work in starting to think through when we have multiple DERs. For example, we just completed a project funded by the DOE and also included SCE and CEC EPIC funding called the electric access system enhancement project. We did work both in the lab and in the field demonstrating algorithms that will help us optimize how multiple DERs on a distribution area fed by one substation and the distribution system could operate together to manage loading on that system. That report will be publicly available soon. We've learned a lot, but we've also identified a lot of questions and things that we need to continue to explore.

Oral Comments

Robin Goodhand, CEC

You described a scenario where a group of entrepreneurs help in developing sensors and challenges with communication protocols. What kinds of services do you have to help entrepreneurs test and validate and prove out performance of individual sensors or inverter or switchgear or other types of DER assets? Is there a central testing facility like a business service offering where engineers can work with the utility?

Organizer Discussion

PG&E: Yes, PG&E does have the ATS which is a laboratory out in San Ramon that is at the end of a feeder, so it's connected to the grid as well and has a large set of laboratories with a lot of demonstrations done of different types, including sensors. In various systems we have operational and test networks that don't have to be as rigorous as they're not connected to any of the operational technology. Where the issues come in is when vendors need real data or real interaction with the operational device technology. It's getting those sensors across, not into a test system, but interacting with live data so there is a real-world test. This gets more difficult when it comes to a security and integrity point of view. Exceptional processes inherent to EPIC, have more friction and so we are looking for ways to reduce that friction in our innovation and emerging technology projects. We are exploring ways to have a common platform for integration, so we don't have to go through so many of the hardware and software issues to get a sensor connected. We can bring it into our big data foundry.

Robin Goodhand, CEC

From my experience overseas, there comes a point where utilities must be able to perform testing. In Australia for example, there was concern about the number of solar inverters connected to the network and they wanted to test out what would happen if 100 inverters were connected together and test it in a controlled environment. They did it in an off-grid testing facility where the utilities could “abuse” systems to see what would happen in those scenarios. Does anything exist like that here?

<u>Organizers’ Discussion</u>

PG&E: Yes, that’s the Applied Technology Center out in San Ramon and is available to tour if you want to see the facility. We have a large set of laboratories and equipment for some of the EPIC 3 projects that are run out of ATS directly where we test the microgrid. Other testing such as sensors and drones are run out of ATS.

<u>Robin Goodhand, CEC</u>

Is there a formalized certification that comes out of that process, such as ATS-approved or certified or conforms to a certain standard?

<u>Organizers’ Discussion</u>

PG&E: We inform the official standards body working with IEEE, ISO, ANSI and other standards groups to modify or often we’re leading those standards efforts. Talking about interoperability, PG&E is not a third-party market based or an industry trade group organization, but we can provide our services. We’ve discussed this as part of the setting up of laboratories and that we have unique skills and facilities for interoperability testing. An interoperability certification program might be able to leverage our labs to get to the goal faster and less expensively.

SCE: We have labs as well for different purposes and I believe SDG&E does as well. We also have world class universities and national labs in the state with capabilities as well. I’m not aware of one single place where you can locate those capabilities across the state. Something interesting to work on possibly is to look at the capabilities in the state in terms of a facility because we have a lot of great options. Another thing to mention is as the utility, we’re not the certifying body. We aren’t going to test the product and say “Ok this product is safe for anyone” or that it meets a certain standard. That is not our role, but we do participate in the standards bodies that help establish industry wide standards that we need and adopt. That way we’re adhering to industry standards and the manufacturers and technology developers aren’t’ having to develop a utility specific product but one that meets the right standards that in theory all of the IOUs can adopt.

SDG&E: SDG&E has multiple labs, the principal lab that might be involved in trying out standards is the one in Escondido called the Integrated Test Facility. We are adding to that facility at this time for more capability around protection and control related standards. We have in the past tried out features of the IEC 61850 communication standards. Examples of features that were investigated are peer-to-peer communications and goose messaging. There is a larger point too and that is adoption. Once the standard is available, does the utility want to adopt it or not? That is where you need to try it out in order to make that decision. Back to the point about sensors and how do we easily integrate? Standards can make a plug-and-play process out of assimilation of these sensors or any other new technologies. That is where you need a universal standards platform. IEC 61850 is probably the best in class in that regard and it has had widespread adoption in Europe and South America where there was more of a greenfield situation. North America has a legacy standard called DNP3 which has a big investment and so to move from that legacy architecture to the 61850 is a big deal. It will probably happen gradually over time. I believe SCE was migrating its substations to 61850, but I don’t’ know if that process has continued or not. In order to make sensors or other devices plug and play, you need a universal standards family that has staying power. The last point is a DER (among other functions already discussed) has the capability to act just as a sensor whether it’s doing the other functions or not. This is where again you take a standard like 61850, and it’s broken down into what are called logical nodes. There’s a group of logical nodes in the DER standard that just deals with its sensor capability. That’s why you move to these standardized platforms, to get everybody doing it the same way, so that when you want to buy a vendor's product, they don't have their own confidential (non-standard) protocol that you have to address with extensive custom design work.

Loon Yee, CEC

I want to find out among the three IOUs, do you actually have any communication to say at what stage you are adopting certain standards? When in the lab to verify that if certain subsystem or components actually meet certain requirements, do you share the information among yourselves? When a supplier or device manufacturer provides these devices off the shelf in the market, how are you going to ensure that those devices meet the requirements of the standards? Do you do this in the lab? I

Organizers' Discussion

SCE: There are industry standards and at SCE we also have our own design standards. When we're building for example, a substation, here are the requirements to implement it. I'm not sure there's a hard rule that says at a certain point of time that a product will get incorporated into an SCE standard and is probably more needs based. It is more the case of what problem is that new opportunity solving and how important is it to solve that relative to all the other things we are trying to do. One of the challenges is prioritization but we do have a well-established internal process where we adopt new internal design standards. For example, we may do something under EPIC, where we test something in a laboratory environment or out in the field showing that a new product, or combination of products is more often the case, is effective. We're confident that it's safe and reliable and that's where the industry standard/product certifications are helpful in enforcing or strengthening that decision and then so we can start our internal process to formally adopt. For example, prior work we've done in EPIC has gone into our distribution design standards. We've updated our distribution design standard in the area of automation where equipment and automation schemes that we've tested in EPIC ultimately became incorporated into our distribution design standards and there are specific examples in the substation area as well.

PG&E: I just want to add on that there's these certifications from interoperability organizations but just because a device or system has this seal of approval doesn't mean that it's perfect. These certification programs are limited themselves, in terms of funding or complexity. They may be testing basic things like conforming to protocol types of things but the more complex types of operations and interactions you get in a real grid environment have not really been fully tested because it's so difficult to do that. It's necessary and a very good thing but there must be more complex scenarios in the ways we're going to be using these things in these complex environments so it's a layering of things.

Loon Yee, CEC

I agree that the standard is meeting the minimum requirement. When you put in that device that's been certified into your application, it may be more complicated. The certification is good for certain aspect of the design but not comprehensively. I agree on that one because based on my experience, certification is a certain aspect of insurance or assurance, but it doesn't mean everything.

Organizers' Discussion

PG&E: I'll say we're not downplaying the importance of these. We prefer standards, we develop standards, and we push standards. They are necessary, and we lean towards them, want to adopt them and push everybody to adopt them. Then there comes the interoperability and testing so it is an evolving thing.

SCE: That's where I see the most value, is the integration and what we learn working through the integration. The industry standards often are a helpful precursor to working through the integration, but we learn a lot and that helps pave the way to actual adoption.

SDG&E: The other piece of the puzzle is new features, and I agree with what Josh and Damian are saying about how utilities are not going to be a certification organization on behalf of the whole industry. There will be new features emerging. Take inverters for example. New features are going to emerge, whether it's inverters or any other device that's being integrated into the utility system. The standards need to evolve over time and be recertified as new features are added into the standards. That has always been the process with IEEE standards and IEC standards, and it will continue.

Loon Yee, CEC

If you have time, I want to come back to the inertia substitution. We really want to find out what kind of projects or work that you plan to do behind that inertia substitution topic. Do you plan to use the battery? I think that that's the one big storage project in Australia that they call digital inertia. The IBR is going to rely heavily on the inverter in the future so we are going to move some of the rotation mechanisms (generators) offline so how will you go about that? I think that will be a big issue from a reliably standpoint.

Organizers' Discussion

SCE: I think batteries are going to be a critical part of that, but they are also not the only tool. There are other types of equipment that we can install and various types of reactors that can also help. So, I think that the work that I envision happening here, still talking about the topic level, should be looking at the simulating in the lab, power systems that are operating under these conditions with batteries and the other equipment that we have in the grid along with the loads to see what combinations and configurations that best support stability under those various conditions. I think we can build on some work that we're already doing that is outside of EPIC but related to work done where we're modeling portions of the bulk power system and simulating how we could use inverter-based resources to black start a portion of the grid. I can see an expansion of this to include how to maintain stability under normal conditions, and we should be thinking about all the resources we can make available to support that. Batteries will be critical but not the only tool either.

Loon Yee, CEC

Is storage the main tool you use, or do you have another means? We talk about superconductor magnetic storage with a very fast response time as maybe one option, but do you have anything specific?

Organizers' Discussion

SCE: I have to go back and look at notes and/or ask for help because you're getting into areas that are beyond me. Maybe we could have some follow up and get into the details and get the right people in the call.

Loon Yee, CEC

A last question is about the edge computing, the edge control. How edge is "edge"? Do you push down to the distribution level, transmission level, substation, receiving station? What level do you consider as edge?

Organizers' Discussion

SCE: I think that's anything within the boundaries of our footprint. So, meters are on the edge. Microgrid controllers are on the edge as are service transformers. Maybe not on the edge but close because there's not a whole lot between them and our customers. So those are some examples, also electric vehicles and support equipment are on the edge. One can envision having some control capability that was operating locally. The benefits of that would include reducing the amount of bandwidth that's needed for communication between the field and back office. Also included are the resiliency benefits and having some local autonomous operation capability.

Loon Yee, CEC

Do you see a demarcation between the utility, OSS and also the microgrid that will define the edge? If you want to come to my grid or territory and we have edge devices, you can call it the entry to migrate?

Organizers' Discussion

SCE: What we're seeing now, and I think will continue to be the case is that there isn't one microgrid controller: ting energy onto that microgrid. That's where those areas and responsibilities overlap.

Loon Yee, CEC

When you mentioned reduced bandwidth because of latency, etc. Do you use commercially available cellular services for your communications, or do you have to rely on some of the satellite communication for your edge?

Organizers' Discussion

SCE: We have multiple modes of communication today. There are wires, fiber optics, cellular and satellite. There isn't just one mode of communication that takes care of everything.

Dr. Mehdi Ganji, CEC

Have you thought about a utility-owned and operated communication and control platform that is going to be used by a DER owner or even in some cases the operator? We know that the biggest barriers toward the integration of the DER and microgrid is the lack of visibility that utilities have on behind the meter resources and also lack of control as well. Through the utility owned and operated communication and control solution, a lot of issues related to the integration of DERs would be addressed. However, it requires a lot of data validation. Have you included this type of project in your EPIC portfolio?

Organizers' Discussion

PGE: Yes, we didn't get down to the details as in the sensing communication topic, but we would like to investigate using some of the newer communication platforms that would solve several of the problems that we have today. We would like to see a more interconnected, singular type of security system that is easier to connect into with the ability to support fixed, mobile and third-party devices. We are looking to find a path to solve our communication problem as it's our problem, and it's also California's problem and our customers' problem. But there's no off the shelf solution.

SCE: I don't know if we have a project dedicated to exploring this issue, but we are touching it in various projects and especially those that involve integration of utilizing third party DER and how to operate a microgrid, in particular. The challenge is how to build these bridges so we can do the things we want to do without taking undue cyber security risk. We have some projects in EPIC 3 that are specifically cyber security projects. Even those that aren't specifically cyber security projects have an element of cyber security because we're integrating equipment communication which impacts cyber security.

SDG&E: The last topic we presented around advanced communication and control is broad enough that it is intended to include some migration to a standardized platform that would enable the easy plug-and-play assimilation. For topics that might emerge, the bandwidth is in that topic area to include the trials and validation of standardized solutions for plug-and-play processes. And the point raised earlier about what is the grid edge is a good point and is dependent on circumstances. A microgrid for example, can be entirely off the edge in customer space, or entirely in utility space, or a hybridization. The original ideas around microgrids before they were so named, was a reconfiguring option to be able to island a part of the distribution system, if it had enough distributed resources in it to do so in an emergency. You could reconfigure by islanding that part and keeping it up when there's a larger system contingency. As microgrids evolved, it has become more about customer owned assets, but not to the exclusion of the possibility of utility owned microgrids. Either way, you want standardized interfaces available in those various resources that are in the microgrid.

3. **Inform California's Transition to a Zero-Carbon Energy System that is Climate-Resilient and Meets Environmental Goals**

Oral Comments

Ben Wender, CEC

Could you talk about the process by which you go from these higher-level concepts to more specific technologies and project plans? Are there opportunities to weigh in during that process? How does that happen?

Organizers' Discussion

PG&E: There will be a level of detail in the investment plan that is below what's been presented here as it's just not possible to go into that level of detail here. We are following the CEC's format for the investment plan, and we will be adding some additional details at a deeper level. Regarding process, there was a lot of collaboration between the CEC and the IOUs in previous EPIC cycles. But because the filing is at the initiative level and not individual projects, there will have to be a much deeper level of collaboration between the IOUs and the CEC. I envision a lot of communication as we set up these individual projects. It won't be as formalized in the EPIC Investment Plans so we will have to make that process work so that we have the most effective projects.

SDG&E: That is true for SDG&E as well. The topics themselves are fluid. They are candidate topics and, if we have placed funding in a given initiative, we will not limit ourselves to one of the topics that we identified as a candidate now, as long as a newly emerging idea has high priority and maps to that initiative. Even though there are no topic areas listed for SDG&E under this third initiative area (zero carbon and climate), we do have a grid hardening program in the company. We could pick up urgent grid hardening or other resiliency demonstration work (if necessary) in the realm of another initiative—for example, in the previously discussed topics on advanced communication control and visualization type activities--rather than create another activity topic in this zero-carbon initiative. There is overlap between the scope of the initiatives. If we take our limited EPIC budget (about 14 million for the whole EPIC-4 cycle), we can't spread it out too broadly, so we've tried to narrow down to the initiatives with the most importance in terms of need for ourselves, the industry, and our customers. We will book our funds by initiative, and then, not only the current candidate topics but also the possibility of funding other topics that may arise and map to those initiatives will be considered. The next step after CPUC approval of our investment plan will be to go to our management with a prioritized list of which topics within these initiatives we recommend pursuing as projects, and we will seek their approval. We won't be able to do everything obviously, but we want to be coordinated with the other utilities, the CEC and what is going on broadly in the industry.

SCE: We will take what we file and then we'll go through some internal brainstorming type of sessions for some project concepts. Part of the requirement by the CPUC of this process is that we hold public comment opportunity for a specific project so there will be opportunity for public comment before we launch these projects. Another opportunity is at www.sceideas.com where anyone can make a submittal to bring things to our attention to work on. This window is always open regardless of where we are in the EPIC cycle.

Ramandeep Bagri, CPUC

I would like to have more elaboration on the zero-carbon energy topic where you mentioned the pinpointing of the fault location. What is a limitation of the current technology that you use for the fault location and when it comes to pinpointing the fault location, why can't we extend that technology for that purpose?

Organizers' Discussion

PG&E: We are putting technology out today like one that uses RF sensors to find grid faults. It's a matter of speed and accuracy. Very little of our system is instrumented down to this level that we could process and be able to find the faults more specifically. We want to reuse sensors out on the grid to fuse them together and infer where the fault is. Any one sensor might not be able to provide a precise location but through intelligence across many data sources, the fault may be located. It's a matter of narrowing it down and since it isn't cost effective to put sensors everywhere , the question is how to use lots of different information plus cost effectively use sensors in some locations to gain precise fault location and what the fault might be. An example is line closures may be communicating but we're not necessarily using those data streams and correlating them with other sets of data. That is what does not exist today.

SCE: Through combinations of switching actions, we can determine where the problem is between two switches. When we start getting more sophisticated and for example, measuring waveforms and collecting data extremely fast, that helps us see the shape of the AC power. If we have multiple views we can start measuring distortions at different places such that through analytics, you can calculate where the problem is. It's a relatively new area. Through the combination of the ability to collect more data and process that data more quickly, data can be interpreted in such a way that the location of a problem can be pinpointed.

SDG&E: A project in the EPIC 3 cycle called Focused Patrol was an initial effort to take data from multiple streams to more rapidly locate faults. A vendor created a software platform to our spec. It was tested on a trial basis and found to be useful and was added as a module to our distribution management system. There is still more we could be doing in this area to capture other data streams, and the decision on whether we do this in our EPIC-4 cycle comes down to the question of priority, given our small EPIC budget, versus other options on the table.

PG&E: One of the things we're looking at is timing through fiber optic cable where you can understand disturbances on collocated, let's say conductors, to that fiber optic cabling and how it affects the signals going through. Those can be analyzed at very high speed to provide information about the conductors. There's also tapes that both can be applied that are sensors along the asset. It is looking at a variety of faults after they've happened but also how to be smarter about trying to detect when things are about to happen and pinpoint it.

Written Comments

Angela Gould, CEC

Do you have specific technologies in mind for grid hardening and remediation?

Organizers' Discussion

SCE: I would have to consult with some colleagues to answer that comprehensively but in the area of undergrounding, one of the most expensive parts is the drilling, digging and boring of the pathways for the underground conduits and lines. There is a need for development and technology that can do that more efficiently and quickly than in the past. It seems there is real potential to have significant cost savings in these areas where there is undergrounding. This is the first thing that comes to mind. I know there are others, but I'd have to get back to you on other examples.

Appendix C – Summary of SDG&E's Approved Energy Efficiency ("EE") and Demand Response ("DR") Projects

D.12-05-037 and D.13-11-025 require IOU Administrators to include information about ongoing Efficiency ("EE") and Demand Response ("DR") projects in their EPIC Plans to avoid duplication between the EE/DR projects and the EPIC projects. Specifically, each IOU Administrator must "include an appendix summarizing the R&D activities undertaken as part of their approved Energy Efficiency and Demand Response portfolios." This appendix should describe each project, including the purpose, funding, deliverables and progress to date.[37] SDG&E has provided the required information on the following pages.

SDG&E's activities that fall under Energy Efficiency are part of SDG&E's Emerging Technologies Energy Efficiency ("ET-EE") subprogram.[38] The mission of the Emerging Technologies subprogram is to support increased energy efficiency market demand and technology supply by contributing to the development and deployment of new and underutilized energy efficiency technologies, practices, and tools, and by facilitating their adoption as measures supporting California's aggressive energy and demand savings goals.[39]

SDG&E's ongoing ET-EE projects are summarized in Tables 1 and 2. None of them overlap with SDG&E's EPIC-4 Research Topic Areas.

SDG&E's ongoing Emerging Technology Demand Response ("ET-DR") efforts consist of evaluating demand-reducing technologies and strategies that are applicable to the San Diego region and market.[40] The ET-DR program's focus is on technologies and strategies that promise significant, cost-effective demand reduction in the short- or midterm, and that appear to be sufficiently reliable and scalable for market-wide implementation. The ET-DR program is intended to identify, evaluate and demonstrate technologies that have strong potential to reduce power consumption during periods of higher energy prices or tight energy supplies in all SDG&E customer segments (i.e., residential, agricultural, commercial and industrial), and to help bring these technologies to commercial availability.[41]

SDG&E's ongoing ET-DR projects are summarized in Table 3. None of them overlap with SDG&E's EPIC-4 Research Topic Areas.

[37] D.13-11-025 at 66.
[38] SDG&E's 2015 ET-EE program was approved by the Commission in D.14-10-046.
[39] SDG&E 2015 EE Portfolio including its EE-Emerging Technology program was approved in D.14-10-046, Figure 7, at pp. 107-108.
[40] SDG&E's 2015 ET-EE program was approved by the Commission in D.14-10-046.
[41] SDG&E's 2017 DRP Portfolio including its DR-Emerging Technology programs was approved in D.16-06-029.

Table 1. SDG&E's Approved Energy Efficiency Portfolio

Program	Project Description	Purpose	Funding	Deliverables	Current Update/Comment
ET-EE	Advanced Lighting Controls Calculator - Field Evaluation	A field evaluation to support PG&E's effort to validate the advanced lighting controls calculator.	90,000	None	Project stopped due to lack of suitable field site
ET-EE	Infinite-R Phase Change Evaluation	Assessment of phase change materials integrated into building materials, such as wall cavities as well as in drop-ceiling applications. This evaluation will be taking place at a local school.	14,500	Final report published to ETCC-CA.com here	Complete
ET-EE	EcoDrain Lab Evaluation	This project is looking at Horizontal Drain Water Heat Recovery (DWHR). DWHR devices transfer a portion of the energy remaining in the hot water to preheat the cold water line either returning back to the water heater or to the end-use fixture. New DWHR units are entering the market to take advantage of this opportunity. Vertical DWHR devices are being added to the compliance algorithms as part of 2019 Title 24 code development process, but horizontal DWHR devices are not yet considered ready for inclusion.	25,000	Final reporting complete	Complete
ET-EE	Nexus E-Water Lab Evaluation	Conduct controlled testing and continuous monitoring of the Nexus eWater greywater recycling technology. The Nexus eWater NEXtreater treats drain water from showers, handsinks, and clothes washers for reuse by desoaping, filtering, and disinfecting the water. After water is treated by the NEXtreater, it can be used to water the landscape or flush toilets.	22,000	Final reporting complete	Complete
ET-EE	CEEL Phase 3 Evaluation of Lab Grade Refrigrators and Low Temperature Freezers	Project will focus on energy savings potential of upright laboratory grade -20°C freezers. Specifically: • Evaluating laboratory grade freezers in the field to establish baseline energy consumption. • Modeling the effects of laboratory grade freezers on HVAC energy use. • Expanding on the work done in Phase I by characterizing the laboratory grade freezer market with respect to market size, turnover, and pricing strategies, and evaluating the market changes that might result from program interventions and other external influences.	60,000	Final report published to ETCC-CA.com here. Co-Funding with SCE	Complete
ET-EE	Small Commercial EMS Technology Assessment	Evaluate small commercial EMS systems via NMEC/HOPPS approved methodologies at 5 fast service restaurants in San Diego.	150,000	Final report published to ETCC-CA.com	Complete
ET-EE	SECC Residential HVAC Controller	This project aims to investigate the functionality and potential performance impact of advanced controls on residential HVAC equipment. The operation and performance of a residential heat pump will be monitored as the control technology adjusts operation of the system.	55,000	Final reporting complete	Complete
ET-EE	Laptop Power Management Investigation	Desktop power management solutions have been around for several years, but tracking energy usage from laptops has proved difficult. This will explore the potential for new solutions for laptops in workplaces.	6,000	Final report published	Complete
ET-EE	Small Commercial EMS Based on Lighting (formerly "Lunera")	Evaluate a small commercial EMS system based on LED tubular lighting and integrated sensors and smart thermostats	84,000	Final report published	Complete
ET-EE	DC Lighting Systems	CLTC at UC Davis will evaluate Direct Current (DC) distribution systems for indoor commercial lighting applications. CLTC will conduct a lab evaluation of various DC distribution systems for commercial interior lighting, to quantify their performance and compare it to that of traditional AC systems. CLTC will identify potential market barriers for each technology and develop recommendations to reduce those barriers.	212,000	Final report published	Complete
ET-EE	Compressorless HVAC Field Test	Testing a new indirect-direct evaporative HVAC system for residential use. The plan is to evaluate the system in the field at 10ish sites some new installs some retrofit.	235,000	Final report published	Complete
ET-EE	Field Study of Drain Water Heat Recovery in Commercial Kitchens	With commercial kitchens having the highest potential heat recovery savings, horizontal drain water heat recover (H-DWHR) devices should be installed at selected foodservice facilities to confirm realized savings and to determine barriers to adoption of this emerging technology. H-DWHR devices will be installed in two foodservice facilities with conveyor dishwashers to determine water heating energy savings; one site apiece in SoCalGas and SDG&E territories.	45,000	None	Co-funding with SoCalGas, This project was stopped due to the lack of sites that were to participate in our territory.
ET-EE	Field Study of High Efficiency Steam Tables in Commercial Kitchens	Commercial hot food steam tables are designed to maintain pre-cooked items at safe serving temperatures. These warming appliances use heated wells filled with water and steam surrounding the food pan inserts. Typical installations are custom devices without insulation or efficient hardware, there are packaged devices available that could provide 60% therm savings through implementation. This project will assess higher efficiency designs.	39,825	Final report published	Complete
ET-EE	EPRI MicroBrewery Energy Savings Opportunities w/San Diego Supplemental	With over 100 microbreweries in San Diego, ET is going to explore what opportunities exist to develop energy savings best practices for breweries and what new technologies could provide therms, kWh, and water savings at smaller scale breweries.	75,000	Final report published	Complete
ET-EE	Container Growing at Salk Institute	Testing side-by-side growing containers one with traditional HID/HPS lighting used in indoor growing operations and the other with symbiotic systems integrated units. Salk Institute to assist with evaluating plant health/growth and yield characteristics	130,000	Final report published	Complete
ET-EE	Residential QI/QM Technologies	Even though SDG&E incentivizes quality installation of residential HVAC systems, there is evidence to show that there are still issues after install that may go unnoticed by customers. In these cases, the system will be able to provide comfort to customers, but will do so while using more energy than necessary if the system were commissioned correctly. This project assesses a sensor-based tool that can provide alerts for QI/QM-related repairs to keep systems running efficiently.	255,993	Final report published	Complete
ET-EE	Gas Heat Pump Market & Technology Development Roadmap	Develop a technology roadmap to identify opportunities, information gaps, impediments and strategies to accelerate the commercialization and market acceptance of Gas Heat Pumps in North America. Includes: technical assessment; market assessment; stakeholder input from mfr, market partners, utilities; technology and market development priorities.	30,000	Final report published	Complete

Table 2. SDG&E's Approved Energy Efficiency Portfolio (Continued)

Program	Project Description	Purpose	Funding	Deliverables	Current Update/Comment
		funding for this project is about $2.7 million.			
ET-EE	EPRI IDSM Smart Home Voice Assistant	Voice Assistants have found very rapid market adoption increasing to nearly 30% market penetration in the US in just about a year. Given that the voice assistants have now become a gateway for many consumer products, it is critical to understand how they can advance utility customer engagement and drive energy benefits acting as the point of entry for residential customers (and potentially small commercial customers as well). This project will assess from a customer programs perspective, how voice assistants could play a role in allowing new programs or increasing adoption of existing programs.	200,000	Final report published	Complete
ET-EE	CLTC ALCS Plug Load Monitoring Lab Test	RMS Energy Consulting will support the California Lighting Technology Center, at UC Davis, to evaluate if an ALCS is capable of accurately reporting energy use of connected plug loads consistent with current utility requirements. Secondly, if the monitoring systems include or enable control aspects for plug loads such as scheduling, occupancy-based control or demand response capabilities, these features will be evaluated against manufacturers claimed performance and anticipated performance requirements for plug load control strategies used in commercial applications. Outcomes of this will include a final report that documents the performance, reporting tolerances and specifications of commercially available ALCS.	193,060	Final report published	Complete
ET-EE	Compressorless HVAC Lab Test	Testing a new indirect-direct evaporative HVAC system for residential use. The plan is to evaluate the system in the lab at the Western Cooling Efficiency Center at UC Davis, to support the findings we get in the field.	50,249	Final report published	Complete
ET-EE	E-Temp Refrigerant Temperature Sensor Evaluation at Petco Park	An assessment of a device that when fitted to the thermostat sensor that controls the compressor in a commercial refrigerator, significantly reduces the frequency of the refrigeration cycles which are now based on food temperature rather than air temperature. Will be evaluating this sensor in a number of walk-in refrigerators at Petco Park.	17,100	Final report published	Complete
ET-EE	EPRI Advanced Energy Communities	This is a demonstration project in our territory that will complement demonstration projects in other locations designed to illustrate the intersection of building decarbonization, flexibility and affordability. While the impacts of various DER and customer technologies have been studied independently, the interactions between them in zero net energy and high performance communities are poorly understood. There may be opportunities to aggregate and potentially control these interactions in a way that simultaneously provides better comfort and convenience for the customer, while also reducing impact to the electricity delivery system. For SDG&E, the focus is on understanding pathways to decarbonization through retrofits, with a particular focus on low income multifamily buildings.	441,890	Active	Ongoing, team in meeting every 2 weeks to discuss progress.
ET-EE	SolX Solar Assisted HVAC Evaluation	The technology uses a custom solar thermal collector to augment a standard packaged HVAC system. The thermal collector provides free energy to the refrigerant cycle, which reduces the amount of energy needed to run the compressor. This study consists of just measurement and evaluation of a system that is being installed by the residential customer.	29,965	Final report published	Complete
ET-EE	CEIVA PEEK IDSM Evaluation	Evaluation of the potential of providing these devices to customers that provide consistent reminders of the TOU time periods for customers to help reduce usage during peak times and participate in DR events. Res-Intel will provide EM&V 2.0 (or normalized metered energy consumption) for developing a pre-treatment baseline and then monthly performance measurement during the pilot period.	77,992	Final report published	Complete
ET-EE	SW-PLA Roadmap CalPlug	CalPlug at UC Irvine will develop a report addressing both the technology and population aspects to targeting continued EE and DR programs on plug load devices. The report will emphasize strategies that support the near term needs of the 3rd party soliciation process. The conclusions of the report would be directed towards implementation over a timeline that breaks out very near term considerations in addition to an extended 5-10 year timeline.	116,424	Final report published	Complete
ET-EE	Development and Field Testing Advanced Heat Pumps	With primary support from CEC's EPIC program, and with cost share from project funders, EPRI is leading a team to develop, test and demonstrate an advanced heat pump system for multi-family or small commercial applications, in the range of 10 to 20 tons of refrigerating capacity, based on a reversible heat pump that uses ammonia and carbon dioxide in a unique way: NH_3 is the primary refrigerant, while CO_2 is used both as a refrigerant and as a distribution fluid, depending on operating mode. For this project, the technology will extend to space heating, thereby extending the system benefits realized for the cooling mode to the heating mode, realizing increased efficiencies, and promoting decarbonization and electrification of heating end use. Increased efficiencies for typical applications may be realized by using the same physical unit for both heating and cooling applications, rather than by separate chiller and boiler, and by lower installation costs compared to current technology.	200,000	Active	Ongoing, holding monthly meetings w/EPRI team for updates
ET-EE	Multi-Family Heat Pump Water Heating	This project will test different versions of multifamily water heating solutions in terms of cost of implementation, energy use and operating cost. CO_2-based heat pump water heaters have the potential to achieve next-level efficiency, meet current tariff requirements, increase code compliance margin, and reduce the use of GHG-intensive refrigerants. This project includes a review of the different products available on the market, lessons learned from their previous application and any data available on monitored energy use. Measured data will be used to help with the implementation of code compliance software and design software to enable affordable housing property developers to implement these newer central systems. The project is being led by the Association for Energy Affordability (AEA) and primarily funded by CEC with cost-share from utilities and EPRI as a subcontractor.	200,000	Active	Ongoing, holding monthly meetings w/EPRI team for updates

Table 3. SDG&E's Approved Demand Response Portfolio

Program	Project Description	Purpose	Funding	Deliverables	Current Update/Comment
ET-DR	Expansion Study of the Statewide Expansion of Auto-DR Express Solutions	The main objective was to increase automated demand response market penetration of SMB customers by expanding SMB eligible measures, adding additional facility types, and increasing customer and vendor awareness of the program.	34,346	Final report published	Complete
ET-DR	Dehumidification & Water Purification Process	Dehumidification units from two different vendors will be installed in buildings around the SDG&E service territory. These units cool air below the dew point to produce water. The collected water is filtered, ozone is injected, then chilled or heated to use as an office 'water dispenser' for drinking water.	72,419	Active	Data analysis is under way; final report to be completed
ET-DR	DR with VRF & IEC Systems	DR potential of the VRF-IEC hybrid system is a potentially compelling value proposition that merits demonstration. Being able to understand the DR characteristics of the hybrid system regulated by a "master controller" during all modes of operation (IEC Only, VRF Only, and simultaneous IEC and VRF), is critical to quantifying their DR impact.	50,000	Active	Data analysis completed; final report is being prepared
ET-DR	EPRI IDSM Smart Home Voice Assistant	The project looked at how voice assistants could play a role in providing notificiations of DR events, educating customers about time of use periods, as well as enery efficiency and demand response tips.	200,000	Final report published	Complete
ET-DR	Esource SDG&E Battery Market Study	The projected looked at understanding the following issues as they pertain to battery storage in SDG&E's service territory: Number and size of batteries; Major battery companies active in the San Diego area; Usage patterns; Demographics of early commercial adopters; The nature of the contracts between the battery vendor and the site owner; Rates that battery-owning customers are on; Peak kW "setpoint" of the installed batteries; Battery participation in other non-SD&E DR programs, including capacity markets, CAISO, etc	141,040	Final report published	Complete
ET-DR	CEIVA PEEK IDSM Evaluation	The project evaluated the Energy Efficiency and Demand Response Potential of providing the devices to customers that provide consistent reminders of the TOU time periods to help reduce usage during peak times and participate in DR events.	77,991.53	Final report published	Complete
ET-DR	Data Analytics to Maximize Demand Response	A data analytics tool was developed to help identify how to incorporate battery storage into Demand Response (DR) programs. The key objectives of the tool were to analyze large customer benefits from battery storage, understand the degree to which customers with battery storage can benefit from participating in DR programs, and identify which customers would benefit the most.	153,770	Final report published	Complete
ET-DR	EV Charging Impact Study	The study will test the real-world impact of EV charging on a commercial office building that has solar generation and battery storage.	29,126	Active	Data analysis completed; final report is being prepared
ET-DR	Eco+ Smart Thermostat Evaluatio	The evaluation focused on customers who have an Ecobee Smart Thermostat installed and have the Eco+ software enabled.	162,920	Final report published	Complete
ET-DR	Shelter Valley Virtual Power Plant	(VPP) project will be comprised of various devices from multiple manufacturers and control tested for two primary objectives, bulk system support and resiliency.	690,322	Active	Ongoing, customer recruitment and device procurement under way

Appendix D - Abbreviations and Acronyms

Acronym	Definition
ADMS	Advanced Distribution Management System
AMI	Advanced Metering Infrastructure
CAIDI	Customer Average Interruption Index
CAISO	California Independent System Operator
CEC	California Energy Commission
CPUC	California Public Utilities Commission
CSIP	Common Smart Inverter Profile
DAC	Disadvantaged Communities
DACAG	Disadvantaged Communities Advisory Group
DER	Distributed Energy Resources
DERMS	Distributed Energy Resource Management System
DG	Distributed Generation
DIAR	Drone Investigation and Repair
DNP3	Distributed Network Protocol 3
DR	Demand Response
DRIVE	Distribution Resource Integration and Value Estimation
DSO	Distribution System Operator
EE	Energy Efficiency
EPIC	Electric Program Investment Charge
EPRI	Electric Power Research Institute
EPZ	Equal Potential Zones
ESS	Energy Storage System
ET-DR	Emerging Technology – Demand Response
ET-EE	Emerging Technology – Energy Efficiency
EV	Electric Vehicle
FAN	Field Area Network
GHG	Greenhouse Gas
GIS	Geographical Information System
GOOSE	Generic Object-Oriented Substation Event
GRC	General Rate Case
HANA	High Performance Analytic Appliance
HIF	Hight Impedance Fault
IDA	Integration Capacity Analysis
IDER	Integrated Distributed Energy Resources
IEC	International Electrotechnical Commission
IED	Intelligent Electronic Device
IEEE	Institute of Electrical and Electronics Engineering
IOU	Investor-Owned Utility
ITF	Integrated Test Facility
LiDAR	Light Detection and Ranging
MBESS	Mobile Battery Energy Storage System
NEM	Net Energy Metering
NPV	Net Present Value

Acronym	Definition
O&M	Operation and Maintenance
PG&E	Pacific Gas and Electric Company
PHIL	Power Hardware in the Loop
PPG	Personal Protective Grounding
PV	Photovoltaic
RD&D	Research Development and Demonstration
RTDS	Real-Time Digital Simulator
SAIDI	System Average Interruption Index
SB	Senate Bill
SCE	Southern California Edison
SDG&E	San Diego Gas and Electric Company
SDO	Standards Development Organization
SME	Subject Matter Expert
SV	Sampled Value
TRL	Technology Readiness Level
UAS	Unmanned Aircraft Systems
VR	Virtual Reality
WMP	Wildfire Mitigation Plan